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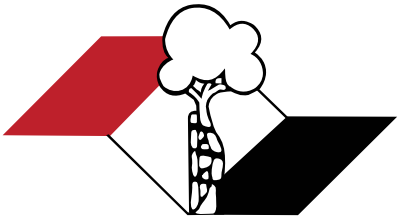

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ACTA ORTOPÉDICA BRASILEIRA

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(Reviewed January 2016)

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ACKNOWLEDGEMENTS
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Ex.: Pavezi N, Flores D, Perez CB. Proposição de um conjunto de metadados para descrição de arquivos fotográficos considerando a Nobrade e a Sepiades. Transinf. [Internet]. 2009 [acesso em 2010 nov 8];21(3):197-205. Available from: http://periodicos.puc-campinas.edu.br/seer/index.php/transinfo/article/view/501

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Levels of Evidence for Primary Research Question[a]

(This chart was adapted from material published by the Centre for Evidence-Based Medicine, Oxford, UK. For more information, please visit www.cebm.net.)

	Types of study			
Level	**Therapeutic Studies Investigating the Results of Treatment**	**Prognostic Studies – Investigating the Effect of a Patient Characteristic on the Outcome of Disease**	**Diagnostic Studies – Investigating a Diagnostic Test**	**Economic and Decision Analyses – Developing an Economic or Decision Model**
I	High quality randomized trial with statistically significant difference or no statistically significant difference but narrow confidence intervals	High quality prospective study[d] (all patients were enrolled at the same point in their disease with ≥80% of enrolled patients)	Testing of previously developed diagnostic criteria on consecutive patients (with universally applied reference ''gold'' standard)	Sensible costs and alternatives; values obtained from many studies; with multiway sensitivity analyses
	Systematic review[b] of Level RCTs (and study results were homogenous[c])	Systematic review[b] of Level I studies	Systematic review[b] of Level I studies	Systematic review[b] of Level I studies
II	Lesser quality RCT (eg, < 80% followup, no blinding, or improper randomization)	Retrospective[f] study	Development of diagnostic criteria on consecutive patients (with universally applied reference ''gold'' standard)	Sensible costs and alternatives; values obtained from limited studies; with multiway sensitivity analyses
	Prospective[d] comparative study[e]	Untreated controls from an RCT	Systematic review[b] of Level II studies	Systematic review[b] of Level II studies
	Systematic review[b] of Level II studies or Level I studies with inconsis tent results	Lesser quality prospective study (eg, patients enrolled at different points in their disease or <80% followup)		
		Systematic review[b] of Level II studies		
III	Case control study[g]	Case control study[g]	Study of non consecutive patients; without consistently applied reference ''gold'' standard	Analyses based on limited alternatives and costs; and poor estimates
	Retrospective[f] comparative study[e]		Systematic review[b] of Level III studies	Systematic review[b] of Level III studies
	Systematic review[b] of Level III studies		Case-control study	
			Poor reference standard	
IV	Case series[h]	Case series		Analyses with no sensitivity analyses
V	Expert opinion	Expert opinion	Expert opinion	Expert opinion

[a] A complete assessment of quality of individual studies requires critical appraisal of all aspects of the study design.

[b] A combination of results from two or more prior studies.

[c] Studies provided consistent results.

[d] Study was started before the first patient enrolled.

[e] Patients treated one way (eg, cemented hip arthroplasty) compared with a group of patients treated in another way (eg, uncemented hip arthroplasty) at the same institution.

[f] The study was started after the first patient enrolled.

[g] Patients identified for the study based on their outcome, called "cases" eg, failed total arthroplasty, are compared with patients who did not have outcome, called ''controls'' eg, successful total hip arthroplasty.

[h] Patients treated one way with no comparison group of patients treated in another way.

SUMMARY

VOLUME 26–Nº 5–2018

Original Articles

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ORIGINAL ARTICLE

ARTHROSCOPIC ASSESSMENT OF THE WRIST WITH KIENBÖCK'S DISEASE

AVALIAÇÃO ARTROSCÓPICA DE PUNHO COM DOENÇA DE KIENBÖCK

Guilherme Augusto Silva Amariz[1], Maria Virginia Arranz Abreu[1], Bruno Azevedo Veronesi[1], Marcelo Rosa de Rezende[1]

1. Grupo de Mão e Microcirurgia, Instituto de Ortopedia e Traumatologia, Hospital das Clinicas (HC-FMUSP), Faculdade de Medicina, Universidade de São Paulo, São Paulo, SP, Brazil.

ABSTRACT

Objective: Treatment of Kienböck's disease is challenging and the variability of results, despite the surgical technique, shows that there must be other aspects that can influence outcomes. The objective of this study is determine, through arthroscopic approach, the pattern of impairment of the carpal bones in Lichtman stage III patients. Method: Wrist arthroscopy was performed in patients with symptoms and evidence of lunate necrosis on x-rays, with signs of 3A and 3B stages. The Outerbridge classification was used to grade the articular status of the carpal bones. Results: Fifteen patients with stage 3 disease were assessed, five of whom were staged as type 3A and ten as 3B using the Lichtman stages. According to the Outerbridge classification, the lunate sulcus was the most affected with means of 2.8 at 3A and 2.9 at 3B. Other areas were significantly less affected with means of 1.1 and 1.3, respectively. Conclusion: Arthroscopic assessment of the wrist could aid in surgical decision making, offering more details on cartilage status in stage 3 Kienböck's disease. ***Level of Evidence III, Study of nonconsecutive patients, without consistently applied reference "gold" standard.***

Keywords: Osteonecrosis. Wrist. Arthroscopy.

RESUMO

Objetivo: O tratamento da doença de Kienböck é desafiador, e a variabilidade dos resultados, apesar da técnica cirúrgica, mostra que deve haver outros aspectos que influenciam os desfechos. O objetivo deste estudo é determinar, por via artroscópica, o padrão de comprometimento dos ossos do carpo em pacientes com estágio 3 de Lichtman. Método: A artroscopia de punho foi realizada em pacientes com sintomas e evidências de necrose do semilunar à radiografia, com sinais de estágios 3A e 3B. A classificação de Outerbridge foi usada para determinar a condição articular dos ossos do carpo. Resultados: Foram avaliados 15 pacientes com doença em estágio 3, sendo que cinco classificados como tipo 3A e dez como tipo 3B usando os estágios de Lichtman. De acordo com a classificação de Outerbridge, o sulco semilunar foi mais afetado, com médias de 2,8 em 3A e 2,9 em 3B. Outras áreas foram significativamente menos afetadas, com médias de 1,1 e 1,3, respectivamente. Conclusão: A avaliação artroscópica do punho pode auxiliar na tomada de decisão cirúrgica, oferecendo mais detalhes sobre a condição da cartilagem no estágio 3 da doença de Kienböck. ***Nível de Evidência III, Estudo de pacientes não-consecutivos, sem padrão de referência "ouro" aplicado uniformemente.***

Descritores: *Osteonecrose. Punho. Artroscopia.*

Citation: Rezende MR, Veronesi BA, Abreu MVA, Amariz GAS. Arthroscopic assessment of the wrist with Kienböck's disease. Acta Ortop Bras. [online]. 2018;26(5):286-9. Available from URL: http://www.scielo.br/aob.

INTRODUCTION

Understanding the etiology and treatment of the osteonecrosis of the lunate or Kienböck disease is still a challenge. However, its natural history, characterized by progressive worsening of pain with changes in carpal dynamics, is well defined, allowing its staging.[1,2] It was later modified by Lichtman et al.[3] and Menth-Chari et al.,[4] who defined 4 stages, ranging from incipient signs of necrosis of the lunate to its complete collapse, leading to carpal derangement, and finally arthrosis. The reliability and reproducibility of this classification, based on radiological findings, were confirmed by the work of Szabo et al.,[2] Jafarnia et al.,[5] Goldfarb et al.[6] and Iwasaki et al.[7] However, it has been shown that in many cases, a physician may err in the staging of the disease if he considers other factors such as time of onset of the condition, intensity of pain and range of motion.[8] These findings support the concept that there is a discrepancy between the radiological staging[9] and the clinical evolution of the patient in Kienböck disease.[9] We believe there are other changes, not visible in the radiographic examination, which may contribute to the clinical presentation of the patient.

Bain et al.[10]; Bain and Begg[11] have proposed that arthroscopy may be the complementary method for best staging of the wrist with Kienböck. They have shown that the articular degenerative process is progressive, beginning in the proximal lunate, followed by the distal lunate, the lunate fossa, then the capitate.

All authors declare no potential conflict of interest related to this article.

Study conducted at the Grupo de Mão e Microcirurgia, Instituto de Ortopedia e Traumatologia, Hospital das Clínicas (HC-FMUSP), Faculdade de Medicina, Universidade de São Paulo, São Paulo, SP, Brazil.

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The lunate does not collapse until stage 3 of Lichtman classification. From stage 3 and on, biomechanical alterations of the carpus, the articular changes of carpal bones become more evident.
It is a belief of the authors of this paper that the knowledge of clinical conditions and articular status of carpal bones, particularly the lunate, may help in the decision making for treatment choice. The aim of this study is to determine, through an arthroscopic approach, the pattern of compromise of carpal bones in Lichtman stage 3 Kienböck disease.

MATERIALS AND METHOD

This study was approved by the Research Ethics Committee of our institution under No. 043578/2018 and the free and informed consent form was obtained from all subjects.
Fifteen patients who had stage 3 Kienböck disease underwent wrist artroscopy. Five were type 3A and ten were type 3B according to the Lichtman classification.[3,4] The patients ages ranged from 25 to 39, with an average of 35. There were 8 males and 7 females. Anterior-posterior and lateral wrist x-rays were made in all patients. Wrist range of motion (ROM) was assessed preoperatively.
Inclusion criteria: subjects older than 18 years of age, wrist symptoms and avascular necrosis of the lunate Lichtman stage 3 on x-ray.
Exclusion criteria: patient non-consent and prior wrist surgery.
Taking into account Lichtman classification, stage 1 has symptoms of wrist pain without radiological changes, and stage 2 has lunate sclerosis, but no collapse. Stage 3 has lunate collapse without carpal instability (3A) or with instability and scaphoid rotation (3B). In the study by Goldfarb et al.[6] and Beckenbaugh et al.,[12] it was shown that the most objective way to decide between stages 3A and 3B for classification was through the radio-scaphoid angle. An angle up to 60 degrees was rated as 3A and an angle greater than 60 degrees was ranked 3B. In stage 4, collapse and perilunate arthrosis is evident.
Each patient underwent wrist arthroscopy followed by a therapeutic procedure. For the arthroscopy, the affected extremity was positioned with the arm supported on the table and the hand distracted towards the ceiling with a 7 kg weight. Radiocarpal 3,4 and 4,5 portals were used for introduction of the arthroscope and probe, respectively. Radial and ulnar mid-carpal portals were used to view the mid-carpal joint. Assessment of the radio-carpal and mid-carpal joints was performed, with particular attention to the lunate and the articular surfaces around it.
The Outerbridge classification[13,14] was used to stage chondral lesions: stage 0 for normal cartilage; stage 1 for edematous and softened cartilage; stage 2 for chondral injury in greater depth and fissure, but without subchondral exposure or a diameter greater than 1.5 cm; stage 3 for fissures reaching the subchondral bone in an area greater than 1.5 cm in diameter; stage 4 for exposure of subchondral bone. Based on arthroscopic findings, a decision to proceed with either partial arthrodesis (scapholunate or scaphocapitate) or total wrist arthrodesis was made. The therapeutic aspect of the technique was not described in this study.

RESULTS

The scaphoid groove (Figure 1), lunate groove (Figure 2 and 3), radiocarpal and mediocarpal articular surfaces of the lunate (Figure 4), hamate and capitate articular surfaces (Figure 5) were visualized through wrist arthroscopy and correlated with the classification of Outerbridge. The degree of damage of the cartilage of the lunate groove and radiocarpal and mediocarpal articular surfaces of the lunate were evaluated in stages 3A (Figure 6) and 3B (Figure 7) of Kienbock's disease. It showed that the lunar groove was slightly more affected at stage 3B, with a mean value of 2.9, than in 3A (mean 2.8). (Figure 8) Other areas analyzed were significantly less affected with mean values of 1.1 and 1.3 respectively. It is important to remark that both groups have great variability of degrees for cartilage damage.

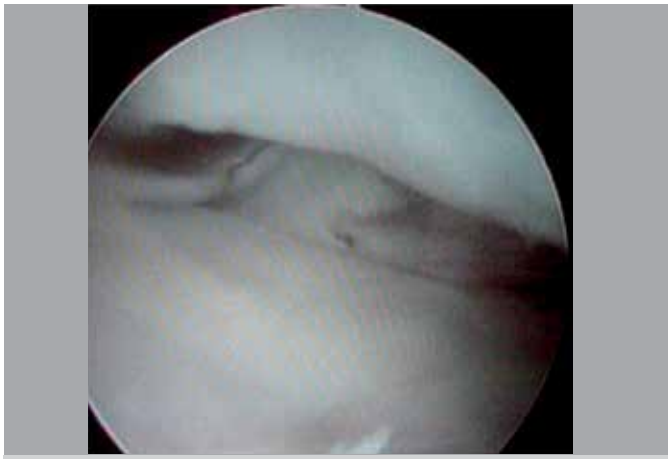

Figure 1. Scaphoid groove view, without chondral damage.

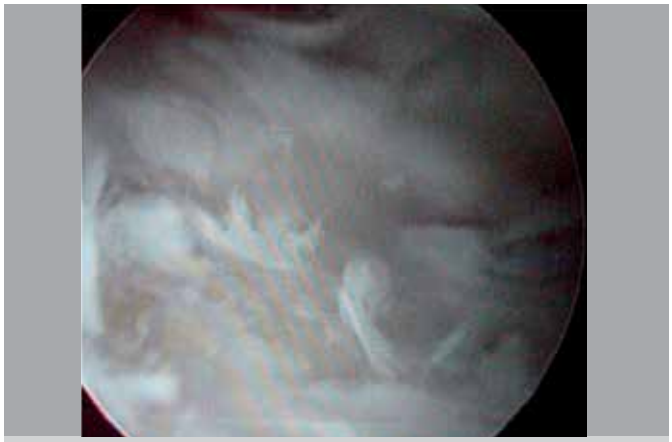

Figure 2. Lunate groove view showing chondral damage (Outerbridge 2).

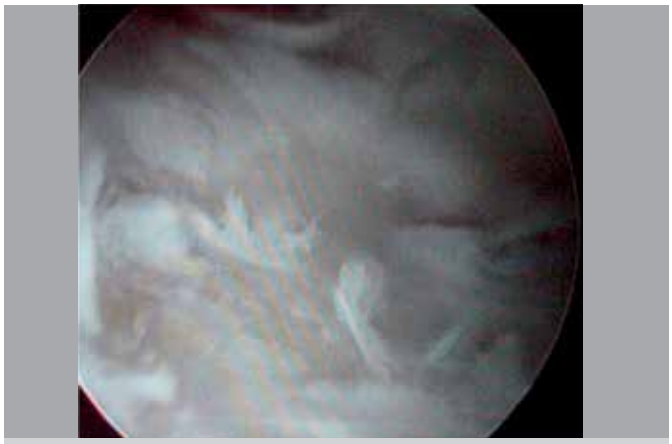

Figure 3. Lunate groove (viewed from radiocarpal joint) showing Outerbridge type 3 chondral defect.

DISCUSSION

Since its description in 1910,[15] Kienbock's disease has been studied from many viewpoints. The etiology of vascular changes of the lunate is still controversial. It has been argued that it is due to fracture, compression factors (ulna minus),[7,8] or even structural changes of the lunate.[12,15,16] In fact, after the vascular impairment of the lunate, a sequence of events is observed, ranging from its sclerosis to total collapse and subsequent carpal derangement.

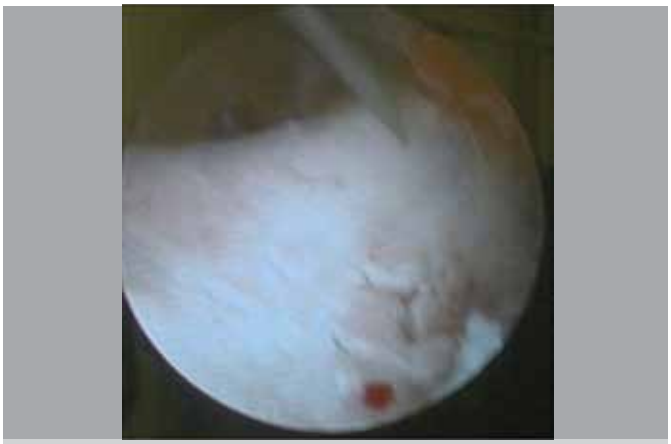

Figure 4. Lunate (viewed from midcarpal joint) showing Outerbridge type 2 defect.

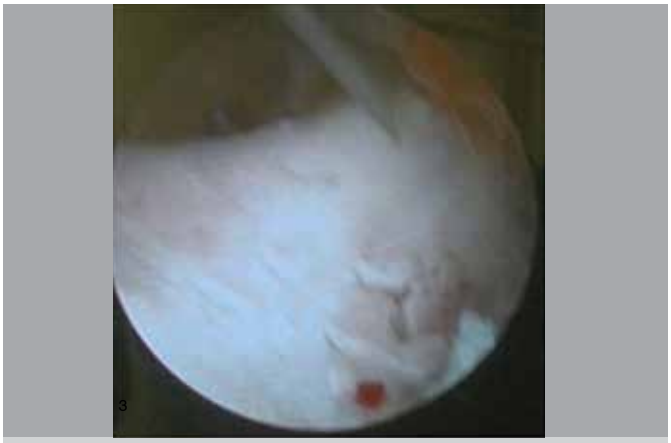

Figure 5. View of the capitate on the left and the hamate on the right, without chondral damage.

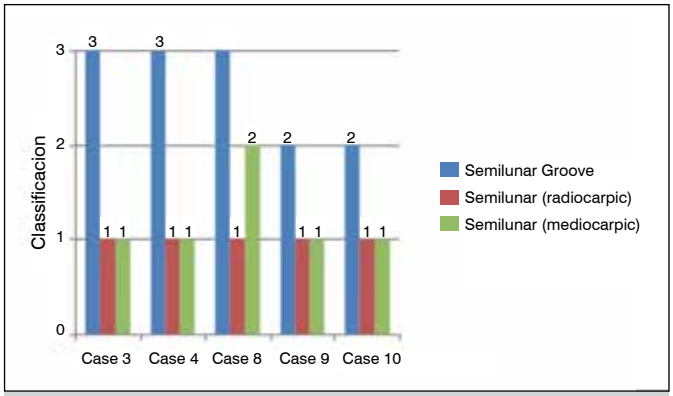

Figure 6. Articular damage degree (Outerbridge classification). The joints are evaluated in group 3A.

The most widely used classification for Kienbock's disease is Lichtman's,[3] which charts the progress of the disease by radiological changes in four stages. Jafarnia et al.[5] has shown great reliability and reproducibility of this classification. Goldfarb et al.[6] confirmed these facts and emphasized the importance of the radio-scaphoid angle for the differentiation of stages 3A and 3B.

In agreement with Menth-Chiari et al.[4] we believe that stage 3 is the most difficult stage for surgical decision-making. In addition to lunate collapse, angular alteration of the scaphoid and its

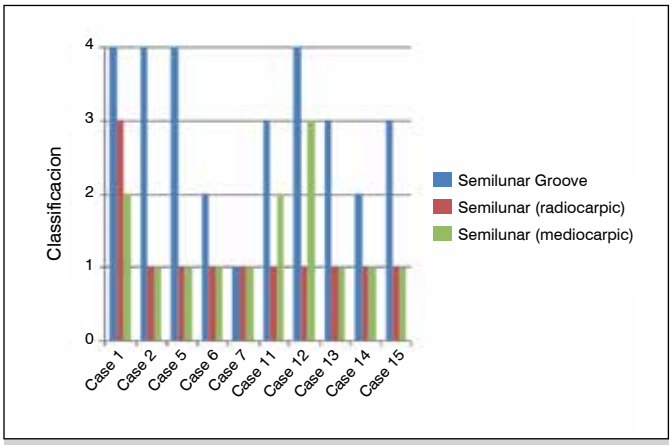

Figure 7. Articular damage degree (Outerbridge classification). The joints are evaluated in group 3B.

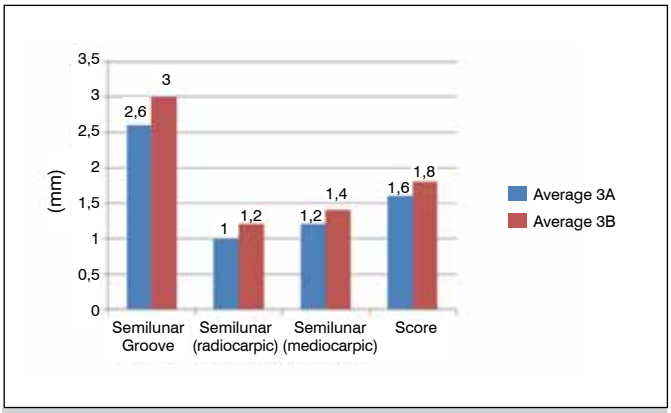

Figure 8. Articular damage degree (Outerbridge classification). The joints are evaluated in group 3A and 3B.

consequences in articular compromise must be considered. As noted by Cameron et al.,[13] we did not observe a direct relationship between the progression of the disease in Lichtman's classification and the clinical worsening of the patient.

We believe that mere radiographic staging does not help to take the best surgical decision. Some departments have treatment protocols according to the stage of the disease, and, therefore, do not take into account the individual characteristics of each patient in surgical planning. We believe it is necessary to make a thorough study of wrist articular alterations which arthroscopy allows.

Few studies have mentioned the use of arthroscopy for staging the degree of articular compromise of the wrist. Bain et al.[10]; Bain and Begg[11] has presented a proposal for arthroscopic staging of Kienbock's disease. In his studies he has shown that compromise begins in the lunate, mostly in its proximal part. He notes subsequent changes in the lunate fossa and finally capitate changes.

In our study in both stages 3A and 3B, although the degenerative process begins in the lunate, the most important degree of articular compromise occurs in the lunate fossa. We did not observe changes in the articular surface of the capitate, in spite of the fact that it is part of the central row of the carpus. From this result we can conclude that the surgical option of carpectomy, especially in stage 3B, would depend basically on the articular conditions of the lunate fossa since the capitate cartilage is preserved.

Iwasaki et al.[7] studied the changes of the carpal pressures in Kienbock's disease, and showed that in stage 3, there is a decrease of pressure in the lunate fossa and an increase in the scaphoid

fossa. In all cases there was preservation of the articular cartilage of the scaphoid fossa, even in 3B cases. The rotatory changes of the scaphoid and the increase in pressure would favor articular surface changes. This finding coincides with those obtained by Bain et al.[10]; Bain and Begg[11] showed that the articular changes in the scaphoid fossa occur only in stage 4.

Regardless of the absolute values obtained, the patterns of articular compromise were similar in stages 3A and 3B.

First we have observed that the radioscaphoid angle as the widely literature shows is different on stages 3A and 3B, in our study with averages of 50º and 68º and, in the statistical study we could demonstrate a direct relationship between the disease and the loss of articular mobility and an indirect relationship between the radioscaphoid angle an joint mobility, both at the expense of loss of extension. An important fact was the great variation of articular compromise, but the range of motion as a role doesn't show significant alteration.

Analyzing our data compared to those obtained by Keith et al.[16] when studying the natural history of the disease, we have come to believe that there are variable periods of duration for each stage of the disease, as we were able to observe at Figures 6 and 7. This explains possible differences of the degree of articular compromise within the same group, more over Kawoosa et al.[8] and Altay et al.,[17] showed same results for both 3A and 3B that reinforces the idea of arthroscopic staging of the wrist in Kienbock's disease, because it gives a much more precise information .

For the arthroscopic evaluation we used portals 3 and 4 and the ulnar and radial midcarpal portals, which were sufficient for a correct articular staging, diagnostic arthroscopy is a quick procedure. In a few minutes, it can establish the degree of articular compromise of the wrist.

In our work, we sought to evaluate objectively the articular conditions of the wrist in Kienbock's disease and the use of arthroscopy for correct articular staging provides more data to choose the best surgical procedure.

CONCLUSION

The best treatment for stage 3 Kienböck disease is controversial. We observed wide variation in the degree of articular compromise and clinical presentation. Therefore, in addition to lunate collapse, the shifting scapholunate angle and its consequences must be considered. Arthroscopic assessment of the wrist could aid in surgical decision making, offering more details about cartilage status.

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ORIGINAL ARTICLE

HOW SCAPHOID FRACTURES ARE TREATED IN BRAZIL

COMO SÃO TRATADAS AS FRATURAS DO ESCAFOIDE NO BRASIL

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ABSTRACT

Objective: To verify how hand surgeons manage scaphoid fractures and their complications. Methods: Two hundred questionnaires were distributed during the 36th Brazilian Hand Surgery Congress (2016). Results: On suspicion of fracture without radiographic confirmation, 57% of surgeons request a CT or MRI scan, while 43% opt for immobilization and consecutive radiographs. In stable fractures the preference was for treatment with plaster cast. In fractures with no scaphoid waist displacement, 33% opt for percutaneous fixation. In displaced waist or proximal pole fractures, 66% and 99.4%, respectively, opted for surgical treatment. Most surgeons treat waist nonunion with a nonvascularized bone graft. When absorption at the site of nonunion is greater than 4 mm, 50% prefer to use iliac graft and screw fixation. In proximal pole nonunion, the Zaidemberg technique is preferred by 64%. More experienced surgeons are more likely to request tests in occult fractures (63.9% versus 47.6%; p=0.04), and tend to recommend surgery for distal third fractures more frequently (16.4% versus 4.7%; p=0.02). Conclusions: We have provided an overview of treatment preferences for scaphoid fractures. It should be noted that more experienced surgeons are more likely to request additional tests for occult fractures and to recommend surgical treatment of distal third fractures. ***Level of Evidence IV,Cross-sectional survey.***

Keywords: Scaphoid bone. Fractures, bone. Diagnosis. Pseudarthrosis. Cross-sectional studies.

RESUMO

Objetivo: Verificar como os cirurgiões da mão conduzem o tratamento da fratura de escafoide e suas complicações. Métodos: Durante o 36º Congresso Brasileiro de Cirurgia da Mão (2016) foram distribuídos 200 questionários. Resultados: Na suspeita da fratura sem confirmação radiográfica, 57% dos cirurgiões solicitam TC ou RM, enquanto 43% optam por imobilização e radiografia seriada. Nas fraturas estáveis, a preferência foi tratamento com gesso. Nas fraturas sem desvio da cintura do escafoide, 33% optam pela fixação percutânea. Nas fraturas desviadas do polo proximal ou da cintura, a opção é o tratamento cirúrgico em 66% e 99,4%. A maioria trata a pseudoartrose da cintura com enxerto não vascularizado. Quando a absorção no foco da pseudoartrose é maior que 4 mm, 50% preferem utilizar enxerto do ilíaco e fixar com parafuso. Nas pseudoartroses do polo proximal, a técnica de Zaidemberg é a preferida por 64%. Os cirurgiões mais experientes têm maior propensão para pedir exames em fraturas ocultas (63,9% versus 47,6%; p = 0,04) e tendem a indicar cirurgia com mais frequência para as fraturas do terço distal (16,4% versus 4,7%; p = 0,02). Conclusões: Forneceu-se panorama das preferências de tratamento para as fraturas do escafoide. Destaca-se maior tendência de cirurgiões mais experientes para solicitação de exames subsidiários para fraturas ocultas e maior indicação cirúrgica para as fraturas do terço distal. ***Nível de Evidência IV, Estudo transversal tipo survey.***

Descritores: *Osso escafoide. Fraturas ósseas. Diagnóstico. Pseudoartrose. Estudos transversais.*

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INTRODUCTION

The scaphoid is the most commonly fractured carpal bone. In adults, 70% of scaphoid fractures affect the waist; 20%, the proximal pole; and 10%, the distal pole. Fractures occur mainly in young adults, an economically active population, after low-energy trauma or in association with sports practice.[1] Given that the scaphoid is the main carpal bone, its integrity is vital for stability and mobility of the wrist. After a fracture, vascularization may be considerably compromised, delaying consolidation or causing non-union, which occurs in approximately 5-10% of non-displaced fractures of the middle third and may reach 90% in displaced fractures of the proximal pole.[1,2]

Increased risk of non-union is associated with fractures of the proximal pole, fractures with an associated carpal ligament injury, delay in diagnosis, inadequate immobilization,[2] and smoking. The diagnosis is suggested when there is a fracture of the wrist with hyperextension trauma in young adults who present with pain and volume increase in the anatomical snuff-box. Radiographic examination is indicated in the initial evaluation; however, 16% to 27% cases show a false-negative result. More specific examinations such as magnetic resonance imaging (MRI) must be performed in order to shorten the time for diagnosis, thus decreasing the direct and indirect costs of treatment. It is estimated that among every

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5 patients, 4 are immobilized unnecessarily until a more precise diagnosis is made.[3]

Classically, the treatment of acute fracture without scaphoid displacement is conservative. However, some authors advocate surgical treatment with percutaneous fixation. This enables a shorter time for immobilization and functional restriction. Although this procedure requires a reasonable learning curve, the low surgical morbidity supports this treatment trend.[4]

Pseudarthroses are traditionally treated via a surgical approach with the use of bone grafts and fixation. Recent studies have shown promising results with percutaneous techniques for fixation and/or possible arthroscopy.[5]

We have witnessed an evolution in the concepts of treatment of scaphoid fractures and their complications, with less invasive methods that enable more rapid rehabilitation. This evolution in the therapeutic approach to fractures of the scaphoid, coupled with their prevalence in young and productive populations, motivated us to conduct a study. Herein we aimed to verify how experts in hand surgery (certified by the Brazilian Society of Hand Surgery-SBCM) plan the treatment of these fractures and manage their complications.

MATERIALS AND METHODS

This cross-sectional study was presented at the 36th Brazilian Congress of Hand Surgery (CBCM - 2016, São Paulo, SP). The study was approved by the ethics committee (protocol number CAAE: 65622817.4.0000.5533). A structured questionnaire with 15 objective questions was devised, with focus on therapeutic planning for scaphoid fractures and management of complications, and was applied with the consent of the Scientific Commission of the Congress. To participate in the study, a physician was required to be certified as a hand surgeon by the SBCM, complete the questionnaire, and be enrolled and present at the 36th CBCM.

Intervention

A questionnaire was developed (Annex) a priori, with dichotomous questions relating to the management of scaphoid fractures (diagnosis, treatment, and complications). The questionnaire was initially applied as a pilot survey to the coauthors of the study, and showed good reproducibility and clarity. Of 200 questionnaires distributed in a convenience sample, 181 were completed, with 5 excluded due to incomplete answers, 14 because they were completed by resident physicians, and 2 because they were completed by non-Brazilians, resulting in a total of 160 for this study.

Statistical analysis

The previously calculated respondent sample size was 158, considering a 95% confidence interval and sampling error of 5%, for an expected proportion of 10% for statistical power. For these calculations we used PASS 8 (Power Analysis and Sample Size System) statistical software - NCSS.[6,7] To verify differences between proportions among interviewees, we used the chi-square test, with significance level of alpha <5 %.

RESULTS

Of the interviewees, the majority were from the southeastern region (69%) and worked in the specialty for more than 5 years (61%).

Regarding the clinical suspicion of scaphoid fracture without radiographic confirmation, 43% of the interviewees immobilize and reevaluate within 15 days, and 38% require early MRI. For classification, 56% use Herbert's method and 33% prefer to use the anatomical level.

The majority (89%) of specialists treated stable and non-displaced fractures of the distal third of the scaphoid with plaster immobilization, and 77% included the thumb, while there was no consensus regarding whether (48%) or not (52%) to immobilize the elbow.

In stable fractures of the scaphoid waist, the majority (67%) preferred plaster immobilization; 33% of respondents treated these fractures surgically using percutaneous fixation with compression screws; 66% of surgeons treated non-displaced fractures of the proximal pole with percutaneous compression screws (53% anterograde and 13% retrograde).

In displaced fractures of the scaphoid waist, the vast majority (99.3%) used reduction and fixation; of these, 52% used closed reduction and percutaneous fixation. The preference was for fixation with compression screws (88%).

The majority of specialists (57%) used Herbert's classification for treatment planning of scaphoid pseudarthrosis and 17% used the Slade classification.

In the treatment of scaphoid waist pseudarthrosis, with focal absorption of up to 3 mm, most used bone grafts (68%), while percutaneous fixation with compressive screws was performed by 32% of the interviewees. When a gap exceeded 4 mm, the most commonly used techniques included iliac grafting with compressive screw (50%) or radial grafting with compressive screws (19%).

For pseudarthrosis of the proximal pole, most (64%) used a dorsal vascularized graft, followed by a non-vascularized bone graft and compressive screws (16%).

In the treatment of pseudarthrosis of the waist, 70% of respondents reported that up to 30% of cases had functional limitation of the wrist or failure, and 47% reported up to 60% restriction in cases involving pseudarthrosis of the proximal pole of the scaphoid. For pseudarthrosis with advanced arthrosis of the wrist, i.e., Scaphoid Nonunion Advanced Collapse (SNAC) type II, 48% of respondents used carpectomy. The second most common treatment (45%) was four-corner fusion or partial arthrodesis.

When comparing the responses of less and more experienced surgeons, there was a difference in preferences for 2 scenarios: more experienced surgeons are more likely to request additional examinations for occult fractures (63.9% versus 47.6%, chi-square, $p = 0.04$) and tended to perform surgery for fractures of the distal third (16.4% versus 4.7%, chi-square, $p = 0.02$). Regarding other items in the questionnaire, there were no differences in management preferences between more and less experienced surgeons (Table 1).

Table 1. Treatment options for fractures of the scaphoid: stratification according to experience (more or less than 5 years).

	More experienced	Less experienced	P-value	Comparison
P1	63.9% (1)	47.6%	0.04	Additional examinations (1) versus immobilization
P2	16.4% (1)	4.7%	0.02	surgical (1) versus conservative
P3	38.1% (1)	23.8%	0.052	surgical (1) versus conservative
P4	64.9% (1)	69.8%	0.052	surgical (1) versus conservative
P5	55.7% (1)	49.2%	0.42	bloody (1) versus bloodless
P6	68.04% (1)	68.2%	1.0	graft (1) versus without graft

P1: Clinical suspicion of fracture, without confirmation on radiography. P2: Stable and non-displaced fractures of the distal third. P3: Stable and non-displaced fractures of the waist. P4: Non-displaced fractures of the proximal pole. P5: Acute displaced fractures of the waist. P6: Waist pseudarthrosis with gaps in a non-displaced fracture focus of less than 3 mm.

DISCUSSION

This work is unprecedented and addresses one of the most important and prevalent subjects in the practice of orthopedics and traumatology. The results aim to show how this condition is treated in Brazil, and thus to provide guidance for management protocols and a basis for research projects.

Our sample was representative, as proven by the distribution of respondents from different states, and the results were similar to those reported by the Brazilian Society of Hand Surgery. Moreover, 61% of respondents had experience exceeding 5 years working in the area.

In relation to the initial approach to wrist trauma without diagnostic confirmation, 2 possible scenarios are well established in the literature: immobilization for up to 15 days[8] and subsequent reevaluation, or early order for an MRI.[9] These options were chosen by most in this study. Despite being commonly used in clinical practice, we believe that serial radiography does not have good inter-observer concordance and is not safe for management.[10] Some authors report similar costs between MRI and serial radiographic monitoring, without considering the loss of productivity due to unnecessary immobilization.[11] Therefore, there is a tendency to request early MRI to verify the diagnosis.

Herbert's classification was the method used most by our interviewees, as it discusses and guides treatment of both acute fractures and pseudarthrosis. Other specific classification systems for pseudarthrosis are available, enabling treatment planning for this complication in accordance with the evolution, location, and degree of bone failure, with the objective of providing less invasive treatment options and a possibility of faster rehabilitation.[5]

In relation to stable and non-displaced fractures of the distal pole of the scaphoid, our results are in agreement with the literature; there is consensus about conservative treatment with immobilization for 4-6 weeks. Although only one clinical trial studied use of a plaster cast with or without thumb immobilization, there is no evidence for a difference in the rate of consolidation between these 2 methods.[12] In relation to immobilization of the elbow, there is also no evidence that the rate of consolidation, the time course, and the complications are different with the 2 treatment methods.[13] Even with the lack of evidence in the literature, 77% of specialists prefer to immobilize the thumb. In stable and non-displaced fractures of the scaphoid waist, 62% of respondents preferred immobilization including the thumb; however, surgical treatment was chosen by 33% of the specialists, which reflects the demand for early rehabilitation. This trend is supported by the literature, as a systematic review reported that after 2-3 months, patients treated operatively had significantly better functional outcomes than those treated non-operatively; further improvement was not observed after 6 months of follow-up.[4] In relation to the duration of absence from work, there is an advantage in favor of surgical treatment.

In the approach to a proximal pole fracture, 66% used a surgical approach, in keeping with a meta-analysis showing that 34% of proximal pole fractures treated without surgery evolve to a pseudarthrosis, with a 7.5-fold higher risk, when compared to other fractures of the scaphoid.[14] In waist fractures with displacement, 99% of the interviewees chose surgery, consistent with the literature. In a systematic review, a 4-fold increased risk of pseudarthrosis was reported when a displaced fracture was treated with cast immobilization, compared to the risk for an undetected fracture, and the risk of non-consolidation was 17 times greater if a displaced fracture was treated without surgery.[15]

When encountering pseudarthrosis of the scaphoid waist with absorption in the fracture focus of less than 3 mm, 32% respondents preferred to treat with percutaneous fixation using compression screws. There is a trend in the literature for less invasive treatment as early as possible to avoid non-union of the scaphoid. Studies have reported a higher rate of consolidation in less time and with less morbidity, in addition to shorter time of immobilization, with the use of percutaneous techniques compared to open techniques.[5,16] Other treatment choices preferred by about 20% respondents included iliac grafts and distal radial grafts (Matti-Russe), in agreement with the literature. Iliac or distal radial grafts have similar consolidation rates, although the approach using another surgical site can result in further complications. In relation to the type of fixation, both Kirschner wires and autocompression bolts have higher consolidation rates, 91% and 88%, respectively, than for non-fixation (79%). In addition, rigid fixation allowed for early mobilization. There was no difference in relation to the dorsal or volar approach.[17]

With absorption or displacement greater than 4 mm at the focus of the pseudarthrosis, all interviewees preferred an open approach, using non-vascularized grafts, with a large preference for the ilium, although there is no evidence in the literature that there is a higher incidence of consolidation; however, there is a higher likelihood of complications.[17] For pseudarthrosis of the proximal pole, 74% of respondents preferred use of a vascularized graft. According to a systematic review, there is no difference in the rate of consolidation with or without the use of a vascularized graft, but the time to union of the pseudarthrosis decreases from 17.7 to 11.9 weeks when scaphoid vascular support is provided.[14]

With regard to complications of fractures of the scaphoid waist, 70% of the experts expect a failure rate of up to 30%; for pseudarthrosis of the proximal pole, 47% agree with this rate and another 46% expect a loss of 60%. With progression to SNAC, the most common surgeries were carpectomy and four-corner arthrodesis, in accordance with the evidence in the literature.[18]

CONCLUSION

There is no consensus on the need for inclusion of the thumb and elbow in the treatment of non-displaced fractures of the scaphoid waist and distal pole, or in the technique for treatment of pseudarthrosis with small bone failure and the technique of choice for treatment of SNAC.

The majority of respondents were found to have a consensus regarding the treatment of non-displaced fractures of the waist and distal pole with plaster casts; surgical treatment of displaced fractures of the waist and all fractures of the proximal pole; the use of bone grafts for pseudarthrosis with any degree of bone failure; and the use of vascularized bone grafts for pseudarthrosis of the proximal pole, even with poor prognosis. The more experienced surgeons tend to request tests with greater accuracy for occult fractures and perform surgery for fractures of the distal third of the scaphoid.

There is a need for additional comparative studies to assess the cost-effectiveness of MRI for early diagnosis, as well as the use of percutaneous fixation of non-displaced fractures of the waist with use of percutaneous fixation technique for treatment of pseudarthrosis with small bone failure.

AUTHORS' CONTRIBUTIONS: Each author made significant individual contributions to this manuscript. JCB (0000-0003-3396-479X)* participated in the conception and design of the study, the data acquisition, the data analysis and interpretation, and in the discussions, critical reviews of the intellectual content and approval of the final version. MF (0000-0003-1646-6764)* participated in the design of the questionnaire and the data acquisition. VYM (0000-0002-4933-4007)* participated in the statistical analysis and data interpretation, and in the revisions and approval of the final version. JRN (0000-0002-0476-8768)* participated in the data acquisition. AO (0000-0003-0115-2236)* participated in the data acquisition. GCN (0000-0002-7881-5475)* participated in the conception and design of the study, the data acquisition, the data analysis and interpretation, and in the discussions, critical reviews of the intellectual content and approval of the final version. *ORCID (Open Researcher and Contributor ID).

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ORIGINAL ARTICLE

TREATMENT OF FINGERTIP INJURIES BY SPECIALISTS IN HAND SURGERY IN BRAZIL

TRATAMENTO DE LESÕES DA PONTA DOS DEDOS POR ESPECIALISTAS EM CIRURGIA DA MÃO NO BRASIL

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ABSTRACT

Objective: To verify if there is consensus about the treatment of each type of injury or amputation of the fingertips, and if there is a statistical difference among the treatment options according to the surgeon's length of time in the hand surgery specialty. Methods: A cross-sectional survey was conducted during the 37th Brazilian Congress of Hand Surgery, when one hundred and twenty questionnaires were randomly distributed. Observing the inclusion and exclusion criteria, ninety completed questionnaires were included. The answers were submitted to descriptive and inferential analysis with a significance level of $p < 0.05$. Results: This study showed agreement of 63.3% for the treatment with statistical difference for dorsal oblique injury less than 1 cm with bone exposure for the VY advancement flap alternative; 46.7% for volar tip oblique injury with bone exposure less than 1 cm for the Cross Finger alternative; 47.8% for oblique thumb volar injury greater than 1 cm with no bone exposure to the Moberg alternative; 54.4% for thumb pulp injury up to 2.5 cm with bone exposure to the Moberg alternative with proximal release, and 92.2% for antibiotic use, for the "cephalexin" alternative. Conclusion: There is no consensus regarding the treatment of most types of fingertip lesions, with agreement of 45.4%. When we subdivided by time group of specialty in hand surgery, there was an increase in agreement to 54.5% of the questions per subgroup. Further comparative studies are needed to assess the consensus among surgeons regarding the treatment of fingertip injury. ***Level of Evidence III; Cross-sectional survey.***

Keyword: Finger injuries. Amputation, traumatic. Treatment. Cross-sectional studies.

RESUMO

Objetivo: Verificar se há consenso sobre o tratamento de cada tipo de lesão ou amputação da ponta do dedo e se há diferença estatística entre as opções de tratamento de acordo com o tempo em que o cirurgião atua na especialidade de cirurgia da mão. Métodos: Pesquisa transversal realizada durante o 37º Congresso Brasileiro de Cirurgia da Mão, quando foram distribuídos cento e vinte questionários de forma aleatória. Observando-se os critérios de inclusão e exclusão, noventa questionários respondidos foram incluídos. As respostas foram submetidas a análise descritiva e inferencial com índice de significância de $p < 0,05$. Resultados: Este estudo apresentou concordância no tratamento com diferença estatística para lesão oblíqua dorsal menor que 1 cm com exposição óssea para a alternativa de retalho de avanço VY com 63,3%; lesão oblíqua volar com exposição óssea menor que 1 cm para a alternativa Cross Finger com 46,7%; lesão oblíqua volar do polegar maior de 1 cm sem exposição óssea para a alternativa Moberg com 47,8%; lesão da polpa do polegar com até 2,5 cm com exposição óssea para a alternativa Moberg com liberação proximal com 54,4% e uso de antibióticos para a alternativa "cefalexina" com 92,2%. Conclusão: Não há consenso quanto ao tratamento da maioria dos tipos de lesão da ponta do dedo, sendo que houve concordância em 45,4%. Quando subdividimos por grupo de tempo de especialização em cirurgia de mão, verificou-se aumento da concordância para 54,5% das questões por subgrupo. Há necessidade de realização de novos estudos comparativos para avaliarmos o consenso entre os cirurgiões com relação ao tratamento da lesão das pontas dos dedos. ***Nível de evidência III; Pesquisa transversal.***

Descritores: *Lesões dos dedos. Amputação traumática. Tratamento. Estudos transversais.*

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INTRODUCTION

A lack of safety in the workplace, coupled with human failures related to incompetence, recklessness, alcohol use, and unpreparedness for performing high-risk activities, leads to finger amputations, with significant economic and social implications.[1] These types of injuries are more common in men between 20 and 45 years of age. In terms of prevalence, amputation of the index finger is the most

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common, with 28%, followed by the middle finger with 24%, the ring finger with 21%, the little finger with 14%, and the thumb with 13%.[2]
A fingertip amputation is the most common type of amputation and, at the same time, is the type that causes the most controversy.[3]
Extensive surgical experience is essential in treating these injuries because, otherwise, there is a risk of delayed return to work, persistent pain, and serious loss of finger function.[4] Therefore, it is important to be familiar with the treatment options available for these injuries, in order to provide patients with good functional and esthetic results. Although reimplantation of the amputated fingertip may be the best way to achieve esthetic and functional reconstruction, it is not always possible.
Although it is generally agreed that the length of the thumb should be maintained, there is less agreement around the need and the means to maintain the length of the other fingers. Various ingenious techniques have been developed to bring the local skin forward or transfer the skin from an adjacent finger to ensure coverage of an area of exposed bone. A technique for microvascular reimplantation of an amputated fingertip has also been described.[5] Other factors that are assessed can be divided into patient-related factors (hand dominance, occupation, age, expectations, previous injuries, smoking, comorbidities), surgeon-related factors (prior experience, training, microsurgical skills), and institutional factors (operating room, equipment, and staff availability).[6]
The general methods used to reconstruct a finger with an amputated distal portion include secondary intention healing, microreimplantation, revision amputation, local and regional flap, skin graft, and composite graft.[6,7] Microreimplantation is beneficial if there is an injury in Tamai zone I that is distal to the lunule, or a crush injury or avulsion injury of the fingertip in Tamai zone II that is between the distal interphalangeal joint and the lunule, because its use is restricted in reimplantation.[6]
Additionally, the composite graft has a high success rate, with good results in the treatment of non-reimplantable fingers in pediatric patients, but a success rate as low as around 20% in adults has also been reported.[7,8] In finger injuries too distally-located to be treated by microsurgery, there are options to avoid shortening of the finger. These include composite grafting and changing the dressing on the stump, which would be essential for secondary intention healing of the finger.
Therefore, there is no set of rules that serves as a satisfactory guide for applying each of these techniques. Each surgeon, in consultation with each patient, should choose the type of coverage that appears to best fit the needs of the individual and the technical skills of the surgeon. Regardless of the treatment selected, the objectives of preserving functional length and restoring adequate sensitivity remains the same.
Although there are several ways to treat an injury or amputation of the fingertip, there is no consensus around the choice of surgical technique to be used under given conditions.
This study will be based on the hypothesis that different surgeons treat the same conditions differently (heterogeneity), according to their time of experience in the specialty.
The objective of the study is to confirm the types of treatment used, and to determine whether there is consensus around each type of fingertip injury or amputation and whether there is a statistical difference in treatment option between surgeons with different lengths of time working in the specialty.

MATERIALS AND METHODS

The data collection was conducted at the 37th Brazilian Hand Surgery Conference in Belo Horizonte (MG) during the period March 30, 2017 to April 1, 2017, with a sample number of 90 questionnaires.
For this study, a structured questionnaire (Attachment 1) was applied, consisting of 13 pertinent work-related questions. This study was approved by the Research Ethics Committee of the institution under approval protocol number 69454417.7.0000.5533.
The inclusion criteria were physicians specializing in hand surgery recognized by the SBCM [Brazilian Hand Surgery Society] and residents in hand surgery at an SBCM- and MEC [Ministry of Education and Culture]-accredited service. The exclusion criteria were professions other than those mentioned above, and foreign physicians.

Interventions

During the 37th CBCN, a hundred and twenty questionnaires were randomly distributed to the conference participants (medical residents or medical specialists in hand surgery), without identification and, therefore, with no need for the ICF. Of these, thirty were excluded because they were incomplete, or because the respondents either worked in other specialties or were foreigners, resulting in ninety questionnaires to be included and considered in the analysis of the final results.

Primary outcome

To obtain self-reported assessments about the preferred treatment for fingertip injury from hand surgery specialists, and to determine whether there is any statistical difference in the option chosen for each question evaluated.
Secondary outcomes
To confirm whether there is any statistical difference in treatment option between subgroups based on length of time working in the Hand Surgery specialty – residents, less than 5 years, and more than 5 years – as an indirect indicator of the number of cases treated, technical experience, and results observed.
Statistical Analysis
The data were presented in descriptive form as a central trend measurement (average) associated with a dispersion variable (standard deviation). For the percentages and averages, a confidence interval (CI 95%) and a level of significance of 5% (< 0.05) were used, with a sampling error of 10% for the sampling proportion. The Statistical Package for Social Science for Windows (SPSS V20), minitab 16, Excel office 2010 was used for these calculations.[6,7]

RESULTS

For the primary outcome, the percentages and relationship between the answers to each question will be analyzed one by one, comparing them for any correlation or concordance in the treatment of fingertip injury, and for any statistical difference in the chosen treatment option (Table 1).
Most of the respondents were from the Southeast Region (58.9%) and, among the three groups, the most prevalent was the group with over 5 years of experience (38.9%).
In question 3 (Table 1, question 3) about emergency treatment for a fingertip injury of less than 1 cm without exposed bone, there was no concordance on treatment, with statistical difference, but the preferred option was secondary intention healing with 47.8%, followed by VY advancement flap with 41.1%, both with statistical difference when compared to the other alternatives. When we compared by time working in the specialty, there was concordance, with statistical difference, in the subgroup of residents for the VY advancement flap option, with 70.8%, and also for the subgroup with more than 5 years of experience for the secondary intention healing option, with 60%.
In question 4 (Table 1, question 4) about emergency treatment for a fingertip injury greater than 1 cm without exposed bone, there was no concordance around treatment, but the preferred option was

secondary intention healing. Of those who selected other options (17 participants), 50% chose homodigital flap and the other 50% chose VY advancement flap. When we compared by time working in the specialty (Table 3, question 4), there was concordance, with statistical difference in the up to 5 years subgroup for the secondary intention healing option with 48.4%.

In question 5 (Table 1, question 5) about emergency treatment for a dorsal oblique fingertip injury less than 1 cm with exposed bone, there was concordance, with statistical difference, for the VY advancement flap with 63.3%. When we compared by time working in the specialty (Table 2, question 5) there was statistically significant concordance in the up to 5 years and more than 5 years subgroups for the VY advancement flap option, with 71% and 74%, respectively.

In question 6 (Table 1, question 6) about emergency treatment for a volar oblique fingertip injury less than 1 cm with exposed bone, there was concordance, with statistical difference, for the cross finger flap option, with 46.7%. When we compared by time working in the specialty (Table 2, question 6), there was a statistical difference in the up to 5 years subgroup for the cross finger flap option, with 67.7%.

In question 7 (Table 1, question 7) about emergency treatment for a transverse fingertip injury less than 1 cm with exposed bone, there was no concordance around the treatment, but the preferred option was the VY advancement flap at 50% followed by Kutler at 37.8%, both with statistically difference compared to the other alternatives. When we compared by time working in the specialty (Table 2, question 7), there was concordance, with statistical difference in the up to 5 years subgroup for the Kutler flap option with 61.3% and also for the more than 5 years subgroup for the VY advancement flap option with 74.3%.

In question 8 (Table 1, question 8) about emergency treatment for a volar oblique injury of the distal phalanx of the thumb of less than 1 cm without exposed bone, there was no concordance around the treatment, but the preferred option was secondary intention healing at 55.6% followed by VY advancement flap at 33.3%, both with statistical difference when compared to the other alternatives. When we compared by time working in the specialty (Table 1, question 8) there was concordance with statistical difference for the up to 5 years and more than 5 years subgroups for secondary intention healing with 58.1% and 65.7%, respectively.

In question 9 (Table 1, question 9) about emergency treatment for a volar oblique injury of the distal phalanx of the thumb greater than 1 cm without exposed bone, there was concordance with statistical difference for the Moberg alternative with 47.8%. When we compared by time working in the specialty (Table 3, question 9), there was a concordance with statistical difference for the residents and the more than 5 years subgroups for the Moberg flap option, with 54.2% and 54.3%, respectively.

In question 10 (Table 1, question 10) about emergency treatment for a transverse injury of the distal phalanx of the thumb less than 1 cm with exposed bone, there was no concordance, but the preferred option was the VY advancement flap at 46.7% followed by Kutler at 28.9%, both statistically different from the other alternatives. When we compared by time working in the specialty (Table 3, question 10), there was concordance with statistical difference in the up to 5 years subgroup for the VY advancement flap option, with 58.1%.

In question 11 (Table 1, question 11) about emergency treatment for a volar oblique injury of the distal phalanx of the thumb less than 1 cm with exposed bone, there was no concordance with statistical difference, but the cross finger flap was the treatment of reference. When we compared by time working in the specialty (Table 3, question 11), there was no concordance with statistical difference in any of the subgroups.

Table 1.

Question 1	N	%	P-value
South	22	24,40%	<0,001
Southeast	53	58,90%	Ref.
North	2	2,20%	<0,001
Northeast	9	10,00%	<0,001
Central-West	4	4,40%	<0,001
Question 2	N	%	P-value
resident	24	26,70%	0,081
less than 5 years	31	34,40%	0,536
more than 5 years	35	38,90%	Ref.
Question 3	N	%	P-value
Occlusive dressing and secondary cover dressing	9	10,00%	<0,001
Secondary intention healing	43	47,80%	Ref.
VY advancement flap	37	41,10%	0,368
Full-thickness skin graft	0	0%	<0,001
Other	1	1,10%	<0,001
Question 4	N	%	P-value
Secondary intention healing	28	31,10%	Ref.
Thenar flap	14	15,60%	0,014
Cross finger flap	19	21,10%	0,127
Full-thickness skin graft	15	16,70%	0,023
Other	14	15,60%	0,014
Question 5	N	%	P-value
VY advancement flap	57	63,30%	Ref.
Thenar flap	7	7,80%	<0,001
Bone shortening and primary closure	21	23,30%	<0,001
Secondary intention healing	2	2,20%	<0,001
Other	3	3,30%	<0,001
Question 6	N	%	P-value
Thenar flap	11	12,20%	<0,001
Cross finger flap	42	46,70%	Ref.
Subcutaneous coverage and secondary intention healing	10	11,10%	<0,001
Bone shortening and primary closure	10	11,10%	<0,001
Other	17	18,90%	<0,001
Question 7	N	%	P-value
VY advancement flap	45	50,00%	Ref.
Kutler	34	37,80%	0,098
Thenar flap	2	2,20%	<0,001
Shortening and primary closure	5	5,60%	<0,001
Other	4	4,40%	<0,001
Question 8	N	%	P-value
Secondary intention healing	50	55,60%	Ref.
VY advancement flap	30	33,30%	0,003
Full-thickness skin graft	9	10,00%	<0,001
Other	1	1,10%	<0,001
Question 9	N	%	P-value
Moberg	43	47,80%	Ref.
Cross finger flap	15	16,70%	<0,001
Littler	11	12,20%	<0,001
Secondary intention healing	18	20,00%	<0,001
Other	3	3,30%	<0,001
Question 10	N	%	P-value
VY advancement flap	42	46,70%	Ref.
Kutler	26	28,90%	0,014
Subcutaneous coverage and secondary intention healing	9	10,00%	<0,001
Bone shortening and primary closure	8	8,90%	<0,001
Other	5	5,60%	<0,001
Question 11	N	%	P-value
Cross finger flap	30	33,30%	Ref.
Bone shortening and primary closure	23	25,60%	0,252
Subcutaneous coverage and secondary intention healing	18	20,00%	0,043
Moberg	9	9,98%	0,03
Other	11	11,10%	0,035
Question 12	N	%	P-value
Moberg with proximal release	49	54,40%	Ref.
Cross finger flap	7	7,80%	<0,001
Innervated cross finger	9	10,00%	<0,001
Littler	22	24,40%	<0,001
Other	3	3,30%	<0,001
Question 13	N	%	P-value
Cephalexin	83	92,20%	Ref.
Oxacillin	1	1,10%	<0,001
Ciprofloxacin	1	1,10%	<0,001
Other	5	5,60%	<0,001
No	0	0	<0,001

In question 12 (Table 1, question 12) about emergency treatment for an injury of the flesh of the thumb up to 2.5 cm with exposed bone, there was concordance with statistical difference for the Moberg with proximal release alternative with 54.4%. When we compared by time working in the specialty (Table 3, question 12), there was concordance with statistical difference in resident and up to 5 years subgroups for the Moberg with proximal release option, with 50% and 74.2%, respectively.

In question 13 (Attachment 1, question 13) about emergency treatment with antibiotics, there was concordance with a statistical difference for the Cephalexin alternative, with 92.2%. When we compared by time working in the specialty (Table 3, question 13), there was concordance with statistical difference in all three subgroups for the Cephalexin alternative, with 95.8%, 93.5%, and 88.6%, respectively.

Table 2.

Question 3	resident			less than 5 years			more than 5 years		
	N	%	P-value	N	%	P-value	N	%	P-value
occlusive dressing and secondary cover dressing	1	4.2%	<0.001	4	12.9%	0.001	4	11.4%	<0.001
secondary intention healing	6	25.0%	0.001	16	51.6%	Ref.	21	60.0%	Ref.
VY advancement flap	17	70.8%	Ref.	10	32.3%	0.123	10	28.6%	0.008
other	0	0.0%	<0.001	1	3.2%	<0.001	0	0.0%	<0.001
Question 4	**resident**			**less than 5 years**			**more than 5 years**		
	N	**%**	**P-value**	**N**	**%**	**P-value**	**N**	**%**	**P-value**
secondary intention healing	4	16.7%	0.104	15	48.4%	Ref.	9	25.7%	Ref.
thenar flap	8	33.3%	0.763	2	6.5%	<0.001	4	11.4%	0.124
cross finger flap	9	37.5%	Ref.	5	16.1%	0.007	5	14.3%	0.232
full-thickness skin graft	1	4.2%	0.004	6	19.4%	0.016	8	22.9%	0.780
other	2	8.3%	0.016	3	9.7%	<0.001	9	25.7%	Ref.
Question 5	**resident**			**less than 5 years**			**more than 5 years**		
	N	**%**	**P-value**	**N**	**%**	**P-value**	**N**	**%**	**P-value**
VY advancement flap	10	41.7%	Ref.	22	71.0%	Ref.	25	71.4%	Ref.
thenar flap	4	16.7%	0.057	1	3.2%	<0.001	2	5.7%	<0.001
bone shortening and primary closure	9	37.5%	0.768	7	22.6%	<0.001	5	14.3%	<0.001
secondary intention healing	0	0.0%	<0.001	1	3.2%	<0.001	1	2.9%	<0.001
other	1	4.2%	0.002	0	0.0%	<0.001	2	5.7%	<0.001
Question 6	**resident**			**less than 5 years**			**more than 5 years**		
	N	**%**	**P-value**	**N**	**%**	**P-value**	**N**	**%**	**P-value**
thenar flap	6	25.0%	0.525	0	0.0%	<0.001	5	14.3%	0.029
cross finger flap	8	33.3%	Ref.	21	67.7%	Ref.	13	37.1%	Ref.
subcutaneous coverage and secondary intention healing	5	20.8%	0.330	3	9.7%	<0.001	2	5.7%	0.001
bone shortening and primary closure	3	12.5%	0.086	4	12.9%	<0.001	3	8.6%	0.004
other	2	8.3%	0.033	3	9.7%	<0.001	12	34.3%	0.803
Question 7	**resident**			**less than 5 years**			**more than 5 years**		
	N	**%**	**P-value**	**N**	**%**	**P-value**	**N**	**%**	**P-value**
VY advancement flap	9	37.5%	Ref.	10	32.3%	0.022	26	74.3%	Ref.
Kutler	8	33.3%	0.763	19	61.3%	Ref.	7	20.0%	<0.001
thenar flap	2	8.3%	0.016	0	0.0%	<0.001	0	0.0%	<0.001
bone shortening and primary closure	4	16.7%	0.104	1	3.2%	<0.001	0	0.0%	<0.001
other	1	4.2%	0.004	1	3.2%	<0.001	2	5.7%	<0.001

Table 3.

Question 8	resident			less than 5 years			more than 5 years		
	N	%	P-value	N	%	P-value	N	%	P-value
secondary intention healing	9	37.5%	0.558	18	58.1%	Ref.	23	65.7%	Ref.
VY advancement flap	11	45.8%	Ref.	10	32.3%	0.041	9	25.7%	<0.001
full-thickness skin graft	3	12.5%	0.011	3	9.7%	<0.001	3	8.6%	<0.001
other	1	4.2%	<0.001	0	0.0%	<0.001	0	0.0%	<0.001
Question 9	**resident**			**less than 5 years**			**more than 5 years**		
	N	**%**	**P-value**	**N**	**%**	**P-value**	**N**	**%**	**P-value**
Moberg	13	54.2%	Ref.	11	35.5%	Ref.	19	54.3%	Ref.
Cross finger flap	5	20.8%	0.017	7	22.6%	0.263	3	8.6%	<0.001
Littler	3	12.5%	0.002	2	6.5%	0.005	6	17.1%	0.001
secondary intention healing	2	8.3%	<0.001	10	32.3%	0.788	6	17.1%	0.001
other	1	4.2%	<0.001	1	3.2%	0.001	1	2.9%	<0.001
Question 10	**resident**			**less than 5 years**			**more than 5 years**		
	N	**%**	**P-value**	**N**	**%**	**P-value**	**N**	**%**	**P-value**
VY advancement flap	9	37.5%	0.768	18	58.1%	Ref.	15	42.9%	Ref.
Kutler	10	41.7%	Ref.	6	19.4%	0.002	10	28.6%	0.212
subcutaneous coverage and secondary intention healing	1	4.2%	0.002	5	16.1%	<0.001	3	8.6%	0.001
bone shortening and primary closure	4	16.7%	0.057	2	6.5%	<0.001	2	5.7%	<0.001
other	0	0.0%	<0.001	0	0.0%	<0.001	5	14.3%	0.008
Question 11	**resident**			**less than 5 years**			**more than 5 years**		
	N	**%**	**P-value**	**N**	**%**	**P-value**	**N**	**%**	**P-value**
Cross finger flap	8	33.3%	Ref.	14	45.2%	Ref.	8	22.9%	0.075
bone shortening and primary closure	8	33.3%	Ref.	10	32.3%	0.297	5	14.3%	0.008
subcutaneous coverage and secondary intention healing	7	29.2%	0.755	4	12.9%	0.005	7	20.0%	0.039
other	1	4.2%	0.010	3	9.7%	0.002	15	42.9%	Ref.
Question 12	**resident**			**less than 5 years**			**more than 5 years**		
	N	**%**	**P-value**	**N**	**%**	**P-value**	**N**	**%**	**P-value**
Moberg with proximal release	12	50.0%	Ref.	23	74.2%	Ref.	14	40.0%	0.808
cross finger flap	4	16.7%	0.014	1	3.2%	<0.001	2	5.7%	<0.001
innervated cross finger	3	12.5%	0.005	3	9.7%	<0.001	3	8.6%	0.001
Littler	4	16.7%	0.014	3	9.7%	<0.001	15	42.9%	Ref.
other	1	4.2%	<0.001	1	3.2%	<0.001	1	2.9%	<0.001
Question 13	**resident**			**less than 5 years**			**more than 5 years**		
	N	**%**	**P-value**	**N**	**%**	**P-value**	**N**	**%**	**P-value**
Cephalexin	23	95.8%	Ref.	29	93.5%	Ref.	31	88.6%	Ref.
Oxacillin	1	4.2%	<0.001	0	0.0%	<0.001	0	0.0%	<0.001
Ciprofloxacin	0	0.0%	<0.001	1	3.2%	<0.001	0	0.0%	<0.001
other	0	0.0%	<0.001	1	3.2%	<0.001	4	11.4%	<0.001

DISCUSSION

This unprecedented work addresses one of the most important and prevalent themes in orthopedics and traumatology practice. Our objective was to map how the treatment of fingertip injuries are carried out in Brazil, in order to provide support for new studies and skills updating, as well as providing information to for student research projects of relevance to our field.

Our sample was representative in terms of consensus and non-consensus around the treatment of fingertip injuries, but new comparative studies of the literature need to be carried out.

We observed concordance, with statistical difference, among hand surgeons in relation to treatment of fingertip injuries in 45.4% of the cases. This concordance with statistical difference increased to 54.5% when evaluated by the time working in the specialty subgroups.

The injuries for which we confirmed a statistically different consensus around treatment were: the VY advancement flap alternative for the dorsal oblique injury less than 1 cm with exposed bone at 63.3%, the cross finger flap alternative for volar oblique fingertip injury less than 1 cm with exposed bone at 46.7%, the Moberg alternative for volar oblique injury of the distal phalanx of the thumb greater than 1 cm without exposed bone at 47.8%, the Moberg with proximal release alternative for injury of the flesh of the thumb up to 2.5 cm with exposed bone at 54.4%, and the use of Cephalexin as the antibiotic of choice, with 92.2%.

The surgical option and preference of the surgeon vary worldwide. The comparative study by Jin Bo Tang, MD et al.[9] of the different continents reported the Moberg flap for the thumb and the VY advancement flap for the thumb and fingers as the first line treatments, which corroborates the result for injuries with exposed bone. In this same study, the author observed that there the use of the cross finger flap is decreasing, which diverges from our results in that there was concordance of 46.7% for volar oblique fingertip injury. In our evaluation of the subgroups, we observed a trend in the more than 5 years subgroup towards conservative treatment with secondary intention healing and weekly changes of occlusive dressing. This technique has gained more universal acceptance in recent years, as it provides excellent restoration of the contour, volume, and sensitivity for small to mid-size defects resulting from fingertip injury.[10]

CONCLUSION

There was no consensus around treatment for most types of fingertip injuries, although there was a concordance with statistical difference in 45.4%. When we divided the surgeons by time working in the Hand Surgery field, there was an increase in concordance with statistical difference to 54.5% for the questions by subgroup, and among those with more than 5 years of experience, there was a trend towards conservative treatment with secondary intention healing and occlusive dressing.

IMPLICATIONS FOR FUTURE RESEARCH

Additional comparative studies need to be conducted, so that we can evaluate the consensus among surgeons on the treatment of fingertip injuries, analyzing the cost-benefit for each injury configuration according to the surgeon's experience, technical difficulty, the need to maintain functional and esthetic length, and complications, since there are no studies of this kind described in the literature.

AUTHORS' CONTRIBUTIONS: Each author made significant individual contributions to this manuscript. MKM (0000-0001-6027-2890)*, JCB (0000-0003-3396-479X)*, and MF (0000-0003-1646-6764)* were the main contributors to the writing of the manuscript and the discussion of the results. VYM (0000-0002-4933-4007)* and AO (0000-0003-0015-2236)* evaluated the statistical analysis data. MF and JRN developed and implemented the study protocol. JCB (0000-0002-0476-8768)* performed the final review of the manuscript. *ORCID (Open Researcher and Contributor ID).

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Attachment 1. Questionnaire

Treatment of fingertip injury by hand surgery specialists in Brazil

1. Which region do you work in?
a) South
b) Southeast
c) North
d) Northeast
e) Central-West

2. How long have you been specializing in hand surgery?
a) I am a resident
b) less than 5 years
c) from 5 - 10 years
d) from 10 – 20 years
e) more than 20 years

3. What emergency treatment do you use for a fingertip injury of less than 1 cm without exposed bone?
a) occlusive dressing and secondary cover dressing
b) secondary intention healing
c) VY advancement flap
d) full-thickness skin graft
e) other: _____

4. What emergency treatment do you use for a fingertip injury greater than 1 cm without exposed bone?
a) secondary intention healing
b) thenar flap
c) cross finger flap
d) full-thickness skin graft
e) other: _____

5. What emergency treatment do you use for a dorsal oblique fingertip injury of less than 1 cm with exposed bone?
a) VY advancement flap
b) thenar flap
c) bone shortening and primary closure
d) secondary intention healing
e) other: _____

6. What emergency treatment do you use for a volar oblique fingertip injury of less than 1 cm with exposed bone?
a) thenar flap
b) cross finger flap
c) subcutaneous coverage and secondary intention healing
d) shortening and primary closure
e) other: _____

7. What emergency treatment do you use for a transverse fingertip injury of less than 1 cm with exposed bone?
a) VY advancement flap
b) Kutler
c) thenar flap
d) shortening and primary closure

8. What treatment do you use for a volar oblique thumb injury of less than 1 cm without exposed bone?
a) secondary intention healing
b) VY advancement flap
c) full-thickness skin graft
d) other: _____

9. What treatment do you use for a volar oblique injury of the distal phalanx of the thumb greater than 1 cm without exposed bone?
a) Moberg
b) cross finger flap
c) Littler
d) secondary intention healing
e) other _____

10. What treatment do you use for a transverse injury of the distal phalanx of the thumb of less than 1 cm with exposed bone?
a) VY advancement flap
b) Kutler
c) subcutaneous coverage and secondary intention healing
d) Moberg
e) other _____

11. What treatment do you use for a volar oblique injury of the distal phalanx of the thumb of less than 1 cm with exposed bone?
a) cross finger flap
b) shortening of the bone and primary closure
c) subcutaneous coverage and secondary intention healing
d) Moberg
e) other: _____

12. What treatment do you use for an injury to the thumb pad of up to 2.5 cm with exposed bone?
a) Moberg with proximal release
b) cross finger flap
c) innervated cross finger flap
d) Littler
e) other: _____

13. Do you prescribe antibiotics?
a) yes:
If yes, which one?
1 – Cephalexin
2 – Oxacillin
3 – Ciprofloxacin
4 – Other: _____
b) no

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ORIGINAL ARTICLE

INCISIONAL NEGATIVE-PRESSURE WOUND THERAPY IN REVISION TOTAL HIP ARTHROPLASTY DUE TO INFECTION

TERAPIA DE PRESSÃO NEGATIVA INCISIONAL NA REVISÃO DE ARTROPLASTIA TOTAL DO QUADRIL POR INFECÇÃO

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ABSTRACT

Objective: To present our institution's experience with negative-pressure wound therapy (NPWT) as an adjuvant in wound healing of patients who have undergone revision total hip arthroplasty (THA) due to septic loosening in the presence of active fistula. Methods: We prospectively assessed patients presenting with THA infection, associated with the presence of fistula, treated with a PICO® device for NPWT, in combination with the standard treatment for prosthesis infection in our institution. Resolution of the infectious process and healing of the surgical wound without complications were considered an initial favorable outcome. Results: We assessed 10 patients who used PICO® in our department. No complications were identified in association with the use of the NPWT device. The mean follow-up of the patients after use of the device was 12.7 months. Only one patient progressed with fistula reactivation and recurrence of infection. Conclusion: NPWT can be used in wound complications and infection following THA procedures safely and with promising results. Randomized prospective studies should be conducted to confirm its effectiveness. ***Level of Evidence IV, Case Series.***

Keywords: Negative-pressure wound therapy. Arthroplasty, replacement, hip. Surgical wound dehiscence.

RESUMO

Objetivo: Apresentar a experiência com terapia com pressão negativa (TPN), como adjuvante no tratamento das feridas cirúrgicas de pacientes submetidos à revisão decorrente de solturas sépticas com presença de fístula ativa em artroplastias totais do quadril (ATQ). Métodos: Foram avaliados prospectivamente pacientes que apresentavam infecção de ATQ, associada à presença de fístula, tratados com dispositivo PICO® para TPN, além do tratamento padrão da infecção protética em nossa instituição. Consideramos como desfecho favorável inicial a resolução do processo de infecção e a cicatrização da ferida operatória, sem eventos complicadores. Resultados: Foram acompanhados 10 pacientes que usaram PICO® em nosso serviço. Não foram identificadas quaisquer complicações com relação ao uso do dispositivo de TPN. A média de acompanhamento dos pacientes após o uso do dispositivo foi de 12,7 meses. Apenas um paciente evoluiu com recidiva da infecção e reativação da fístula. Conclusão: A TPN pode ser usada em complicações de feridas e infecção depois de ATQ com segurança e com resultados promissores. Estudos prospectivos randomizados devem ser realizados para comprovar sua eficácia. ***Nível de Evidência IV, Série de Casos.***

Descritores: *Tratamento de ferimentos com pressão negativa. Artroplastia de quadril. Deiscência da ferida operatória.*

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INTRODUCTION

Total hip arthroplasty (THA) is the standard of care for cases of primary or secondary osteoarthrosis in which conservative treatment has failed. With the increase in the number of arthroplasties and the number of young and old patients with more comorbidities, the number of revision surgeries and complications of this procedure have also increased, including surgical wound complications and infections. Known risk factors for skin complications and postoperative infection after THA include rheumatological diseases, diabetes, obesity, poor nutrition, smoking, and chiefly, previous surgeries.[1] Some of the measures recommended in the literature to decrease the risk of infection after THA include the use of prophylactic antibiotics before the incision, shaving with a trichotomizer and not with a blade, *adequate sanitazation of the hands and forearms*, a strictly sterile technique, preparation of the skin with an alcohol solution, control of comorbidities such as diabetes and malnutrition in the perioperative

Conflicts of interest: Author Camilo Partezani Helito is a speaker for Smith-Nephew. Author José Ricardo Negreiros Vicente is a speaker for Stryker. All other authors declare no potential conflict of interest related to this article.

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period, maintenance of normothermia during the procedure, and an adequate surgical technique, accounting for the dissection planes and minimizing the pressure of the skin retractors to avoid skin damage.[2]
Upon the diagnosis of prosthetic infection, treatment varies from antibiotic therapy to surgical cleaning, implant removal, and placement of spacers with antibiotics. Normally, the treatment is lengthy and involves decline of quality of life and function of the patients, and it is associated with high costs to health services.[3]
Negative-pressure wound therapy (NPWT) is a form of adjuvant treatment that has been gaining attention recently in the orthopedic literature. Although its use is well established in other areas of medicine and orthopedics, especially in cases of trauma with severe lesions in soft parts and exposed fractures,[4-6] its use in the field of primary arthroplasties and prosthetic revision surgeries is still not well established. Studies of cases of periprosthetic fractures after knee and hip and ankle arthroplasties have demonstrated the benefit of using this type of therapy.[4,7] However, few studies have demonstrated the use of this procedure in cases of primary arthroplasties, and these do not allow a definite conclusion regarding its use. Despite the theoretical benefit reported in a recent review, no prospective studies have clearly documented its benefits. Some of the patients that can benefit from NPWT in hip arthroplasty are those with complications such as dehiscence or prolonged secretion by the surgical wound and those with infection, which would present greater damage to the skin and soft parts that hinder healing.
Thus, the objective of this study was to describe our experience with NPWT in the treatment of surgical wounds in patients who had undergone THA revision by septic loosening in the presence of fistula.

MATERIALS AND METHODS

Ten cases of THA revision were prospectively evaluated because of septic loosening with active fistula (Figure 1). The study was approved by the ethics committee of the institution under registration of protocol IOT-1117, and informed consent was obtained from the included patients. From the time of hospitalization, patients who had an active fistula and signs of prosthetic release on radiographs in at least one of the components were treated using the following protocol for arthroplasty infection at our institution: two-time revision surgery, which involves antibiotic therapy associated with surgical cleaning and debridement with removal of the implant and placement of a cement spacer with antibiotic (femoral and acetabular; Figure 2) and subsequent replacement of implants, using the surgical technique as needed in each case. In some cases, homologous bone grafts were used for acetabular bone defects associated with a reinforcement ring; in others, non-cemented metal cups were used. In the femoral part, the cases were resolved with cementless primary or modular stems for distal fixation or impacted graft technique with short cemented stems. After the usual treatment, at the time of the implant replacement and during the second treatment, the NPWT device was placed on the wound as an additional measure (Figure 3). Intraoperative culture samples were harvested during all surgeries, and postoperative antibiotic therapy was defined in accordance with the antibiogram.
The use of the device did not prevent the patients from receiving the standard rehabilitation that would be used in the case of nonuse of the device. Thus, the amplitude of movement and gait with partial load were encouraged, except when contraindicated for the surgical procedure. The portable device PICO 10 × 40 (Smith & Nephew) was used in this study, with a continuous negative pressure of 80 mmHg. After 7 days, the duration of operation using the device, the wound, and appearance of the dressing (Figure 4) were analyzed, and the need to install a new device was determined. This procedure was performed every 7 days, when the appliance was shut down. The total time of therapy for each patient was quantified.
The resolution of the infection process, closure of the fistula, and good evolution of the surgical wound (Figure 5), without complicating events or the need for a new surgical intervention, were considered initial favorable outcomes.

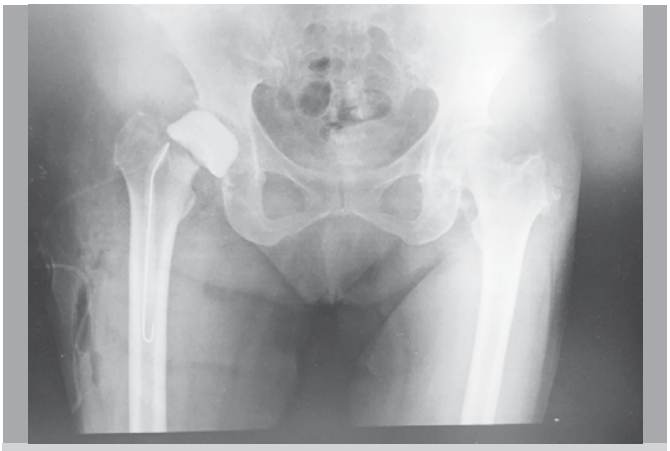

Figure 2. Anteroposterior radiograph of the pelvis demonstrating use of a spacer with antibiotics.

Figure 1. A patient with septic loosening after total hip arthroplasty, featuring an active fistula.

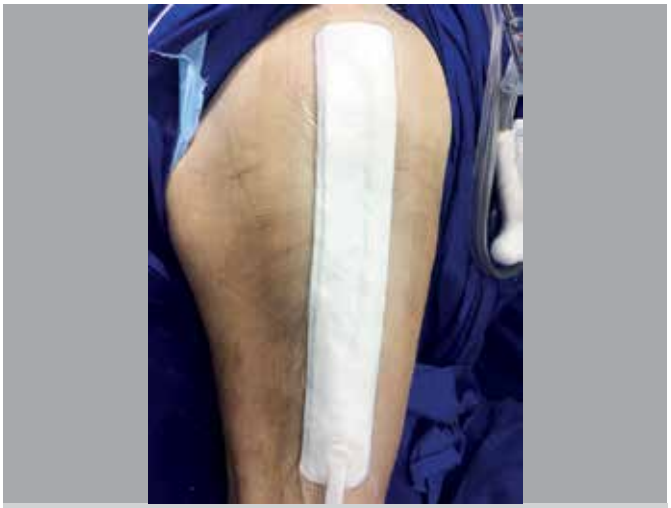

Figure 3. Negative-pressure therapy device applied over the wound.

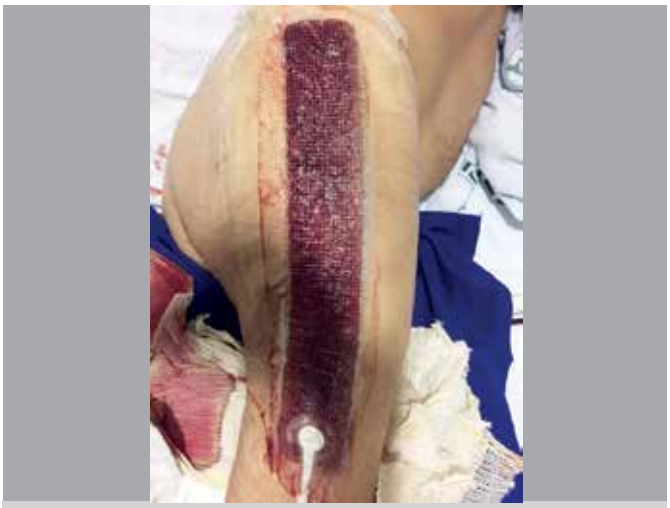

Figure 4. Aspect of the dressing.

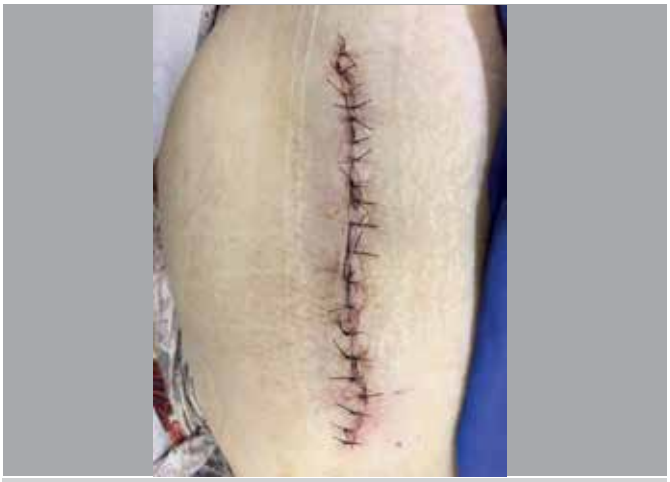

Figure 4. Aspect of the dressing.

RESULTS

Ten patients diagnosed as having septic loosening with an active fistula underwent a two-stage THA revision, and PICO was used in the second revision when the implants were placed. The patients' data are summarized in Table 1. Four patients had rheumatoid arthritis and four others were smokers. Two patients used the device for 21 days (three sets of dressings), one with rheumatoid arthritis and the other a smoker. Eight patients used it for 7 days (one set). The average use for each patient was 9.8 days. None of the patients required therapy for more than 3 weeks.

In relation to the outcome, nine patients presented with a favorable outcome based on the established criteria as follows: one patient had reactivation of the fistula 1 year after the operation (after the implants were replaced) and when a surgical reapproach was needed; the other nine patients presented with wound closure and control of the infectious processes without the need for reintervention until the end of follow-up.

No complications were associated with the use of NPWT. The mean follow-up of the patients after the use of the device was 12.7 months, ranging from 12 to 16 months.

DISCUSSION

The main finding of this study was that NPWT may be safely used in revision surgeries of hip prosthesis for chronic infection, without any complications and impairment of the rehabilitation of patients, and with satisfactory initial results.

Table 1. Patients' data.

Patient	Age	Sex	Comorbidities	Days of use	No. Of dressings	Follow-up (months)	Resolution
1	46	Female	Rheumatoid Arthritis	21	3	15	Yes
2	46	Female	Rheumatoid Arthritis	7	1	12	Yes
3	65	Male	Smoker	7	1	16	No
4	65	Male	Smoker	7	1	12	Yes
5	65	Male	Smoker	21	3	12	Yes
6	65	Male	Smoker	7	1	12	Yes
7	78	Female	Rheumatoid Arthritis	7	1	12	Yes
8	78	Female	Rheumatoid Arthritis	7	1	12	Yes
9	85	Female	Obesity/ SAH/DM	7	1	12	Yes
10	32	Male	Sickle Cell Anemia	7	1	12	Yes

SAH: systemic arterial hypertension; DM: diabetes mellitus.

Among the described mechanisms of action of NPWT, which are potentially important in its use in arthroplasties, are the removal of fluid; decrease in edema, dead space, and soluble inflammatory molecules; mechanical stabilization; reduction of tension on the wound; and increased blood flow and angiogenesis.[8] DeCarbo et al. conducted a study involving NPWT in hindfoot and ankle lesions and wounds, and demonstrated improvement in edema, pain control, and healing.[9]

The usefulness of NPWT has not been proven in arthroplasty surgeries, although several authors have shown a potential benefit of its use as an adjuvant therapy. A recent study by Strugala et al. showed a shorter hospitalization duration and lower incidence rates of dehiscence and postoperative infections with the use of the PICO dressing.[10] In a study that used primary total hip prosthesis, Gillespie et al. observed a reduction of 3% in the number of infections with the use of NPWT and recommend a series with approximately 900 patients to achieve a statistically significant result regarding the incidence of infectious complications related to the procedure.[11] Karlakki et al. reported a shorter hospitalization time with the use of negative pressure dressings in primary prosthesis of the knee and hip than with the use of conventional dressings.[12] Pachowsky et al. concluded an improvement in the drainage of persistent seroma and, consequently, better healing in THA cases.[13] Cooper showed a lower number of infections and no relevant complication with the use of NPWT in revision surgeries of hip and knee prostheses.[15] Ene et al. conducted a study with infected knee prosthesis and obtained good results (no wound dehiscence and complications) with the use of NPWT.[16] In a series of 10 cases of complex lesions of the knee, Helito et al. demonstrated promising results in the healing of wounds and no complications with the use of NPWT.[17]

Nonetheless, a randomized study that involved the use of NPWT in knee arthroplasties had to be terminated before its completion because of the formation of blisters around the skin lesion. To prevent blister formation, technological changes have already been incorporated in new devices, which minimized this problem. We did not find this type of complication in our series. The NPWT system used (PICO) consisted of a silicone dressing in multiple layers, designed to prevent blister formation or maceration of the wound.[18] In our series,

no other complications occurred that were directly related to the use of NPWT, similar to other studies that used the same updated device. In our study, the patient with recurrence of fistula had rheumatoid arthritis as a comorbidity. Sun et al. already reported worse results in patients with rheumatoid arthritis.[19]

Contrary to the studies that showed benefits, other authors such as Manoharan et al. observed no clinical benefit or cost reduction with the use of negative-pressure dressings.[20]

Although we did not find complications in this series, NPWT should be used with caution. Situations such as the exposure of neurovascular bundles or unexplored fistulas are contraindications to the use of NPWT. Patients with coagulopathies or those taking anticoagulants should be monitored with caution when using the device. Circumferential dressings should also be avoided to prevent possible limb ischemia.

Another important benefit of the type of therapy used in this study is the possibility of outpatient treatment. Once the bandage is placed, the patient needs to perform daily changes, and the device can be carried with ease. Payne et al. studied the use of these devices for the most diverse types of skin infections and lesions and showed a possible reduction of costs due to no hospitalization required.[21]

Frazão et al. reported a significant increase in costs for the treatment of hip arthroplasty infections in a tertiary hospital as compared with cases without infection.[3] Thus, any economy with safety for the patient may be important for the health system.

Despite the small number of cases, the initial results presented in this study are promising. In the treatment of infections, NPWT can be used as an adjunct procedure for the treatment of patients, in no way replacing the treatment algorithm and the consecrated conduct of antibiotic therapy, surgical cleaning, and implant removal. The small number of patients and the short follow-up time, in addition to the heterogeneous sample and absence of a control group are the limitations of this study. Nevertheless, we believe that the study obtained satisfactory results and the results are beneficial as they demonstrate the absence of possible complications and reinforce indications for the use of NPWT.

CONCLUSION

NPWT may be safely used in surgical revision of hip prosthesis due to septic loosening, with promising results. Long-term prospective randomized studies with larger samples should be conducted to prove their effectiveness.

AUTHORS' CONTRIBUTIONS: Each author contributed individually and significantly to the development of this work. HSM (0000-0002-2532-2685)* was responsible for the design of the study, bibliographic survey, participation in surgical procedures, and supervision. FRS (0000-0001-8430-536X)* participated in the bibliographic survey, and data acquisition and analysis. LE (0000-0002-9866-1960)* participated in the surgical procedures, data interpretation, and drafting of the manuscript. ALLML (0000-0002-2396-9880)* and JRNV (0000-0003-3528-9249)* guided, critically analyzed, reviewed, and oversaw all phases of the work. CPH (0000-0003-1139-2524)* participated in the intellectual conceptualization, surgical procedures, and drafting of the manuscript. *ORCID (Open Researcher and Contributor ID).

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Appendix 1. Mapping of the injuries sustained in the 2017 São Paulo state football championship.

Report on orthopedic injuries sustained during the 2017 São Paulo state football championship

1. This report refers to the following match:

_____

2. What was the weather like at the time of the match?
- ☐ Sunny
- ☐ Cloudy
- ☐ Rainy
- ☐ Sun shower
- ☐ Rain and lightning
- ☐ Night - clear sky
- ☐ Night - rainy

3. Temperature measured at the time of the match:

_____

4. Location
- ☐ Home game
- ☐ Up to 200km away
- ☐ From 200 to 400km away
- ☐ More than 400km away

5. Were there injuries sustained during the match?
- ☐ Yes
- ☐ No

Fill out the following items only if injuries were sustained

6. Name of the injured athlete:

Date of birth:_____

7. Athlete's position:
- ☐ Goalkeeper
- ☐ Central defender
- ☐ External defender
- ☐ External midfielder
- ☐ Central midfielder
- ☐ Forward

8. When was the injury sustained?
- ☐ 0-15 Min
- ☐ 15-30 Min
- ☐ 30-45 Min
- ☐ 45-60 Min
- ☐ 60-75 Min
- ☐ 75-90 Min
- ☐ Overtime — 1st half
- ☐ Overtime — 2nd half

9. Did the injury occur after contact or collision with the ball, goal or with another athlete?
- ☐ Yes

Appendix 2. Injury Report: 2017 São Paulo State Football Championship.

Report on orthopedic injuries sustained during the 2017 São Paulo state football championship

1. Name of the injured athlete
Date of birth:_____
Position:_____
Injury:_____
Date of the injury:_____

2. Complementary tests/exams requested:
- ☐ None
- ☐ Radiography (rx)
- ☐ Ultrasound (us)
- ☐ Cat scan
- ☐ Mri
- ☐ Others:_____

3. Did the injury require surgery?
- ☐ Yes
- ☐ No

4. If yes, specify:

_____

5. Athlete's return date to sports activities:

_____

6. Days of time loss:

_____

7) Injury severity scale:
- ☐ Slight (up to 3 days of time loss)
- ☐ Minor (3 to 7 days of time loss)
- ☐ Mild (7 to 28 days of time loss)
- ☐ Major (7 days to 8 weeks of time loss)
- ☐ Severe (more than 8 weeks of time loss)

8) Did the final diagnosis confirm the initial diagnosis?
- ☐ Yes
- ☐ No

Final diagnosis:

_____

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BONE TUNNEL ENLARGEMENT WITH NON-METALLIC INTERFERENCE SCREWS IN ACL RECONSTRUCTION

ALARGAMENTO DOS TÚNEIS ÓSSEOS NA RECONSTRUÇÃO DO LCA COM PARAFUSOS DE INTERFERÊNCIA NÃO METÁLICOS

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ABSTRACT

Objective: To compare the widening of bone tunnels between poly- etheretherketone (PEEK), absorbable polylactic acid DL (PLDL) and tricalcium phosphate (TCP) interference screws in anterior cruciate ligament (ACL) reconstruction. Methods: Three groups of patients undergoing ACL reconstruction with at least 1 year of follow-up using the out-in drilling technique and hamstring as a graft were assessed. The patients were divided according to the type of interference screw used (PEEK, PLDL and TCP). Computed tomography (CT) was performed to measure the greatest femoral and tibial tunnel widening regarding to the initial tunnel, and then it was compared between groups. Results: Mean widening in group 1 (PEEK) was 39.56% (SD 16%) in the femoral tunnel and 33.65% (SD 20%) in the tibia. In group 2 (PLDL) mean widening was 48.43% in the femoral tunnel (SD 18%) and 35.24% (SD 13%) in the tibial tunnel. In group 3 (TCP) mean widening was 44.51% in the femur (SD 14%) and 36.83% in the tibia (SD 14%). The comparison between groups (PLDL-PEEK, PLDL-TCP, PEEK-TCP) shows no statistically significant difference. Conclusion: Bone tunnel enlargement values after ACL reconstruction with the use of different types of materials (bioinert and biomaterials) of interference screws (PEEK, PLDL and TCP) were similar. ***Level of Evidence III, Comparative retrospective study.***

Keywords: Anterior cruciate ligament reconstruction. Hamstring tendons.

RESUMO

Objetivo: Comparar o alargamento dos túneis ósseos entre parafusos de interferência de poli-éter-etil-cetona (PEEK), ácido poli lático (PLDL) absorvível e tricálcio fosfato (TCP) na reconstrução do ligamento cruzado anterior (LCA). Métodos: Foram avaliados três grupos de pacientes submetidos à reconstrução do LCA com ao menos um ano de acompanhamento, com perfuração de fora para dentro, tendões flexores quádruplos como enxerto, que foram divididos de acordo com o parafuso de interferência utilizado (PEEK, PLDL e TCP). Realizou-se tomografia computadorizada (TC) para aferição do maior alargamento do túnel tibial e femoral em relação ao túnel inicial, e foi comparado o alargamento entre os grupos. Resultados: O alargamento médio no grupo 1 (PEEK) foi 39,56% (DP = 16%) no túnel femoral e 33,65% (DP = 20%) na tíbia. No grupo 2 (PLDL) o alargamento médio do túnel femoral foi 48,43% (DP = 18%) e 35,24% (DP = 13%) na tíbia. No grupo 3 (TCP) 44,51% (DP = 14%) foi o alargamento médio no fêmur e 36.83% (DP = 14%) na tíbia. Na comparação entre os grupos (PLDL-PEEK, PLDL-TCP, PEEK-TCP) não houve diferença estatisticamente significante. Conclusão: O alargamento dos túneis ósseos após a reconstrução do LCA com a utilização de diferentes tipos de materiais (bioinertes e biomateriais) de parafusos de interferência (PEEK, PLDL e TCP) foi semelhante. ***Nível de Evidencia III, Estudo retrospectivo comparativo.***

Descritores: *Reconstrução do ligamento cruzado anterior. Tendões dos isquiotibiais.*

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INTRODUCTION

Anterior cruciate ligament (ACL) reconstruction is performed for professional and recreational athletes and in cases of daily life instability. The ligament reconstruction techniques, with the anatomical positioning of the graft, leads to good results with the use of different methods and fixation devices.[1]

The interference screw is still the most widely used fixation,[2] and is made from many different types of materials, such as titanium, bioinert materials such as polyether-ethyl ketone (PEEK), and bioabsorbable materials, such as poly-lactic acid (PLDL) that may be associated with biocomposites, such as hydroxyapatite (HA), and tricalcium phosphate (TCP), each with their advantages and disadvantages.[3,4,5]

Metal (titanium) interference screws, although widely used due to their lower cost, have some disadvantages such as the difficulty of being removed in a revision surgery[3,4] and the presence of

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artifacts in magnetic resonance imaging (MRI) that may hamper a correct interpretation, which directed several surgeons to opt for screws made of bioinert materials and biomaterials.[5]

According to the literature, regardless the screw material, the surgical outcomes are similar.[3] Some authors, however, have questioned the use of biomaterials, which could cause local inflammation during their absorption, leading to an enlargement of the bone tunnels.[5,6]

However, this enlargement has multifactorial causes[7] and does not interfere with the clinical outcome,[1,5,8,9] it occurs also with the use of non-absorbable screws, and in extracortical fixation, without material inside the bone tunnel, like the "EndoButton".[10]

The objective of this study is to compare the enlargement of bone tunnels one year after ACL reconstruction, with computed tomography (CT), among three types of interference screws: pure poly-lactic acid (PLDL), absorbable poly-lactic acid with tricalcium-phosphate (TCP), and polyether-ethylketone (PEEK). We hypothesize that the enlargement of the bone tunnels among the raw materials of interference screws is similar, which would be a safety factor for the use of biomaterials.

MATERIALS AND METHODS

Three groups of patients were retrospectively selected one year after ACL reconstruction and divided according to the type of interference screw used (PLDL, TCP, or PEEK).

The inclusion criteria consisted of patients aged between 18 and 55 years who presented with an ACL injury, confirmed by MRI, with complaints of instability for physical activity or in daily life, with a positive Lachman and/or Pivot Shift test, and were submitted to ACL reconstruction, by drilling technique of tunnels from outside in (OUT-IN), with the hamstring as a graft by the same surgeon.

ACL reconstruction was performed by a drilling technique (OUT- IN) according to Chambat,[11] but with quadruple hamstring keeping the distal insertion on the tibia. Once prepared, the graft was passed from the distal to proximal and fixed with interference screws of the same diameter of the tunnel, first in the tibia and subsequently in the femur, from outside in, at 30° of flexion.[12]

Remnants of the ACL, when present, were preserved and the graft routed through the remnant.

No immobilization was used, patients were instructed to initiate active contraction of the quadriceps soon after the procedure and were discharged the following day with progressive partial load with the aid of crutches for two weeks.

The physiotherapy program was started on the second postoperative day, total range of motion in 4-6 weeks, running at 12 weeks, and return to sport activities after 6 months.

No patients experienced complications related to the surgical technique.

Patients who underwent associated procedures during the same surgery such as osteotomy or multi-ligamentous injury, and patients with pre-existing tunnels, were excluded.

A total of three non-randomized groups were analyzed. Group 1: 20 patients with PEEK interference screws (Masterteck-BIOTECK); group 2: 20 patients with absorbable poly-lactic acid (PLDL) screws (Sinfix-SINTEGRA) and group 3: 10 patients with PLDL absorbable screws with tricalcium phosphate (TCP) (Sinfix-SINTEGRA).

The average age of the groups, was 34.85 years in the PEEK group, and 37.05 and 36.2 years in the PLDL and TCP groups, respectively. The gender of patients was 85% males in the PLDL group, 80% in the PEEK group, and 90.0% in the TCP group, as shown in Table 1.

Non-contrast CT scan was performed using a Toshiba Aquilion CXL 128-channel device with 0.5 mm cuts. In the coronal, sagittal, and oblique incidences, the region of greatest enlargement of the femoral and tibial tunnel was located, and through the axial section, this enlargement was measured and compared to the size of the initial femoral and tibial tunnel performed during surgery. The measurements were performed by two evaluators who were unaware of the type of screw used and the average between them was taken into account. (Figure 1)

Table 1. Sex and age groups.

Group	Mean age	Male N (%)	Female N (%)
PEEK	34.85	16 (80%)	4 (20%)
PLDL	37.05	17 (85%)	3 (15%)
TCP	36.2	9 (90%)	1 (10%)

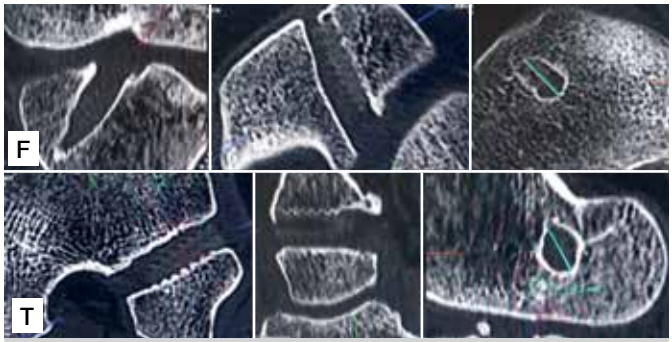

Figure 1. Measure of the enlargement of the femoral (F) and tibial (T) tunnel.

Statistical analysis

The statistical analysis was performed using the Student's t-test, adopting a confidence interval of 95% (p=0.05).

RESULTS

The three non-randomized groups evaluated in our study were: Group 1: 20 patients (80% male) in which PEEK (Masterteck-BIOTECK) interference screws with mean age 34.85 years, group 2: 20 (85% male) with polylactic acid (PLDL) absorbable screws (Sinfix-SINTEGRA) with a mean age of 37.05, and group 3: 10 patients (90% male) with PLDL absorbable screws with tricalcium phosphate (TCP) (Sinfix-SINTEGRA) and with a mean age of 36.2 years. There was no statistically significant difference between sex and age among the groups according to the ANOVA analysis with 95% CI.

The average enlargement in group 1 (PEEK) was 39.56% (SD 16%) in the femoral tunnel and 33.65% (SD 20%) in the tibia. In group 2 (PLDL), the average enlargement of the femoral tunnel was 48.43% (SD 18%) and 35.24% (SD 13%) in the tibia. In group 3 (TCP), the enlargement on the femur was 44.51% (SD 14%) and 36.83% (SD14%) in the tibia (Table 2).

The comparison between groups was performed with a confidence interval of 95% (p= 0.05). The values of femoral and tibial tunnels enlargement compared between the groups (PEEK X PLDL, PEEK X TCP, PLDL X TCP), didn't show statistically significant difference.

DISCUSSION

In our study, the comparison of the enlargement of the bone tunnels between the different types of non-metallic materials of interference screws evaluated was similar. There are biological and mechanical hypotheses of bone tunnels enlargement after ACL reconstruction. Some of the biological factors include the inflammatory response to the graft, necrosis from bone drilling, synovial fluid within the

Table 2. Enlargement of the tunnels.

Group	Enlargement in the femur	Enlargement in the tibia
PEEK	39.65%	33.65%
PLDL	48.10%	35.24%
TCP	44.51%	36.83%

tunnel, and absorption of the intra-tunnel material.[1,13] Accelerated rehabilitation, the "windshield-wiper" and the "bungee cord" effect due to the movement of the graft inside the tunnel and incorrect positioning of the tunnels are mechanical hypotheses.[5,10,13] Xu[1] found that the anterior, proximal, and vertical positioning of the femoral tunnel leads to a greater enlargement of the tunnels in both the femur and the tibia.

Some studies show greater enlargement of the tunnels with the use of indirect fixation, such as the extracortical "EndoButton" compared with the fixation within the tunnel as the interference screw.[8,13] However, Fauno[10] compared extracortical and direct fixation and found no significant difference between the two methods.

It is believed that the greatest enlargement of the tunnels occurs within the first postoperative year[5,10] with little to no change in the time following. Webster[14] mentions that the enlargement found within the fourth month after the surgery was the same as at one and two years postoperatively, while Fink[15] found the greatest enlargement in the first six weeks. We opted for an evaluation at one year postoperatively because the enlargement would already have been established.

The measurement of tunnel enlargement can be performed through digital radiography (RX), CT, and magnetic resonance imaging (MRI), and although some authors report that all methods are similar[8,10,14] we opted for the CT as being more precise[16] on the location of the margin of the tunnel sclerosis.

The measure of the enlargement can be performed 2 cm from the articulate edge,[5] on the articulate edge,[7] on the widest and central part of the tunnel, and usually in two radiological imaging planes[1] or by the total area of the increase volume of the tunnel.[3,13]

We use three CT plans (sagittal, coronal, and oblique) to identify the location of greatest enlargement of the tunnel, and we measured the enlargement on this site in the axial plane.

The material of the absorbable interference screw can influence the enlargement of the bone tunnel due to formation of an inflammatory process during its absorption.[4] Moisala[6] found that PLDL compared with metal screws led to greater enlargement of the femoral tunnel. The average widening of the tunnels within the three types of interference screws evaluated in our study showed that PEEK, a bioinert material with no absorption, led to a smaller tunnel expansion, but it was statistically similar to biomaterials, such as PLDL and TCP.

It is believed that the addition of biocomposites, such as tricalcium phosphate (TCP) and hydroxyapatite (HA) in PLDL, can accelerate the process of graft incorporation with improved conversion to cancellous bone which reduces acidity during degradation.[17] Lee[4] using MRI, compared the enlargement of the tibial tunnel between PLDL with hydroxyapatite (HA) and pure PLDL screws and found a smaller tibial tunnel enlargement (27.4% x 41.3%), similar to Robinson[18] who also found a smaller tibial tunnel enlargement using CT, 29.9% with the addition of HA to PLDL compared to pure PLDL 46%. In our study, the screw with biocomposite (TCP) showed a 36.83% enlargement of the tibial tunnel, close to studies with addition of HA.[4,18] However, in the group with pure PLDL, enlargement of the tibial tunnel (35.24%) was slightly lower than the TCP group, unlike most studies.[4,17,18]

Wang[19] found a greater enlargement in the TCP group compared with the pure PLDL group, in the region of the tunnel without the presence of the screw, believing it to be due to a cellular response of tricalcium-phosphate degradation, which generates particles that activate osteoclasts, similar to debris in aseptic loosening of arthroplasties. However, the region of the tunnel without the screw is an area susceptible to the "windshield-wiper" effect, which can lead to a further enlargement due to the movement of the graft. We did not evaluate the position of the screw inside the tunnel, but we were able to observe in some cases, that the greatest enlargement was near to the articular exit of the tunnel without the presence of the screw (Figure 2).

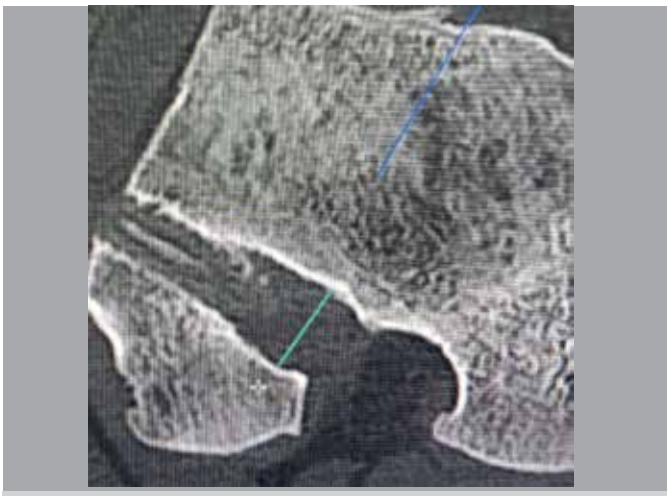

Figure 2. Enlargement in the area without a screw.

The variation on the composition of the bioabsorbable material of each screw used in the different studies, such as the percentage of dextrorotatory acid and levorotatory acid in the PLDL screws, and the different percentages of TCP added to the PLDL should also be considered, which may influence the speed of degradation and osseointegration of the material, and was not evaluated in our study. Our study did not evaluate the absorption of the material of the screw (screw volume inside the tunnel), or the filling of the tunnel by bone tissue, which, according to the literature, occurs more intensely on the TCP screw due to osteoinduction properties.[19]

In our study, we did not differentiate patients in whom the remnants of the ACL were preserved, which could reduce the intra-tunnel synovial liquid and change the enlargement.[20] However, Hwang[13] compared ACL reconstruction with the hamstring and press-fit fixation, believing that this would reduce the intra-tunnel synovial fluid and would have a smaller increase of the total tunnel volume, but no difference was found compared to the conventional technique. Although the enlargement of the bone tunnels is common in ACL reconstruction and has no correlation with the clinical outcome[5,8,9] we did not compare clinically the patients among the different groups. One limitation of our study was that the TCP group had a smaller number of patients compared to the other groups.

Further analysis should be conducted with a longer follow-up, observation of the screw positioning inside the tunnel and the enlargement around the screw during the absorption of biomaterials.

CONCLUSION

ACL reconstruction using interference screws made of biomaterials with or without biocomposites (pure PLDL and with TCP) and bioinert materials (PEEK) showed a similar enlargement of the bone tunnels, without a statistically significant difference.

AUTHORS' CONTRIBUTIONS: Each author contributed individually and significantly to the development of this maniscript. HSM (0000-0002-2532-2685)* was responsible for the design of the study, bibliographic survey, participation in surgical procedures, and supervision. FRS (0000-0001-8430-536X)* participated in the bibliographic survey, and data acquisition and analysis. LE (0000-0002-9866-1960)* participated in the surgical procedures, data interpretation, and drafting of the manuscript. ALLML (0000-0002-2396-9880)* and JRNV (0000-0003-3528-9249)* guided, critically analyzed, reviewed, and oversaw all phases of the work. CPH (0000-0003-1139-2524)* participated in the intellectual conceptualization, surgical procedures, and drafting of the manuscript. *ORCID (Open Researcher and Contributor ID).

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RISK FACTORS FOR EARLY HOSPITAL READMISSION FOLLOWING TOTAL KNEE ARTHROPLASTY

FATORES DE RISCO DE REINTERNAÇÃO HOSPITALAR PRECOCE APÓS ARTROPLASTIA TOTAL DO JOELHO

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ABSTRACT

Objective: To identify independent risk factors, complications and early hospital readmission following total knee arthroplasty. Methods: Using the ACS-NSQIP database, we identified patients who underwent primary TKA from 2012-2015. The primary outcome was early hospital readmission. Patient demographics, preoperative comorbidities, laboratory data, operative characteristics, and postoperative complications were compared between readmitted and non-readmitted patients. Logistic regression identified independent risk factors for 30-day readmission. Results: 137,209 patients underwent TKA; 3.4% were readmitted within 30 days. Advanced age, male sex, black ethnicity, morbid obesity, presence of preoperative comorbidities, high ASA classification, and increased operative time were independently related risk factors. Asian and no reported race were negative risk factors. Postoperative complications: acute myocardial infarction, acute renal failure, stroke, pneumonia, pulmonary embolism, and deep vein thrombosis show positive associations. Conclusions: Advanced age, male sex, black ethnicity, morbid obesity, presence of comorbidities, high ASA classification and long operative time are independent risk factors for postoperative complications and early hospital readmission following total knee arthroplasty. ***Level of Evidence III, Case control study.***

Keywords: Arthroplasty. Knee. Patient readmission. Risk factors.

RESUMO

Objetivo: Identificar fatores de risco independentes, complicações e reinternação precoce após artroplastia total do joelho. Métodos: A partir de banco de dados ACS-NSQIP, identificamos pacientes submetidos à ATJ primária de 2012 a 2015. O desfecho primário foi a reinternação hospitalar precoce. Dados demográficos, comorbidades pré-operatórias, dados laboratoriais, características cirúrgicas e complicações pós-operatórias foram comparadas entre os pacientes reinternados e não reinternados. A regressão logística identificou fatores de risco independentes para a reinternação em 30 dias. Resultados: Foram identificados 137.209 pacientes submetidos à ATJ, sendo que 3,4% foram reinternados no período de 30 dias. A idade avançada, o sexo masculino, a raça negra, a obesidade mórbida, a presença de comorbidades pré-operatórias, a alta classificação ASA e o aumento do tempo cirúrgico foram fatores de risco relacionados independentemente. A raça asiática e as não relatadas foram fatores de risco negativos. As complicações pós-operatórias infarto agudo do miocárdio, insuficiência renal aguda, acidente vascular cerebral, pneumonia, embolia pulmonar e trombose venosa profunda apresentaram associações positivas. Conclusões: Idade avançada, sexo masculino, raça negra, obesidade mórbida, presença de comorbidades, classificação ASA elevada e tempo cirúrgico prolongado são fatores de risco independentes de complicações pós-operatórias e reinternação precoce após artroplastia total do joelho. ***Nível de evidência III, Estudo de caso de controle.***

Descritores: *Artroplastia. Joelho. Readmissão do paciente. Fatores de risco.*

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INTRODUCTION

Total knee arthroplasty (TKA) is the most common arthroplasty in the United States.[1] The elderly, obese, and those with multiple comorbidities are at increased risk of developing complications, leading to high readmission rates.[2-4] With increases in these patient factors, complications and readmission rates may continue to rise in patients undergoing TKA. Preoperative comorbidities, like cardiac disease, chronic obstructive pulmonary disease (COPD), diabetes mellitus, and obesity, increase the likelihood of postoperative complications.[3,5-7] Demographic factors, such as age, sex, and race, Charlson Comorbidity Index, insurance type, and hospital volume have also shown to be indicators for adverse events and readmission rates.[6,8] Readmission rates after TKA are under scrutiny in the United States since the implementation of Medicare Hospital Readmission

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Reduction Program and the second phase of the Patient Protection and Affordable Care Act, which took effect in 2015. Under these policies, hospitals incur financial penalties for readmission rates higher than the national average after TKA.[9] It is therefore crucial to investigate the risk factors leading to readmission to decrease the Medicare burden, prevent hospitals from incurring penalties, and improve patient outcomes.

A previous study of all NSQIP-database patients undergoing TKA in 2011 showed that older age, male gender, positive cancer history, elevated blood urea nitrogen (BUN), presence of a bleeding disorder, and high American Society of Anesthesiologists (ASA) score were positive predictors of readmission.[10] With increasing numbers of TKA being performed in a rapidly changing healthcare landscape, it is necessary to update and refine our understanding of factors influencing readmission. The objective of this study was to identify significant, independent risk factors for readmission following TKA using data from the 2012-2015 NSQIP database.

MATERIALS AND METHODS

This study uses de-identified data from public data sets that is not considered Human Subjects Research, and was exempt from review by the Institutional Review Board. Data was obtained from the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP), a large national database of information voluntarily provided by over 300 hospitals in 43 states, from small rural community hospitals to large, urban academic centers.[11] ACS-NSQIP is a validated, risk-adjusted, outcome based program used to measure and improve the quality of surgical care in hospitals.[12] We queried for all patients in the ACS-NSQIP database who underwent TKA between 2012 and 2015. We retrospectively selected only primary TKA with Current Procedural Terminology (CPT) code 27447. We excluded uni-compartmental knee arthroplasty and total knee arthroplasty with patellofemoral arthroplasty. All variables considered in this study were used as mentioned by the NSQIP User Guide, which can be referenced for detailed variable definitions.[13] We followed preoperative laboratory values including total white blood cell (WBC) count, hematocrit, platelets, creatinine, serum albumin, and international normalized ratio (INR). Preoperative comorbidities such as insulin-dependent diabetes mellitus, non-insulin dependent diabetes mellitus, smoking, COPD, current dialysis use, preoperative blood transfusion, open wound, corticosteroid use for chronic conditions, bleeding disorder, sepsis, and several other variables were followed and separated in each group. Operative variables including operative time (incision to dressing application), postoperative stay longer than 24 hours, and number of days from operation to discharge were included.

Outcomes were followed for thirty days. All postoperative complications were stratified as medical or surgical (Table 3) by NSQIP clinical reviewers. Medical complications included pneumonia, unplanned intubation, mechanical ventilation for greater than forty-eight hours, acute renal failure, urinary tract infection, stroke or cerebrovascular accident, myocardial infarction (MI), blood transfusion, sepsis or septic shock, and cardiac arrest. Surgical complications included superficial surgical site infection, deep or incisional surgical site infection, organ or space surgical site infection, wound dehiscence, peripheral nerve injury, pulmonary embolism, graft or prosthesis failure, and deep venous thrombosis.

Demographic and clinical variables were compared between readmitted and non-readmitted patients using t- and chi-square tests for continuous and categorical variables, respectively. Logistic regression was used to estimate odds ratios (OR) and 95% confidence intervals (CI) for the association between readmission and the previously mentioned variables. Only variables demonstrating significant unadjusted associations and without significant amounts of missing data, defined as less than 80% data completion, were included in the multivariate analysis. The laboratory variables had extensive missingness and were therefore excluded from the multivariate analysis. Septic shock, sepsis, and deep tissue and organ infection were also excluded from multivariate analysis due to extensive missing data. Due to limited data for individual medical comorbidities, all comorbidities were combined and analyzed. The presence or absence of comorbidity was reported as a single dichotomous variable.

RESULTS

A total of 137,209 patients were included in the study. The overall 30-day readmission rate for patients after primary TKA was 3.4% (4,668 of 137,209 patients).

The average age for patients in this study was 66.6 years. Older age, male sex, black race, and higher BMI category were significant ($p<0.0001$) demographic factors positively associated with readmission (Table 1 and Table 2). Asian and unreported race were significant ($p<0.0001$) demographic factors negatively associated with readmission (Table 1 and Table 2). For the medical comorbidities, smoking, insulin-dependent vs non-insulin-dependent diabetes, dialysis use, hypertension, congestive heart failure, dyspnea, COPD, bleeding disorder, preoperative open wound and wound infection, as well as corticosteroid use were significantly ($p<0.0001$) positively associated with readmission. Laboratory values such as elevated WBC count, low hematocrit, low platelets, elevated creatinine, low serum albumin, and elevated INR were also significantly ($p<0.0001$) positively associated with readmission. Other operative variables, such as increased operation time, use of general anesthesia vs other techniques, and increased time from operation to discharge also demonstrated significant ($p<0.0001$) positive associations with readmission.

All variables shown in Table 3 demonstrated statistically significant ($p<0.0001$) positive associations with readmission. The overall complication rate among readmitted patients was 58.0% (6,143 of 137,209 patients) compared to 10.4% among non-readmitted patients. Among readmitted patients, 32.4% developed medical complications and 25.6% developed surgical complications.

Each year of increasing age (OR, per year: 1.02; 95% CI, 1.02 to 1.03) and black vs white race (OR, black vs white race: 1.24; 95% CI, 1.11 to 1.37) were significant independent positive risk factors for 30-day readmission. Female vs male sex (OR, female vs male: 0.78; 95% CI, 0.73 to 0.83), Asian vs white race (OR, Asian vs white race: 0.62; 95% CI, 0.48 to 0.80), and unknown or unreported vs white race (OR, unreported vs white race: 0.87; 95% CI, 0.78 to 0.96) demonstrated significant protective effects. Morbidly obese patients had significantly higher odds of readmission than overweight patients (OR: 1.20; 95% CI, 1.08 to 1.32). Patients with ASA class 4 had more than twice the odds of being readmitted compared to those with ASA class 2 (OR: 2.06; 95% CI, 1.73 to 2.44). Patients with ASA class 3 also had significantly higher odds of readmission compared to those with ASA class 2 (OR: 1.43; 95% CI, 1.34 to 1.53). Each additional minute of operative time was found to be an independent positive risk factor for readmission (OR per minute: 1.002; 95% CI, 1.002 to 1.003). The presence of one or more preoperative comorbidity was positively associated with readmission compared to patients with no comorbidities (OR: 1.29; 95% CI, 1.25 to 1.34, $p<0.0001$). (Table 2)

All postoperative complications included in the multivariate analysis demonstrated significant independent associations with readmission (Table 3). Patients who were readmitted had over ten-times the odds of postoperative pneumonia, MI, acute renal failure, stroke, or ventilator use for over 48 hours. Similarly, patients who were readmitted had over ten-times the odds of postoperative superficial surgical site infection, pulmonary embolism, or deep vein thrombosis.

Table 1. Preoperative and Operative Characteristics.

Variable	Not Readmitted* (N= 132,541)	Readmitted* (N=4,668)	P Value	Variable	Not Readmitted* (N= 132,541)	Readmitted* (N=4,668)	P Value
Age¥	66.53	68.49	<0.0001	Pre-op blood transfusion	67 (0.1%)	7 (0.2%)	0.004
Sex [8]			<0.0001	Open / infected wound	325 (0.3%)	35 (0.8%)	<0.0001
Male	49,856 (37.6%)	2,039 (43.7%)		Systemic Sepsis			0.16
Female	82,685 (62.4 %)	2,629 (56.3%)		SIRS	241 (0.2%)	15 (0.3%)	
Race [8]			<0.0001	Septic Shock	5 (0.0%)	0 (0.0%)	
White	103,659 (78.2 %)	3,691 (79.1%)		Sepsis	5 (0.0%)	0 (0.0%)	
Black	9,567 (7.2%)	440 (9.4%)		Corticosteroid use	4,675 (3.5%)	260 (5.6%)	<0.0001
Asian	2,845 (2.2%)	63 (1.4%)		**Preoperative Labs**			
American Indian	711 (0.5%)	15 (0.3%)		WBC count ($X10^3$/ L)	7.05 (2.75 - 11.35)	7.26 (1.64 - 12.88)	<0.0001
Native Hawaiian	418 (0.3%)	9 (0.2%)		Hematocrit (%)	40.82 (32.74 - 48.9)	40.29 (31.51 - 49.07)	<0.0001
Unreported	15,341 (11.6%)	450 (9.6%)		Platelets ($X10^3$/ L)	244.12 (111.52 - 376.72)	239.44 (97.78 - 381.1)	<0.0001
BMI Category[8]			<0.0001	Creatinine (mg/dL)	0.91 (0.11 - 1.71)	1.01 (0.21 - 1.81)	<0.0001
Underweight (<18.5)	287 (0.2%)	10 (0.2%)		Serum albumin (g/dL)	4.10 (3.34 - 4.86)	4.02 (3.2 - 4.84)	<0.0001
Normal (18.5 - 25)	12,938 (9.8%)	466 (10.0%)		INR	1.02 (0.52 - 1.52)	1.06 (0.56 - 1.56)	<0.0001
Overweight (25 - 30)	35,731 (27.0%)	1,211(26.0%)		**Operative Variables**			
Obese (35 - 35)	37,746 (28.6%)	1,246 (26.8%)		ASA class[8]			<0.0001
Very obese (35 - 40)	25,312 (19.2%)	824 (17.7%)		1	2,837 (2.1%)	66 (1.4%)	
Morbid Obese (≥ 40)	20,186(15.3%)	894 (19.2%)		2	67,123 (50.6%)	1,683 (36.1%)	
Comorbid Conditions[8]				3	60,447 (45.6%)	2,745 (55.8%)	
Recent weight loss	146 (0.1%)	6 (0.1%)	0.711	4	2,025 (1.5%)	169 (3.3%)	
Smoking	11,401 (8.6%)	482 (10.3%)	<0.0001	5	4 (0.00%)	0 (0.00%)	
Diabetes			<0.0001	Not assigned	105 (0.08%)	5 (0.11%)	
Insulin- dependent	5,759 (4.4%)	345 (7.4%)		Operation time# (min)	93.59 (55.24 - 131.94)	97.78 (53.78 - 141.78)	<0.0001
Non-insulin	17,830 (13.5%)	706 (15.1%)		Anesthesia technique[8]			<0.0001
Dialysis Use	197 (0.2%)	22 (0.5%)	<0.0001	General	67,722 (51.1%)	2,563 (54.9%)	
Hypertension	86,387 (65.2%)	3,460 (74.1%)	<0.0001	Neuraxial	51,743 (39.0%)	1,685 (36.1%)	
CHF	336 (0.3%)	44 (0.9%)	<0.0001	Regional	2,644 (2.0%)	83 (1.8%)	
Dyspnea	7,821 (5.9%)	456 (9.8%)	<0.0001	MAC or IV sedation	10,235 (7.7%)	327 (7.0%)	
COPD	4,605 (3.5%)	373 (8.0%)	<0.0001	Local	38 (0.0%)	0 (0.0%)	
Bleeding disorder	3,022 (2.3%)	241 (5.2%)	<0.0001	Days to discharge#	2.99 (2.16)	3.36 (2.13)	<0.0001

* Some data points were unrecorded and were therefore unavailable for inclusion in the evaluation. ¥ The values given represent the average age of patients, in years. 8 The values are given as a number of patients, with the percentage in parentheses. # The values given represent an average, with 1 standard deviation in parentheses.

Table 2. Preoperative and Operative Characteristics as Risk Factors for Readmission After Total Knee Arthroplasty

Variable	Odds Ratio (95% CI) ¥ǂ	P value ǂ
Preoperative Characteristics		
Age (per year)	1.021 (1.018 to 1.025)	<0.0001
Sex female vs male	0.78 (0.73 to 0.83)	<0.0001
Race		
Black vs White	1.24 (1.11 to 1.37)	<0.0001
Asian vs White	0.62 (0.48 to 0.80)	0.0002
Native Hawaiian vs White	0.58 (0.30 to 1.13)	0.1118
American Indian vs White	0.60 (0.36 to 1.00)	0.0514
Non reported vs White	0.87 (0.78 to 0.96)	0.0048
BMI Category		
Underweight vs Overweight	1.06 (0.56 to 1.99)	0.8670
Normal vs Overweight	1.11 (0.99 to 1.23)	0.0750
Obese vs Overweight	0.96 (0.88 to 1.04)	0.2742
Very obese vs Overweight	0.92 (0.84 to 1.01)	0.0715
Morbidly Obese vs Overweight	1.20 (1.08 to 1.32)	0.0003
Comorbidities	1.29 (1.25 to 1.34)	<0.0001
Operative variables		
ASA class		
1- No disturb vs 2 -Mild Disturb	1.19 (0.93 to 1.53)	0.1705
3- Severe Disturb vs 2 -Mild Disturb	1.43 (1.34 to 1.53)	<0.0001
4- Life Threat vs 2 -Mild Disturb	2.06 (1.73 to 2.44)	<0.0001
Non Assigned vs 2 -Mild Disturb	1.75 (0.71 to 4.32)	0.2225
Operation time (per min)	1.002 (1.002 to 1.003)	<0.0001

¥ The values are given as the odds ratio, with the 95% CI in parentheses. ǂ Logistic regression modeling adjusted for age, sex, race, BMI category, and presence of one of more preoperative comorbidities, ASA class, and operative time.

DISCUSSION

The number of TKA being performed across the U.S is increasing, presenting a challenge in a rapidly changing healthcare landscape. Changing patient demographics and regulations creating financial penalties for adverse patient outcomes has created an incentive for scrutiny in this area. A previous study of the ACS-NSQIP database from 2011 found that older age, male gender, positive cancer history, elevated BUN, presence of a bleeding disorder, and high ASA score were shown to be positive predictors of readmission, though, this focused on all joint arthroplasties.[10] However, with TKA being the most common performed arthroplasty along with the availability of multiple years of additional data, it is necessary to update and refine our understanding of factors influencing readmission following TKA. Our analysis of the data from a cohort of 137,209 patients from 2012-2015 found that the 30-day readmission rate following TKA was 3.4%. Many demographic characteristics, preoperative comorbidities, laboratory abnormalities and postoperative complications were associated with higher rates of readmission following TKA. Increasing age, male sex, black race, morbid obesity, presence of one or more comorbidities, postoperative complications, ASA class 3 or 4, and longer operation time demonstrated significant, independent positive associations with 30-day readmission following TKA.

Our study's 30-day readmission rate (3.4%) is consistent with existing literature; 30-day readmission rates following TKA have been reported between 2.4% - 5.8%.[10,14-18] Our study reports a lower 30-day readmission rate compared with Pugely et al's 2011 study of the same NSQIP database (3.4% vs 4.6%),[10] which may suggest that regulatory efforts and risk reduction initiatives in recent years have had a positive effect. This is consistent with an institutional cohort by Keeney et al which showed that introduction of risk reducing initiatives significantly reduced 30-day readmission rates following

Table 3. Postoperative complications as risk factors for readmission after total knee arthroplasty.

	Not Readmitted*ϑ (N=132,541)	Readmitted*ϑ (N=4,668)	P Value ¶	Odds Ratio (95% CI) ¥ǂ	P Value ǂ
Overall complications	13,835 (10.4%)	6,143 (58.0%)	<0.0001		
Medical complications	11,753 (8.9%)	1,513 (32.4%)	<0.0001		
Pneumonia	327 (0.3%)	176 (3.8%)	<0.0001	12.15 (10.04 to 14.71)	<0.0001
Unplanned intubation	138 (0.1%)	66 (1.4%)	<0.0001	9.94 (7.35 to 13.46)	< 0.0001
Urinary tract infection	975 (0.7%)	225 (4.8%)	<0.0001	6.22 (5.34 to 7.23)	<.0.0001
Ventilator for more than 48 hours	62 (0.1%)	35 (0.8%)	<0.0001	11.16 (7.28 to 17.09)	<.0.0001
Stroke or cerebrovascular accident	72 (0.1%)	37 (0.8%)	<0.0001	12.18 (8.11 to 18.28)	<.0.0001
Acute renal failure	41 (0.0%)	33 (0.7%)	<0.0001	15.26 (9.50 to 24.52)	<.0.0001
Cardiac arrest	81 (0.1%)	30 (0.6%)	<0.0001	7.68 (5.00 to 11.81)	<.0.0001
Septic Shock	32 (0.0%)	57 (1.2%)	<0.0001		
Sepsis	67 (0.1%)	191 (4.1%)	<0.0001		
Myocardial infarction (MI)	152 (0.1%)	125 (2.7%)	<0.0001	18.48 (14.47 to 23.58)	<.0.0001
Blood transfusion	9,806 (7.4%)	538 (11.5%)	<0.0001	1.41 (1.28 to 1.55)	<.0.0001
Surgical complications	2,082 (1.6%)	1,195 (25.6%)	<0.0001		
Superficial surgical site infection	481 (0.4%)	224 (4.8%)	<0.0001	13.53 (11.46 to 15.98)	<.0.0001
Deep or incisional surgical site infection	49 (0.0%)	164 (3.5%)	<0.0001		
Organ or space surgical site infections	26 (0.0%)	179 (3.8%)	<0.0001		
Pulmonary embolism	613 (0.5%)	319 (6.8%)	<0.0001	16.45 (14.27 to 18.96)	<.0.0001
Deep venous thrombosis	913 (0.7%)	309 (6.6%)	<0.0001	10.32 (9.02 to 11.82)	<.0.0001

* Some data points were unrecorded and were therefore unavailable for inclusion in the evaluation. ϑ The value are given as a number of patients, with the percentage in parentheses. ¶ P value from univariate modeling. ¥ The values are given as the odds ratio, with the 95% CI in parentheses. ǂ Logistic regression modeling adjusted for age, sex, race, and presence of one of more preoperative comorbidities, ASA class, and operative time. Not adjusted for concurrent medical or surgical complications.

TKA at their institution from 5.6% in 2006-2009 to 3.0% in 2010-2013 ($p<0.001$).[17] However, it is also possible that our large sample size was responsible for the differences between our results and the previous study by Pugely et al.

Our findings that increasing age, male sex, comorbidities, high BUN and high ASA score are associated with higher rates of readmission are consistent with other studies,[10,18] although large amounts of missing data points prevented us from identifying BUN as a predictor on multivariate analysis. We identified additional variables as risk factors for 30-day readmission that were not found by Pugely et al, including black versus white race, operative time, morbid obesity, and medical and surgical postoperative complications. D'Apuzzo, et al's 2017 study of 377,705 patients from the Statewide Planning and Research Cooperative System (SPARCS) database reported that black race was associated with increased TKA-specific 30-day readmissions, but not all-cause readmissions, as was the case in our study. Similar to our study D'Apuzzo found that Asian race was significantly negatively associated with all cause 30-day readmission (OR: 0.65; 95% CI, 0.56 to 0.75; $p<0.001$).[18] However, unreported race was significantly negatively associated with readmissions compared to white race (OR: 0.87, 95%CI, 0.78 to 0.96) in our study, whereas D'Apuzzo reported a significant positive association (OR: 1.62; 95%CI, 1.52 to 1.71).[18]

Readmission rate was higher among morbidly obese patients (4.24%, 894 of 21,080 patients) compared to all other BMI categories, and morbid obesity was associated with higher odds of readmission (OR: 1.20; 95%CI, 1.08 to 1.32). Neither Pugely or D'Apuzzo reported that BMI over 35 kg/m^2 or obesity, respectively, were risk factors for all-cause readmission in TKA, though D'Apuzzo did report a positive association between obesity and TKA-specific readmission.[10,18]

In this study, 58% of readmitted patients experienced medical or surgical complications in the postoperative period compared to 10.4% of non-readmitted patients, and multiple medical and surgical complications were positively associated with increased odds of readmission. D'Apuzzo et al also found medical and surgical in-hospital complications to be associated with increased odds of 30-day readmission, although they did not stratify by individual complication type. In our study the largest positive association with readmission among postoperative complications was MI. Readmitted patients had more than 18 times higher odds of experiencing MI than non-readmitted patients. Thus improvements in preventing MI or identifying patients most at risk of developing MI prior to surgery may help decrease readmission. Acute renal failure (Odds Ratio 15.26) and other pulmonary complications (ventilator use, pneumonia, and unplanned intubation) were close behind MI as high magnitude positive risk factors of readmission. While a cardiopulmonary exam and basic renal function panel are staples of the preoperative assessment, our results emphasize the importance of thorough preoperative workup when attempting to reduce hospital readmissions. Many surgeons require a note from the primary care provider before a total knee replacement or that patients demonstrate a certain level of cardiopulmonary fitness prior to surgery. Standardized preoperative assessments and further identification of patients at risk of developing these complications may help reduce readmission after TKA. Postoperative deep venous thrombosis and pulmonary embolism were also high magnitude independent risk factors for readmission (Odds Ratio 16.45 and 10.32, respectively). While the majority of institutions and physicians implement prophylactic pharmacologic anticoagulation in the post-operative period, our findings emphasize the importance of patient education and preventive care to decrease hospital readmissions within 30 days of surgery.

Aside from medical and surgical complications, very high ASA class was associated with the highest odds of readmission. Patients with ASA class 4 had more than twice the odds of readmission compared to ASA class 2. Similarly, patients with ASA class 3 had 1.43 times the odds of readmission than ASA class 2 patients. Multiple retrospective studies of individual institutions report similar findings.[16,19] The ASA classification system is widely utilized and available as a reliable predictor of readmission risk after TKA.

Better understanding of risk factors allows the development and implementation of evidence-based interventions aimed at mitigating risks and reducing 30-day readmission rates following TKA. These risk factors for readmission are already being utilized to reduce hospital costs; young patients with low ASA scores and few medical comorbidities are often discharged early (0-2 days) and these early discharges are not associated with increased complications or readmissions.[20]

Information from this study can be used to identify and counsel high-risk patients prior to surgery. Continued research and understanding in this area will allow more informed discussion of each patient's individual risks and benefits for undergoing TKA. We hope this information will be used by healthcare providers to improve

the anticipation, prevention, and early detection of poor outcomes, leading to reduced cost and improved patient care.

The results of this study should be interpreted in light of certain limitations. Demographically our patient sample was majority female (62.2%) and racially non-diverse. The overwhelming majority of patients were white (78.2%) or unreported (11.5%). Although we used a widely studied, validated database, errors in data entry or misclassifications may have occurred. This may be particularly important in calculated variables, such as BMI, which relies on the accuracy of both height and weight. This study was also limited by significant amounts of missing data in certain variables of interest.

CONCLUSION

This study was successful in identifying new variables associated with early readmission in patients undergoing TKA. Increasing age, male sex, black race, morbid obesity, the presence of preoperative comorbidities, high ASA class and increased operative time were significant positively associated independent risk factors rates following TKA.

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ORIGINAL ARTICLE

PERCUTANEOUS TREATMENT OF ANEURYSMAL BONE CYST WITH CALCITONIN AND METHYLPREDNISOLONE

TRATAMENTO PERCUTÂNEO DE CISTO ÓSSEO ANEURISMÁTICO COM CALCITONINA E METILPREDNISOLONA

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ABSTRACT

Objective: To introduce the intralesional calcitonin and methylprednisolone percutaneous injection method, which results in the promotion of primary aneurysmal bone cyst (ABC) healing. Methods: A retrospective cohort study involving 76 patients diagnosed with ABC was performed between 2005 and 2014. Patients treated with calcitonin and methylprednisolone injection and who underwent more than 2 years of follow-up were considered eligible for the study (n=47). The Enneking staging and Capanna classification systems were used during the initial evaluation. Treatment response was assessed by Rastogi radiographic grading based on the degree of healing. X^2 and Wilcoxon signed-rank tests and odds ratio calculations were used in the statistical analysis with a 5% significance level. Results: The proximal tibia extremity was the most commonly affected site (17.0%). Thirty-three (70.3%) ABC cases were staged as B3 and 28 (59.7%) were classified as type II. The average number of injections performed was 2.8 per patient, with an average reduction of the initial lytic area of 83.7% (p-value=0.00001). Satisfactory results for 91.4% (n=43; p-value=0.00001) were obtained and 5 recurrences occurred. No side effects were observed. Conclusion: Intralesional calcitonin and methylprednisolone percutaneous injection is a minimally invasive, effective, and safe method for promoting primary ABC healing. ***Level of evidence IV, Type of study: case series.***

Keywords: Bone cyst. Calcitonin. Methylprednisolone.

RESUMO

Objetivo: Apresentar o método de injeção intralesional percutânea de calcitonina e metilprednisolona para promover a ossificação do cisto ósseo aneurismático (COA). Métodos: Foi realizado um estudo retrospectivo de coorte envolvendo 76 pacientes com diagnóstico de COA entre 2005 e 2014. Os pacientes tratados com injeção de calcitonina e metilprednisolona e acompanhados durante mais de dois anos foram considerados elegíveis para o estudo (n = 47). Foram utilizados o sistema de estadiamento de Enneking e a classificação de Capanna durante a avaliação inicial. A resposta ao tratamento foi avaliada pela classificação radiográfica Rastogi, com base no grau de cicatrização. Os testes X^2, Wilcoxon e o cálculo da razão de chances foram utilizados na análise estatística com nível de significância de 5%. Resultados: A extremidade proximal da tíbia foi o local mais frequente (17,0%). Trinta e três (70,3%) COA eram B3 e 28 (59,7%) do tipo II. O número médio de injeções aplicadas foi de 2,8 por paciente, com redução média da área lítica inicial de 83,7% (p = 0,00001). Resultados satisfatórios para 91,4% (n = 43; p = 0,00001) dos pacientes e houve cinco recidivas. Nenhum efeito colateral foi observado. Conclusão: A injeção intralesional percutânea de calcitonina e metilprednisolona é um método minimamente invasivo, eficaz e seguro para promover a ossificação do COA. ***Nível de evidência IV, Tipo de estudo: série de casos.***

Descritores: *Cistos ósseos. Calcitonina. Metilprednisolona.*

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INTRODUCTION

Aneurysmal bone cyst (ABC) was first described by Jaffe and Liechestein in 1942 91). The World Health Organization defines ABC as an "expanding osteolytic lesion consisting of blood-filled spaces of variable size separated by connective tissue containing trabeculae of bone or osteoid tissue and osteoclast giant cells." It is considered an active or aggressive benign bone tumor that may result in high morbidity and recurrence if not properly treated.[1]

ABC accounts for approximately 1% of all primary bone tumors and most commonly occurs during the first and second decades of life, with a slight predominance in females.[1,2] The main affected sites are the distal end of the femur and proximal end of the tibia.[1,2] The optimal treatment for ABC is controversial and several methods have been reported.[1-3] The recurrence rate ranges from 5% to 40%, depending on the method of treatment used.[1-3] Currently, the most widely used method is curettage combined with grafting.[1-4] This

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method results in a high relapse rate, prolonged recovery period, risk of bleeding, and damage to surrounding structures essential for maintaining the function of the affected segment, especially in vertebral and pelvic lesions.[4-6] Therefore, less invasive methods to promote ABC healing with reduced surgical morbidity, especially in areas with difficult access, are increasingly being used. Accordingly, percutaneous intralesional injection of sclerosing agents and healing stimulators has proven to be a promising alternative to conventional surgical treatment.[1,3,6-9]

Recently, given the presence of osteoclastic giant cells in this bone tumor, the receptor activator of nuclear kappa-B ligand has been used as a potential target for promoting ABC healing through its inhibition by denosumab.[10] However, in case studies, calcitonin and methylprednisolone percutaneous intralesional injection also promoted the healing of ABCs located in the spine, where the risks and surgical morbidity are higher.[7-9] Given these favorable results, we have been using this method to treat primary ABCs in long bones as a minimally invasive and low-cost alternative in our institution since 2003. Therefore, the present study describes a calcitonin and methylprednisolone intralesional injection method that promotes primary ABC healing.

MATERIAL AND METHODS

Study population

A retrospective cohort study involving 76 patients with ABCs diagnosed between January 2005 and December 2014 at a single institution was performed.

After the initial selection of patients from the database of the Pathological Anatomy Unit, the following exclusion criteria were applied: secondary ABC, ABC located in the spine, initial surgical treatment, and incomplete radiographic evaluation.

Twenty-nine patients were excluded according to the following criteria: secondary ABC (n=10), spine ABC (n=3), surgery as the initial treatment (n=10), and absence of complete radiographic evaluation available (n=6). The study group consisted of 47 patients with primary ABC treated with calcitonin and methylprednisolone intralesional injection.

Diagnosis

The method used for diagnosis of primary ABC in all patients involved histopathological study of specimens collected by percutaneous biopsy of the lesion using a bone marrow biopsy needle guided by computed tomography or radioscopy. The anatomopathological, clinical, and radiological correlations were performed by a pathologist who specialized in bone pathology to confirm the diagnosis.

Variables

To determine the demographic profile of the sample, age at diagnosis and gender were collected by reviewing the medical records. The following radiographic variables were assessed at diagnosis: lesion volume, staging according to the Enneking system,[11] affected bone, and location of the tumor according to the Capanna classification[12] (Table 1).

Table 1. Capanna classification.

Type	Morphological characteristics
I	Central
II	Central affecting the entire bone diameter
III	Eccentric
IV	Subperiosteal
V	Subperiosteal extending to soft parts

Method

The procedure followed the same protocol for all patients and was conducted by two surgeons who used sedation and local anesthesia with an aseptic technique, percutaneously guided radioscopy in appendicular lesions, and computed tomography in pelvic lesions. The method consists of introducing an 11-gauge bone marrow biopsy needle into the lesion with the guidance of imaging until it reaches the largest lytic portion of the tumor. The cyst walls are manually scarified using the end of the needle to break the non-healed septa and the hematic content is aspirated. Then, a 5-ml syringe containing a solution of 200 IU calcitonin and 120 mg methylprednisolone and another syringe containing 10 ml distilled water are attached to the bone marrow biopsy needle through a 3-way connector. Subsequently, the solution is injected into the lesion (Figure 1). Then, the biopsy needle introduced into the lesion and still containing the residual solution is rinsed with distilled water, which is injected from the second syringe, so that the entire dose of drugs reaches the lesion. Finally, pressure dressing is performed and maintained for 3 days. The patient is discharged on the same day as the procedure and the healing status is followed-up monthly through radiographs or computed tomography scans according to the location of the lesion. According to the classification proposed by Rastogi,[6] the procedure is repeated if no satisfactory healing of the lesion occurs after 2 months.

Treatment response

Treatment results were measured based on monthly evolutionary radiographic evaluation until the lesion healed and quarterly evaluation during the first 2 years after healing. Evaluation consisted of comparing the percentage of volumetric reduction of lytic bone involvement before and after treatment and quantifying healing at each follow-up appointment according to the classification proposed by Rastogi[6] (Table 2). At the end of the follow-up period, the outcome was classified as satisfactory (excellent or good) or unsatisfactory (poor or unresponsive).

The criteria for treatment discontinuation were satisfactory result assessment or treatment failure, which was defined as healing less than 50% after the first two injections or disease progression before reaching degree II of healing as identified by an increase in lytic area. Recurrence was defined as an increase of the lytic area after reaching degree I or II (excellent or good) of healing. Surgical treatment was performed if percutaneous treatment failure occurred. However, in the recurrence, the percutaneous procedure was still indicated. The minimum follow-up period after healing was 2 years.

Statistical analysis

The ratios of cases that did and did not responded to treatment were compared using the $\chi 2$ test**.** The Wilcoxon signed-rank test was used to compare the lytic areas before and after treatment. Analysis of the effect of study variables on treatment response was performed by calculating the odds ratio with a 95% confidence interval. SPSS 10.0® software was used and p-value <0.05 was considered significant.

Research ethics

This research project numbered as 50105815.7.0000.5273, which was approved by our institution's Research Ethics Committee, is in accordance with the Helsinki Declaration for experiments involving humans. All participants read and signed the informed consent form.

RESULTS

The sample of 47 patients consisted of 23 men and 24 women. The average age was 17.5 years (4–54 years). Patient characteristics are outlined in Table 3.

ABC was predominantly located in the proximal tibia extremity (19.1%; n=9). Figure 2 shows the distribution of ABC.

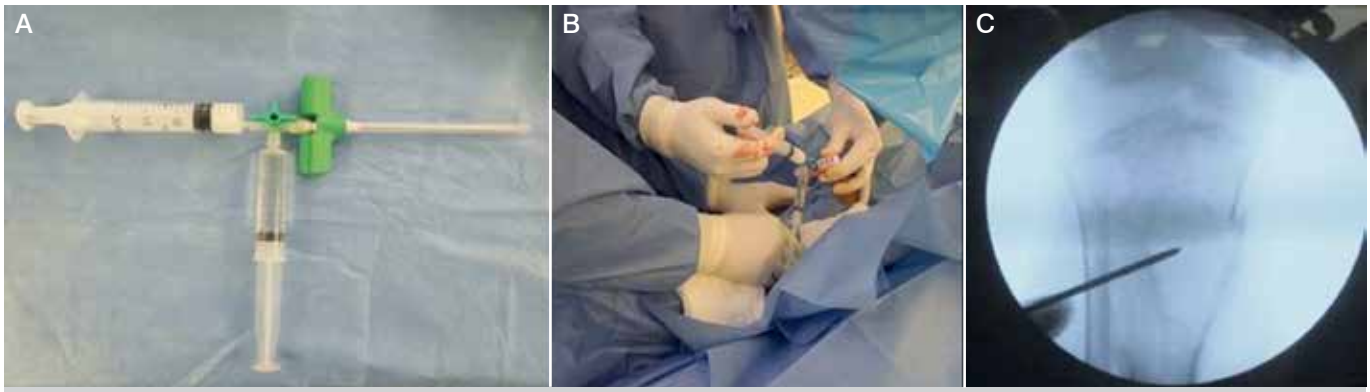

Figure 1. Injection method. A) Biopsy needle with a 3-way connector attached to two syringes containing the calcitonin and methylprednisolone solution and distilled water. B) Intralesional injection of calcitonin and methylprednisolone. C) Radioscopic control of the injection.

Table 2. Radiographic classification according to Rastogi.

Degree	Characteristic	Result
I	Residual lesion <25%	Excellent
II	Residual lesion 25–50%	Good
III	Residual lesion 50–75%	Poor
IV	Residual lesion >75%	Unresponsive

Table 3. Patient characteristics

Variable		
	n	%
Average age (range)	17.5 years (4–54)	
≤16 years	28	59.5
>16 years	19	40.5
Gender		
Male	23	48.9
Female	24	51.1
Average volume (range)	50.6 cm^3 (9.4–163.6)	
Enneking		
B1	—	—
B2	14	29.7
B3	33	70.3
Capanna		
I	5	10.6
II	28	59.7
III	13	27.6
IV	1	2.1
V	—	—

Figure 3 shows the number of procedures required to promote ABC healing according the number of treated patients. A total of 131 procedures were performed (average=2.8/patient), with an 83.7% average reduction of the initial lytic area (p-value=0.00001). Only 1 procedure was performed in 9 patients (19.1%), 2 procedures were performed in 14 (29.7%), 3 procedures were performed in 10 (21.2%), 4 procedures were performed in 7 (14.8%), 5 procedures were performed in 5 (10.6%), 6 procedures were performed in 1 (2.1%), and 7 procedures were performed in 1 (2.1%; Figure 4). The average length of treatment was 10.3 months (2–59.5 months) and the average length of follow-up was 45.5 months.

According to the radiographic classification used to assess the treatment response, 91.4% (n=43) of patients showed satisfactory (excellent or good) results (p-value=0.00001) and 72.3% (n=34) showed complete cyst healing (degree I; Table 4).

Figure 4 shows an outcome classified as excellent (degree I) at the end of treatment.

Table 5 shows the average number of procedures performed according to the study variables and indicates the initial average volume of lesions and the residual percentage at the end of treatment.

Among the variables studied as possible prognostic factors, younger patients (≤16 years) had a higher percentage of good results than did older patients (>16 years) (92.8% and 89.4%, respectively), but the difference was non-significant. B2 ABCs (active) had better outcomes (100%; n=14) than B3 ABCs (aggressive) (87.8%; n=29), but the difference was non-significant. Conversely, patients with Capanna type II lesions had worse outcomes (89.2%; n=25) than all others (94.7%; n=18), although the difference was also non-significant (Table 6).

During follow-up, 5 patients (10.6%) experienced recurrence. Therefore, the percutaneous procedure was repeated; 3 patients progressed with an excellent or good response after 1 or 2 injections. The other 2 patients were surgically treated due to disease progression. One progressed with a pathological fracture, although the lesions subsequently healed.

DISCUSSION

ABC is a rare, locally aggressive, benign tumor with a prevalence of 1.4 cases per 100,000 individuals.[1,2] The lesion may occur in any bone and at any age, although more than 50% occur in long bones and approximately 80% of the cases involve patients younger than age 20 years.[1,2] Approximately 70% of ABCs are primary and the remaining 30% are secondary to hemorrhagic degenerative events in preexisting bone lesions, including giant cell tumor, simple bone cyst, and chondroblastomas.[1]

The vascular theory of pathogenesis postulates that ABC is a reaction to a local hemodynamic disorder resulting in increased venous pressure and formation of a dilated vascular bed in the affected bone.[1] However, the vascular theory has been surpassed by the clonal theory based on more recent studies describing the recurring presence of a specific chromosome translocation, t(16;17) (q22;p13), in primary ABC and insulin-like growth factor 1 (IGF-1) expression.[13] These findings confirm that primary ABC is a true tumor and not a pseudotumoral lesion, as previously believed, which may explain the effect of drugs with angiostatic, cytostatic, and bone-forming properties in promoting healing.[14]

Several methods have been described for ABC treatment, and the best therapeutic option is still undergoing debate. Recurrence within 24 months after treatment is common and ranges from 10 to 59% depending on the method used.[2,6] Intralesional curettage combined with grafting is still the most often indicated method.[1,15]

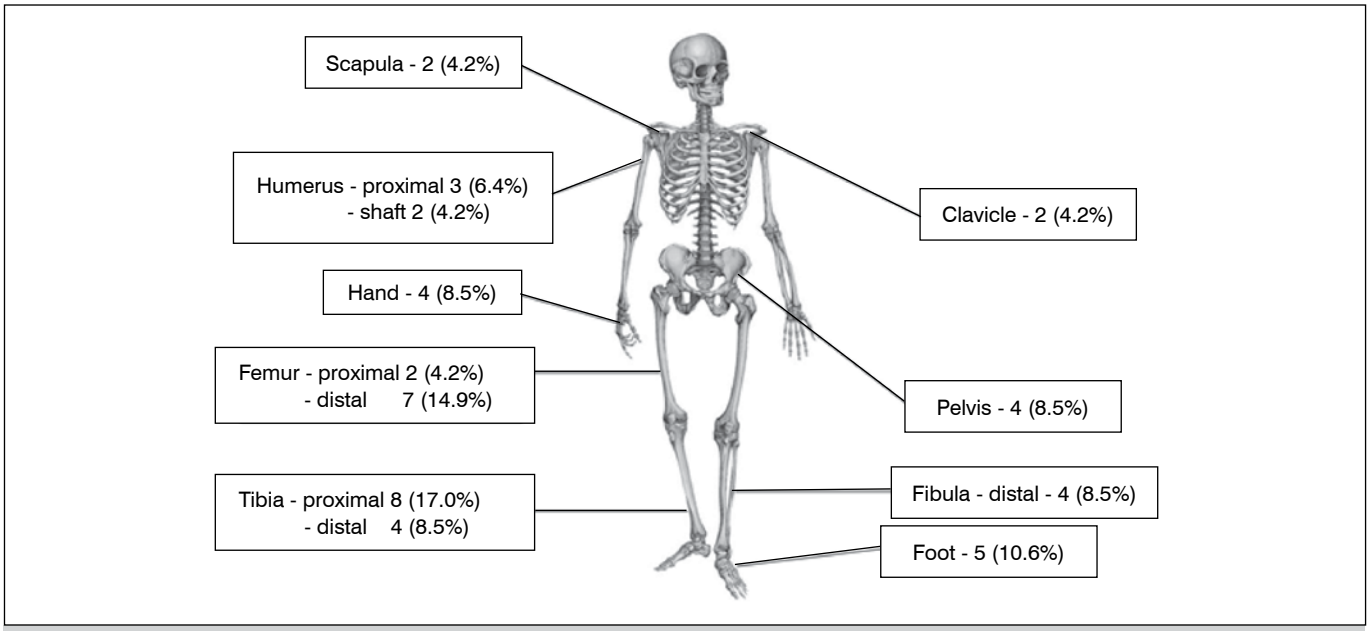

Figure 2. Location of aneurysmal bone cysts.

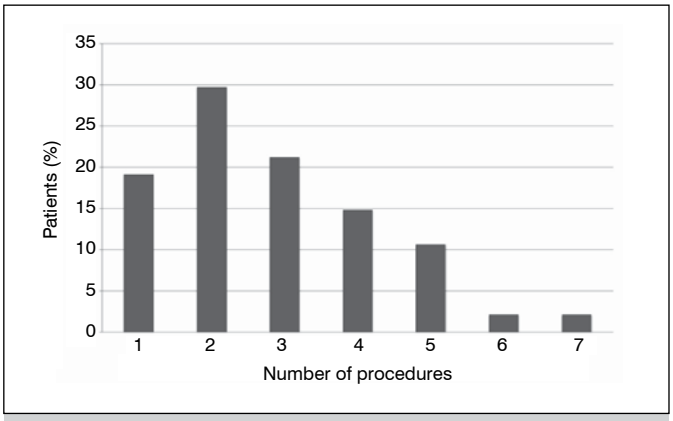

Figure 3. Distribution of the number of procedures at the end of the follow-up period.

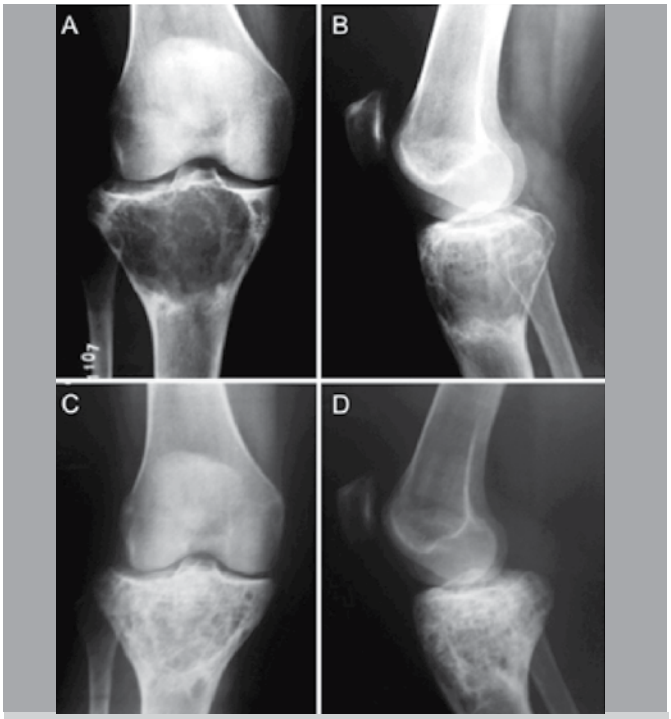

Figure 4. Excellent outcome. A/B) Plain films showing a large ABC in the proximal tibia before treatment. C/D) Plain films 4 months after the end of treatment showing complete ABC healing.

However, surgical treatment may result in extensive bone defects and involves a significant risk of bleeding and damage to key anatomical structures. In addition to profuse bleeding, the risk of lesions of the physeal plate among growing children also renders surgical treatment challenging.[7] Therefore, non-surgical methods, including sclerotherapy, selective arterial embolization, and injection of healing-inducing agents, are gaining relevance in the management of these patients.[6,7,15,16] High success rates were reached using those different treatment modalities. However, no prospective, randomized, controlled studies comparing them with conventional surgical treatment have been published in the literature. Thus, the choice of method is usually guided by the experience and preference of the surgeon.

Percutaneous methods have been increasingly used for ABC treatment to cause the least possible morbidity to patients. Selective arterial embolization and sclerotherapy are the most widely used non-surgical methods.[15] However, calcitonin and methylprednisolone percutaneous intralesional injection is a promising alternative that is expected to deliver lower complication rates.[7,9,17]

The first study describing the use of calcitonin for ABC treatment was published by Szendroi, who retrospectively assessed 7 patients

Table 4. Treatment outcome at the end of the follow-up period

Degree of healing		
	N	%
I	34	72.3
II	9	19.1
III	3	6.3
IV	1	2.1

Table 5. Average number of procedures.

Variable			
	Procedures	**Volume (cm^3)**	**% Residual**
Gender			
Male	3.0	58.8	16.3
Female	2.6	43.2	16.3
Age			
≤16 years	3.1	45.2	19.1
>16 years	2.4	55.1	20.3
Enneking			
B2	2.2	42.0	13.9
B3	2.9	56.6	18.4
Capanna			
II	2.9	46.1	16.4
I, III, IV, or V	2.5	54.7	18.7

Table 6. Univariate analysis.

Category	**Good result**				
	N	**%**	**OR**	**95% CI**	**p-value**
Age					
≤16 years	28	92.8	1.52	0.19–11.9	0.68
>16 years	19	89.4			
Gender					
Male	24	91.3	0.95	0.12–7.40	0.96
Female	23	91.6			
Enneking					
B2	14	100	4.42	0.22–87.8	0.32
B3	33	87.8			
Capanna					
II	28	89.2	0.46	0.04–4.82	0.51
I, III, IV, or V	19	94.7			

receiving 3 weekly injections for 5 weeks. In this series, 3 cysts completely healed, 3 cysts partly healed, and the treatment of 1 patient was discontinued due to hypersensitivity reaction.[18]

The combination with methylprednisolone as an adjuvant was first described for the treatment of cervical spine ABC in children at increased risk for devastating complications due to inadvertent embolization of the vertebral artery because invasive procedures may result in vertebral instability.[7,9,19] Gladden and collaborators proposed that the combination of methylprednisolone with calcitonin would result in a synergistic effect to promote ABC healing because of the angiostatic and fibroblast formation-inhibitory activities of the corticoid combined with the inhibitory effect on osteoclasts and trabecular bone formation-stimulating effects of calcitonin.[7-9] The authors reported the case of a child with ABC who underwent 2 injections with 6-month intervals. Lesion healing occurred after 2 years and 7 months without side effects.[7] Rai and Collins[19] and Ohashi and collaborators[9] also published similar results using this method; they observed progressive healing and no adverse effects. Only two injections were performed over several months in both studies.[9,19]

To our knowledge, no studies assessing the method used with a larger case series than that of the present study have been published in the literature. Articles initially published were limited to case reports of ABCs located in the axial skeleton.[7-9,19] The articles identified in the literature review include 7 patients with primary ABC treated with the calcitonin and methylprednisolone intralesional injection method. The protocols used in these studies vary regarding the dose and dosing interval, but the results show good treatment response.[7-9,17,19]

The high percentage of satisfactory results (91.4%; n=43) and a low recurrence rate (10.6%, n=5) were observed in this cohort. The lesions showed an 83.7% average reduction of the initial lytic area; 2.8 procedures were required per patient, with no reported side effects (vomiting and/or convulsions). The fixed dose of calcitonin (200 IU) and methylprednisolone (120 mg) used in this study was established empirically without variation according to the size of the lesion, similar to previous studies. However, further studies are needed to determine the relationship between the initial lesion volume and the response to the dose used. The number of procedures required to promote healing varied in this study, thus suggesting the existence of treatment response determinants. However, the study was not able to determine the treatment response–related factors. Therefore, further studies are necessary to establish whether factors previously described as determinants of worse prognosis also affect the response to this treatment method, including vascular pattern, histological characteristics, and age of patients.[20]

The main advantages of this study are the relevant case series, the inclusion of appendicular lesions, and consistent satisfactory outcomes of the largest known case series of patients with primary ABC treated with the same protocol (calcitonin and methylprednisolone injection) at a single institution. The treatment was proven effective and safe, with a low relapse rate during follow-up. Healing progressed after further treatments and surgical treatment was not precluded in necessary cases. Potential advantages of the described method include the following: lower local morbidity, especially in lesions with difficult surgical access; increased patient acceptance; shorter hospital stays; and low frequency of side effects or hypersensitivity reactions. However, treatment should only be started after proper radiological evaluation and histopathological confirmation of diagnosis. We believe that two to three injections at 2 to 3 month intervals adequately treat most ABCs.

CONCLUSION

Calcitonin and methylprednisolone intralesional injection is a safe and effective method with a low relapse rate that promotes ABC healing. The method has been consolidated as a minimally invasive treatment alternative to reduce surgical morbidity associated with ABC, although prospective studies comparing this method with surgical treatment should be performed to definitively establish calcitonin and methylprednisolone intralesional injection as a first-line treatment.

AUTHORS' CONTRIBUTIONS: Each individual author contributed individually and significantly to the development of this work. MBRO (0000-0003-1986-7002): wrote, reviewed, performed the procedures, analyzed the data, evaluated the plain films; WM (0000-0003-1402-9667): performed the procedures and wrote the article; RRS (0000-0002-7200-6634): analyzed the data; and reviewed the article; GSC (00000-0002-0645-4308) participated at the surgeries, collected the data, evaluated the plain films and reviewed the article; FCCQM (0000-0003-3250-6738): drafted and reviewed the article and contributed to the intellectual concept of the study; MEMP (0000-0002-8699-3933): wrote the article, performed statistical analysis and contributed to the intellectual concept of the study and the entire research project. *ORCID (Open Researcher and Contributor ID).

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ORIGINAL ARTICLE

PROGNOSTIC FACTORS IN PATIENTS WITH APPENDICULAR MYXOFIBROSARCOMA

FATORES DE PROGNÓSTICO EM PACIENTES COM MIXOFIBROSSARCOMA APENDICULAR

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ABSTRACT

Objective: Myxofibrosarcoma (MFS) is a common soft tissue sarcoma (STS) that affects the extremities in elderly patients. The objective was to analyze the prognostic factors and outcomes of patients with MFS treated at a single institution. Methods: We retrospectively reviewed the records of 75 patients with MFS. We compared age, sex, tumor size and location, grade and stage of the disease. Median age was 49.7 years (range, 1 to 88 y). Location: upper extremity (25.4%), lower extremity (66.6%) and pelvis (8%). Patients had high-grade tumors in 46.7% of the reports. Margins were negative in 76% of the cases. Bivariate Cox regression analysis was used to determine associations between clinical and treatment factors with local recurrence (LR). Results: Median follow-up time was 30.7 months (range, 1.8 to 383.8 m). We found 26.7% of LR. Distant metastasis (DM) was reported in 27 (36%) patients. Lung was the most common site of DM, reported in 92.6% of patients. Overall survival (OS) with metastasis was 21.2 months (range, 4.8 to 114.8 m). Predictors of OS were grade, LR (hazard ratio [HR] 5.13, 95% confidence interval, 2.15-12.24, P <0.001), and DM (HR 540.97, 95% confidence interval, 5.04-58112.03, P< 0.001). Conclusions: Tumor grade, LR, positive margins and DM were significant predictors of poor OS prognosis. ***Level of Evidence IV, Case Series.***

Keywords: Sarcoma. Excision margins. Recurrence. Radiotherapy. Neoplasm metastasis.

RESUMO

Objetivos: O mixofibrossarcoma (MFS) é um sarcoma de partes moles (SPM) frequente em idosos, que afeta os membros. O objetivo foi analisar os fatores prognósticos e os desfechos dos pacientes diagnosticados com MFS em uma única instituição. Métodos: Foram analisados retrospectivamente prontuários de 75 pacientes com MFS. Comparamos idade, sexo, tamanho e localização do tumor, grau histológico e o estádio da doença. A media da idade foi 49,7 anos (faixa de 1 a 88 anos). A localização foi: membro superior (25,4%), membro inferior (66,6%) e pelve (8%). Dos tumores, 46,7% foram de alto grau. As margens foram negativas em 76%. A análise de regressão de Cox bivariada foi usada para determinar as associações entre os fatores clínicos e de tratamento com a recorrência local (RL). Resultados: A media do acompanhamento foi 30,7 meses (faixa de 1,8 a 383,8 meses) e 26,7% dos pacientes tiveram RL. Metástases a distância (MD) foram relatadas em 27 (36%) pacientes. O local mais comum de MD foi o pulmão (92,6%). A sobrevida geral (SG) com metástase foi 21,2 meses (faixa de 4,8 a 114,8 meses). Os fatores preditivos de SG foram grau, RL (razão de probabilidades [HR] 5,13, intervalo de confiança de 95%, 2,15-12,24, P < 0,001) e MD (HR 540,97, intervalo de confiança de 95%, 5,04-58.112,03, P < 0.001). Conclusões: Grau histológico do tumor, margens comprometidas, RL e MD foram fatores preditivos de pior prognóstico da SG. ***Nível de Evidencia IV, Série de Casos.***

Descritores: *Sarcoma. Margens de excisão. Recidiva. Radioterapia. Metástase neoplásica.*

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INTRODUCTION

MFS is one of the most common STS of elderly patients. Histologically, is defined as a spectrum of fibroblastic lesions with variable myxoid stroma, pleomorfism and a distinctive curved-shaped vascular pattern.[1] It was classified as a unique entity by the World Health Organization (WHO) in 2002, due to its own clinical pattern and pathological behavior.[2] Commonly they rise in the extremities, but they can be found in the abdomen, retroperitoneum and in the head as well.[3]

Surgery continues to be the gold standard treatment for MFS. To achieve wide surgical margins during the procedure, is not only the desirable goal of every surgeon, but also remains a challenge due to its poorly understood behavior.[3-4] Chemotherapy (CT) and radiotherapy (RT) can be used as adjuvant or neoadjuvant settings, but the definitive role of both are not totally defined. They can be also used as palliative therapies for metastatic patients.[5-6] But still, little have been investigated and documented about the clinical treatment of the disease.[7] Given the lack of randomized trials for

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the creation of treatment guidelines, the outcomes and prognostic factors for MFS, remain uncertain.[2] They exhibit a relatively better OS rate than the other STS, however, their propensity for LR, which can be as high as 60%, still remains as an important issue.[8-9] Also, LR is directly associated with tumor grade and DM. Some studies, with poor casuistry, suggest that tumor size, positive surgical margins at resection and necrotic percentage, are possible prognostic factors for OS.[10] Nevertheless, an advantage in the prognosis of MFS, is a low risk of DM with reports in between 20-30% and an OS with reports in between 70-80% in five years.[11-12] However, no large publications have yet totally investigated or defined the prognostic factors of MFS. Then, in an effort to improve the understanding of the clinical outcomes and the prognosis of appendicular MFS, we conducted a retrospective study, evaluating a series of 75 patients, with the purpose of describing the factors associated with the poor prognosis of the disease after surgical treatment.

MATERIALS AND METHODS

A retrospective study was performed after we obtained the approval from the ethical committee review board from our institute. We identify the clinical records from every patient diagnosed with MFS that underwent surgery, in the division of orthopedic oncology, in the last 25 years. A total of 75 patients with MFS in the extremities were included in this study. All the patients with incomplete data in the medical files, with the tumor located in the trunk or the head and that didn't received surgery as treatment, were excluded from our investigation. Diagnoses were performed by the pathology division of our institute, based on the WHO classification of STS. Demographic data including: gender, age, tumor location, surgery and number of surgeries, surgical margins, histologic grade, adjuvant or neoadjuvant therapy, LR and time to develop LR, DM and time to develop DM, follow up and oncologic status were collected. Histologic grade was determined based on French Federation of Cancer Centers (FNCLCC). The decision on using CT and RT for each patient was studied in multidisciplinary meetings. Of these patients, 44 were female and 31 were male, with a mean age of 53 (range, 1-88years). Most of the tumors (56%) appeared on the right side of the body. The thigh was the most affected anatomical location with 31 cases, followed by the calf 16 cases, forearm 10 cases, pelvis 6 cases, shoulder 4 cases and arm, hand and foot with 3 cases each (Table 1). The size of the tumor was divided in four groups in accordance with the American Joint Committee on Cancer (AJCC) staging system. Group II had 32 patients, group III had 19 patients, group IV had 14 patients and group I had 10 patients reported (Table 1). Sixty four (85.3%) patients received tumor wide resection surgery, while 11 (14.7%) patients underwent limb amputation. Margins were microscopically positive in 18 (24%) cases and negative in 57 (76%) cases. Most cases, 35 (46.7%), had grade 3 (FNCLCC) tumor report. LR was found in 20 (26.7%) cases, of which, 16 (80%) underwent multiple surgical procedures (MSP). Also, we had 27 (36%) reports of DM, being the lungs 25 (97%), lymph nodes 5 (18.5%), abdominal cavity 2 (7.4%) and brain 1 (3.7%) the affected sites (Table 1). Twenty (26.7%) patients received neoadjuvant RT. Median follow up in this study was 30.7 months (range, 1.8-383.8 months among surviving patients). Median survival time was 29 months, OS rate was 59.3%. Twenty three (30.7%) patients died of the disease (Table 1). Pathology reports of surgical margins, LR and OS after the first surgery, were considered the principal objectives of this study. Time for LR, single or multiple, was calculated from the first surgical procedure. OS was estimated using the Kaplan-Meier method. The relation between single surgical procedure (SSP), LR, DM and oncologic status were investigated using the log-rank test for categorical variables. Differences of the $p < 0.05$ were considered statistically significant. Disease free overall survival (DFOS) was also estimated using the Kaplan-Meier method. MSP, DM and deaths were considered the secondary objectives of this study. Also, we calculated the OS, time to LR and DFOS using Kaplan-Meier functions and log-rank tests to compare the outcomes of the qualitative variables. The influence of age on the outcomes of the patients was tested using the Cox bivariate regression. The not adjusted HR with their respective confidence interval of 95%, were calculated using the Cox bivariate regression. All the variables, that in the bivariate tests presented significant level of 0.10 ($p < 0.1$) with the use of multiple Cox regression, were tested in multiple models. The selected variables that when together presented significant level of 5% in the final model,

Table 1. Patient demographics and clinical characteristics.

Variable	Description (n=75)
Age	
mean ± SD	49.7 ± 20.7
median (min.; max.)	53 (1; 88)
Gender	
female	44 (58.7)
male	31 (41.3)
Follow up (months)	
mean ± SD	78.2 ± 90.8
median (min.; max.)	30.7 (1.8; 383.8)
Grade, n (%)	
I	22 (29.3)
II	18 (24)
III	35 (46.7)
Local, n(%)	
shoulder	4 (5.3)
arm	3 (4)
forearm	10 (13.3)
hand	2 (2.7)
pelvis	6 (8)
thigh	31 (41.3)
calf	16 (21.3)
foot	3 (4)
Size, n(%)	
< 5cm	10 (13.3)
5cm to 9.99cm	32 (42.7)
10cm to 14.99cm	19 (25.3)
>15cm	14 (18.7)
Side, n(%)	
right	42 (56)
left	33 (44)
Surgery, n(%)	
resection	64 (85.3)
amputation	11 (14.7)
Margins, n(%)	
negative	57 (76)
positive	18 (24)
Adjuvance, n(%)	
yes	20 (26.7)
no	55 (73.3)
Local Recurrence, n(%)	
yes	20 (26.7)
no	55 (73.3)
Multiple Surgeries, n(%)	
yes	16 (21.3)
no	59 (78.7)
Distant Metastasis, n(%)	
yes	27 (36)
no	48 (64)
Local for Distant Metastasis, n(%)*	
abdomen	2 (7.4)
brain	1 (3.7)
lung	25 (92.6)
lymph nodes	5 (18.5)
Death, n(%)	
yes	23 (30.7)
no	52 (69.3)
Overall Survival, n(%)**	
mean SD	29 ± 24.2
median (min.; max.)	21.2 (4.8;114.8)

* Based on patients with metastasis; ** For the 23 patients that died.

were tested in multiple models also. For all the statistical analyses, we used the IBM-SPSS software for Windows version 20.0. For tables and charts, we used the Microsoft Excel 2008 version software. All the tests were realized with a significant level of 5%.

RESULTS

LR was statistically influenced by tumor margins, MSP and DM ($p < 0.001$) (Figures 1-3). FDOS was statistically influenced by tumor grade (FNCLCC), tumor margins, MSP and DM ($p < 0.05$). LR suffered statistical influence by MSP alone or by tumor margins and DM together. Patients with MSP had 18.82 times a higher risk of LR than patients that had SSP. Positive microscopically margins with DM had 2.84 times a higher risk of LR than negative microscopically margins. Patients with DM had 6.59 times a higher risk of LR than patients without metastasis. DFOS was statistically influenced by MSP and DM. Patients with MSP had 3.11 times a higher risk of diminished DFOS, and patients with reports of DM had 8.17 times a higher risk of diminished DFOS (Figure 4). OS was statistically influenced by tumor grade (FNCLCC), LR, MSP and DM ($p < 0.05$) (Table 2-3) (Figure 5-6). Together, tumor grade (FNCLCC) and LR had a negative influence in the OS of the patients, being grade III (FNCLCC) 5.79 times a higher risk of death than grade I (FNCLCC) ($p = 0.022$), and patients with LR had 3.72 times a higher risk of death than patients with no report of LR ($p = 0.003$). DM is probably the most important prognostic factor to explain OS in patients with MFS, but we were not able to use this variable since none of the patients without metastasis died.

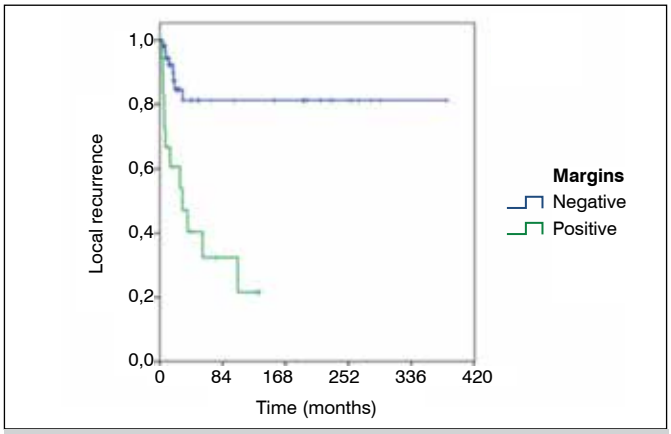

Figure 1. Kaplan-Meier curve for local recurrence according to surgical margins.

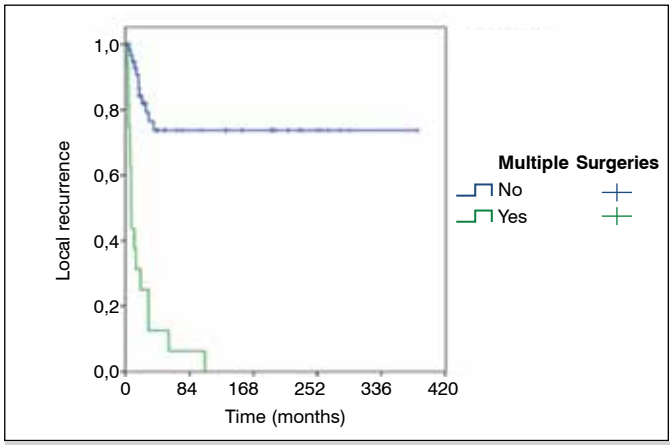

Figure 2. Kaplan-Meier curve for local recurrence according to multiple surgeries.

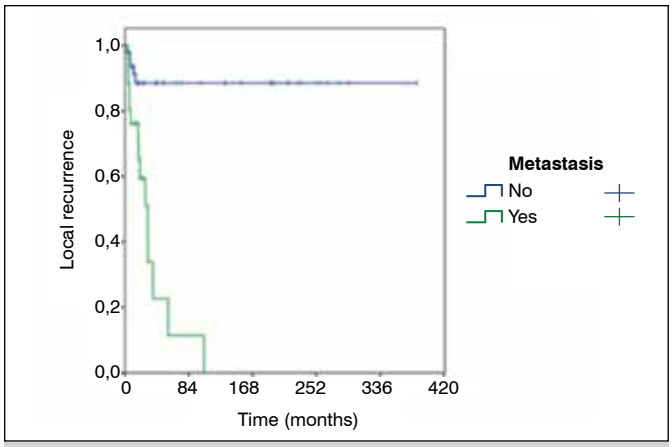

Figure 3. Kaplan-Meier curve for local recurrence according to distant metastasis.

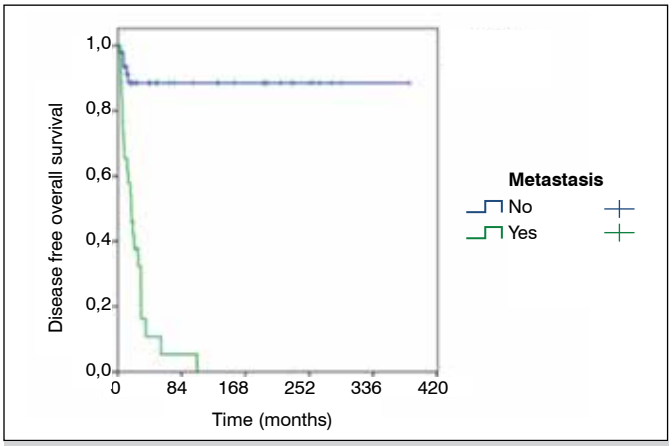

Figure 4. Kaplan-Meier curve for disease free overall survival according to metastasis.

DISCUSSION

MFS it's a rare tumor that represents 5% of all STS. Considered as the most frequent STS in elderly patients, it has a high rate of LR when compared with other sarcomas. MFS is usually reported as a high grade tumor, with an important potential of DM.[13] It is also often inappropriate excised, due to its variable presentation, infiltrative growth pattern and multiple onset location.[3,11,14] The reasons of the high rates of LR are not completely understood. Some authors believe that MFS cause an extensive invasion on the neighbor tissues, fact that is not visible during surgery.[3] Reports of small superficial MFSs, excised in not oncologic centers, treated as benign tumors, which end up being referred to specialized center with LR, is a common finding.[11] Some facts, described in few studies, can be considered to be important for the prognosis of MFS: tumor grade, surgical inadequate or positive margins, LR and DM.[15-17] To our knowledge, this is the first study that describes MFS as a unique entity, in a Latin American hospital, and the casuistry in this case series, is among the largest found in the investigated studies. In our study, 75 patients with pathologically confirmed diagnosis of MFS, and a median follow up of 30.7 months presented: 25% had positive surgical margins, 46.7 % had high grade tumors, 26.7 % had reports of LR and 36% presented DM. This study had a number of limitations. First, the lack of studies on this disease as a unique entity becomes a major difficulty on the research for information. Also the publications are

Table 2. Analysis of the estimated overall survival of patients according to the different characteristic.

Variable	Estimated mean time (months)	CI 95%		HR not adjusted	IC 95%		Death	Total N	%	p
		Inferior	Superior		Inferior	Superior				
Gender										**0.166**
female	246.82	181.85	311.78	1.00			11	44	25.0	
male	162.55	111.93	213.17	1.77	0.78	4.02	12	31	38.7	
Age (years)				1.02	1.00	1.04				0.108*
Grade										**0.002**
I	340.98	285.18	396.77	1.00			2	22	9.1	
II	183.11	107.12	259.10	3.54	0.68	18.31	5	18	27.8	
III	121.71	70.09	173.34	8.70	1.98	38.17	16	35	45.7	
Local										**0.883**
shoulder	200.73	89.87	311.58	0.98	0.11	8.74	1	4	25.0	
arm	160.23	46.08	274.39	0.96	0.11	8.58	1	3	33.3	
forearm	102.93	67.52	138.35	1.02	0.19	5.62	2	10	20.0	
hand	65.57	65.57	65.57	#			0	2	0.0	
pelvis	38.08	24.41	51.57	1.73	0.31	9.63	2	6	33.3	
thigh	176.07	123.67	228.47	1.22	0.39	3.83	11	31	35.5	
calf	258.64	157.97	359.31	1.00			4	16	25.0	
foot	40.41	10.34	70.49	3.15	0.57	17.39	2	3	66.7	
Size										**0,110**
<5cm	337.53	252.75	422.31	1.00			1	10	10.0	
5 to 9.99cm	158.06	111.70	204.42	3.56	0.45	27.92	10	32	31.3	
10 to 14.99cm	177.91	112.21	243.61	4.04	0.50	32.87	7	19	36.8	
>15cm	41.73	23.91	59.64	9.11	1.05	79.14	5	14	35.7	
Side										**0.129**
right	165.80	118.40	213.20	1.00			16	42	38.1	
left	272.38	203.11	341.65	0.51	0.21	1.24	7	33	21.2	
Surgery										**0.688**
resection	234.23	182.39	286.08	1.00			20	64	31.3	
amputation	173.94	76.86	271.02	1.28	0.38	4.35	3	11	27.3	
Margins										**0.067**
negative	274.12	222.87	325.36	1.00			13	57	22.8	
positive	73.44	49.32	97.57	2.13	0.93	4.87	10	18	55.6	
Adjuvance										**0.840**
yes	185.10	122.87	247.34	0.91	0.38	2.22	7	20	35.0	
no	239.95	182.96	296.95	1.00			16	55	29.1	
L. Recurrence										**<0.001**
yes	61.85	32.67	91.03	5.13	2.15	12.24	15	20	75.0	
no	317.40	274.99	359.81	1.00			8	55	14.5	
M. Surgeries										**0.005**
yes	71.98	36.63	107.02	3.04	1.33	6.92	11	16	68.8	
no	288.06	240.52	355.60	1.00			12	59	20.03	
Metastasis										**<0.001**
yes	31.11	20.73	41.49	540.97	5.04	58112.03	23	27	85.2	
no	383.77	383.77	383.77	1.00			0	48	0.0	
Total	236.82	188.17	285.47				24	75	32.0	

Log-rank test; *Cox bivariate regression results.

Table 3. Results of the adjusted models for overall survival, local recurrence and disease free overall survival.

Outcome	Model	Variable	HR adjusted	CI (95%)		p
				inferior	superior	
		Grade (ref.: I)				
		II	2.38	0.45	12.74	0.310
	Initial	III	5.59	1.22	25.51	0.026
		Margins (positive)	0.98	0.39	2.48	0.970
Overall		Local Recurrence	6.94	1.79	26.99	0.005
Survival		Multiple Surgeries	0.47	0.14	1.55	0.214
		Grade (ref.:I)				
	Final	II	2.54	0.48	13.41	0.271
		III	5.79	1.28	26.17	0.022
		Local Recurrence	3.72	1.54	8.97	0.003
		Margins (positive)	1.22	0.44	3.36	0.708
Local	Initial	Multiple Surgeries	18.82	4.35	81.38	<0.001
Recurrence		Metastasis	1.59	0.44	5.78	0.482
	Final	Margins (positive)	2.84	1.08	7.48	0.035
		Metastasis	6.59	2.17	20.02	0.001
		Grade (ref.: I)				
		II	1.41	0.32	6.17	0.647
Disease		III	2.15	0.52	8.98	0.294
Free	Initial	Side (left)	0.75	0.30	1.90	0.546
Overall		Margins (positive)	0.82	0.32	2.07	0.668
Survival		Multiple Surgeries	3.91	1.55	9.86	0.004
		Metastasis	6.04	1.91	19.09	0.002
	Final	Multiple Surgeries	3.11	1.32	7.34	0.009
		Metastasis	8.17	2.68	24.92	<0.001

Cox multiple regression.

often focused on specific subjects of MFS, instead of describing general information on the disease. Second, there are limitations for the applicability of this retrospective study. The information represents those of a single institution, and although it's the only documented paper of MFS in Latin America, we found a limited capacity of describing prognostic factor with narrow confidence intervals. Third, the information on the medical files is not always complete or understandable, which makes the number of cases included less representative. And fourth, the fact that the follow up time of 30.7 months is short, given that a five year OS is the expected in MFS, it becomes an inherent bias for this study. Clinically, MFS tend to have higher rates of LR when compared with other STS. In older publications, when MFS was known as Malignant Fibrous Histiocytoma (MFH), LR rates ranged from 22% to 79%.[16] In newer studies, this range is reported as lower, from 16% to 31%.[16-17] The present study reports a LR rate of 26.7%, corresponding to the reports of modern papers. It seems that LR has a direct relation with tumor grade, surgical margins and DM. Most of the pathological reports for MFS are high grade tumors (FNCLCC). In a series of three different studies, we found that high grade MFS was predominant with 71%, 67% and 88% respectively.[3,12,14] In our study, high grade tumors were also predominant, but with 46.7%, which is less that the reported in other studies. There is no definitive information to categorize surgical margins,

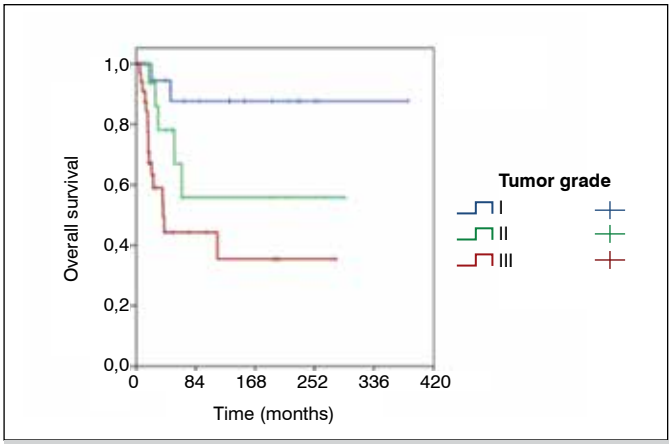

Figure 5. Kaplan-Meier curves for overall survival according to tumor grade.

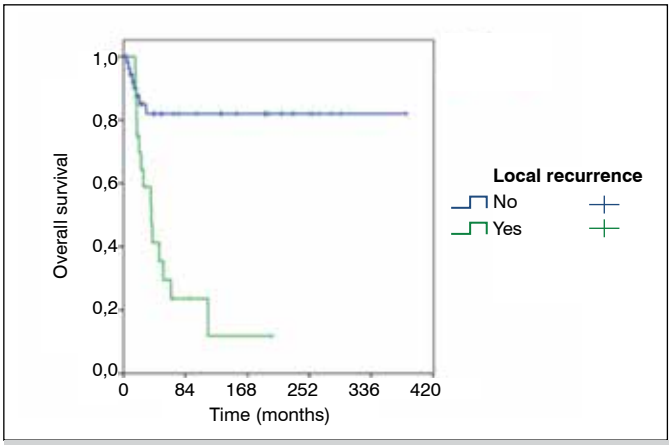

Figure 6. Kaplan-Meier curves for overall survival according to local recurrence.

specifically when they are inadequate.[15] But evidence supports that positive margins, in fact, increases LR, affecting the DFOS.[10,11,18] As for DM, most of the studies report low rates with a range varying from 15% to 30%. The most common affected organ is the lung. In accordance to the findings in literature, our rate of DM was 36%, also being the lung the predominant affected organ. Although, the prognostic factors for MFS haven't been totally defined, there are some facts about the disease that have a direct connection with OS. Authors agree that tumor grade and surgical margins have a close relation with LR, being grade III tumors and reports of positive or not adequate margins, important factors for increasing the rates of LR.[11,18] Another important fact is that the LR also increases the potential for DM, which has a direct effect on follow up time and consequently OS.[4,19-20] In our study, we identified that high grade tumors and positive margins, alone or together, directly increase the rates of LR. Also, we observed that LR has a principal role on the DM appearance. Interestingly, these facts separately or in group affect directly the OS of the patient with MFS. Anyhow, future studies are needed, to see whether these results are similar or not to the new information obtained.

CONCLUSION

In this institutional series of MFS, positive margins and DM were significantly associated with a higher risk of LR. Tumor grade, positive margins LR and DM are significant predictors of OS poor prognosis.

AUTHORS' CONTRIBUTIONS: Each author made significant individual contributions to this manuscript. JPZ (0000-0001-5941-7714)*, FARB (0000-0002-6691-8901)*, AMB (0000-0002-0830-4602)*, MTC (0000-0003-4891-0276)*, LPRM (0000-0002-4280-4053)*, OPC (0000-0002-1128-7292)*, were the main contributors in writing this work. JPZ participated in: research, design, writing and data collection; FARB participated in: concept, research, writing and data collection; AMB participated in: concept, research, writing and data collection; MTC participated in: writing, concept, design, and analysis; LPRM participated in: concept, research, writing and data collection; OPC participated in: concept, writing and analysis. *ORCID (Open Researcher and Contributor ID).

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CASE STUDY OF CONGENITAL ANOMALIES OF THE UPPER LIMB IN REFERENCE AMBULATORY CARE FACILITY

ESTUDO DE CASOS DE ANOMALIA CONGÊNITA DO MEMBRO SUPERIOR EM SERVIÇO AMBULATORIAL DE REFERÊNCIA

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ABSTRACT

Objective: The epidemiological profile of congenital anomalies of the upper limbs (CAULs) is of major relevance to monitoring and planning. A study of this profile may reveal if there is prevalence of some specific type of malformation in comparison to a more comprehensive epidemiological sample. The Latin American Collaborative Study of Congenital Malformations (ECLAMC) has an extensive database, providing an excellent source of comparison. This study aims to evaluate the epidemiological profile of CAULs at the hand surgery department of the Hospital Federal da Lagoa (HFL) in Brazil, and compare it to the ECLAMC data. Methods: We conducted a retrospective analysis of patients who underwent treatment at the pediatric outpatient hand surgery clinic. The sample universe consisted of 126 patients (4 of these patients presented with 2 simultaneous anomalies), totaling 130 malformations. Results: The results demonstrated that the comparable pathologies have significantly similar incidence rates. It is worth noting the polydactylies (pre- and post-axial), where the percentile of incidence in the ECLAMC was higher. Conclusion: This study showed that the epidemiological profile of patients who underwent treatment at this hospital was equivalent to that found in the ECLAMC database. ***Level of evidence III, Retrospective epidemiological study.***

Keywords: Epidemiology. Upper extremity. Congenital abnormalities. Hand deformities.

RESUMO

Objetivo: O perfil epidemiológico das anomalias congênitas dos membros superiores (ACMS) é de suma relevância para monitoramento e planejamento. Um estudo nesse sentido pode revelar se há prevalência de algum tipo específico de malformação em comparação com amostra epidemiológica mais abrangente. O Estudo Colaborativo Latino Americano de Malformação Congênita (ECLAMC) tem uma extensa base de dados, que serve como excelente fonte de comparação. Este estudo tem por escopo avaliar o levantamento da casuística das ACMS no serviço de cirurgia da mão do Hospital Federal da Lagoa (HFL) e compará-la aos dados do ECLAMC. Métodos: Foi realizada uma análise retrospectiva dos pacientes atendidos no ambulatório infantil de cirurgia da mão. O universo amostral foi de 126 pacientes (sendo que 4 pacientes apresentavam 2 anomalias simultaneamente), totalizando 130 malformações. Resultados: Demonstrou-se que as patologias que puderam ser comparadas têm percentuais de incidência significativamente semelhantes. Cabe ressalvar as polidactilias (pré e pós-axiais), em que o percentil de incidência no ECLAMC foi maior. Conclusão: Este estudo evidenciou que o perfil epidemiológico dos pacientes atendidos neste hospital foi equivalente ao encontrado na base de dados do ECLAMC. ***Nível de evidência III, Estudo epidemiológico retrospectivo.***

Descritores: *Epidemiologia. Membros superiores. Anormalidades congênitas. Deformidades da mão.*

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INTRODUCTION

Congenital anomalies affect from 1 to 3% of live births and about 10% of these children have abnormalities of the upper limbs. The incidence of congenital anomalies has not changed much over the last decade. Most occur spontaneously or due to genetic inheritance and few are attributed to teratogens.[1]

Epidemiological data for congenital anomalies of the upper limb (CAULs) are significant for planning, monitoring, and research. Research on etiology and prevention depends on high-quality epidemiological data.[2]

In Latin America, there is a universal database for recording all congenital malformations; the program is named the Latin American Collaborative Study of Congenital Malformation (ECLAMC).

The ECLAMC is a clinical and epidemiological research program for developmental anomalies that works with hospital births in Latin American countries. Therefore, this is a program for research on risk factors for malformations with a case-control methodology.

Ideally, a classification for CAUL should incorporate the primary etiology and evaluate prognosis and treatment planning, besides

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adopting a universal language for discussion.[3] In 1964, Swanson proposed a new classification system, aimed at hand surgeons and regarded as anatomical and clinical, which indicates the type of primary embryogenic defect.

OBJECTIVE

Evaluating the epidemiological profile of CAULs at the hand surgery service of the Brazilian Federal Hospital of Lagoa (HFL) within the period from May 2015 to October 2017, and comparing it to the incidence of these anomalies in the ECLAMC database.

MATERIALS AND METHODS

This study has been developed at the hand surgery service of the HFL. Since this is a retrospective study, there was no need for either a Brazilian free and informed consent term (TCLE) or the approval by a Brazilian research ethics committee (CEP). It is worth noticing there is no conflict of interest between researchers regarding this study.

All patients with some CAUL provided with care at the child outpatient hand surgery clinic from May 2015 to October 2017 have been selected for this study. Patients with deformities or lesions acquired after birth or those who had deformities that were not in the upper limbs have been excluded from this study.

The selected patients were grouped according to the Swanson's Universal Classification in order to evaluate the prevalence of each deformity and they were referred for surgical correction of it. After obtaining data in the aforementioned period, the ECLAMC database was accessed to validate the proportions of congenital malformations of the upper limb and their proportions in relation to other research centers.

RESULTS

The study sample consists of 126 patients with some CAUL, where 4 of them had 2 anomalies simultaneously, totaling 130 malformations. Out of the total sample, 87% refer to patients with duplication or failure to differentiate the parts according to the classification of the International Federation of Societies for Surgery of the Hand (IFSSH). Patients were separated according to their pathology, as proposed by the Swanson's classification. A total of 126 new patients were registered, out of which there were 9 formation failures (7%), 55 differentiation failures (42%), 58 duplication failures (45%), 6 constriction band syndromes (5%), and 2 skeletal abnormalities (1%). (Figure 1) Among these malformations, we observed 34 cases of post-axial polydactyly (27%), 18 cases of thumb duplication (14.3%), 17 cases of congenital trigger (13.5%), 22 cases of syndactyly (17.5%), 8 cases of camptodactyly (6.3%), 6 cases of constriction band syndrome (4.8%), 3 cases of split hand (2.4%), 4 cases of radial club hand (2.4%), 3 cases of three phalanges thumb (2.4%), 3 cases of pre-axial polydactyly (2.4%), 2 cases of clinodactyly (1.6%), 2 cases of ulnar club hand (1.6%), 3 cases of thumb hypoplasia (2.4%), 1 case of Kirner's deformity (0.8%), 1 case of arthrogryposis (0.8%), 1 case of metacarpal synostosis (0.8%), 1 case of thumb agenesis (0.8%), and 1 case of Madelung's deformity (0.8%). Out of this total number of patients, 71 were men (56.3%) and 55 were women (43.7%). (Figure 2)

By comparing the records available in the ECLAMC database for some anomalies, it is observed that the proportions of cases with post-axial polydactyly in the study sample are slightly higher than half the proportion registered by the ECLAMC. (Table 1)

By analyzing the demographic and epidemiological profile of the patients under study, it is observed that most of them are men (56.3%), aged up to 4 years old (84.2%). (Table 2) As for laterality, a good balance is noticed between the total number of patients having only one side affected and that of patients with both sides affected. (Table 3)

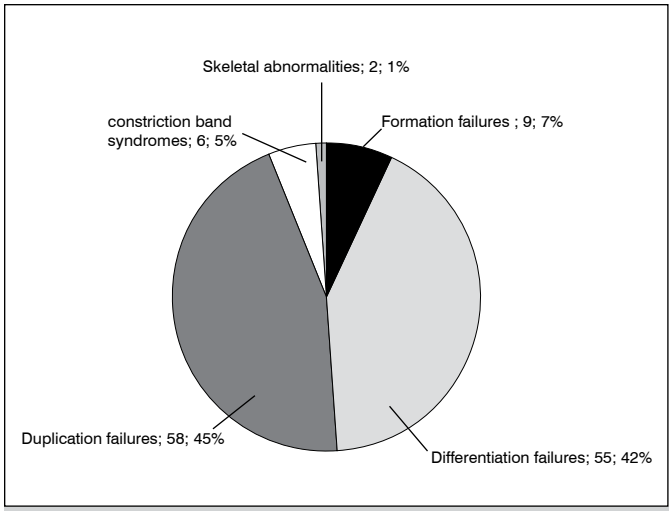

Figure 1. Total number of patients with anomalies diagnosed according to the IFSSH classification.

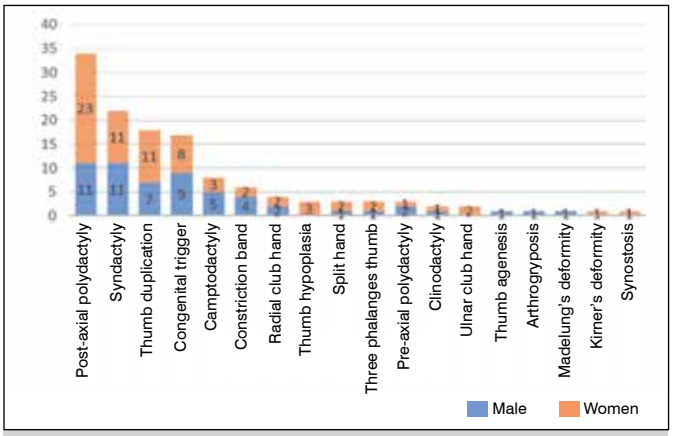

Figure 2. Total number of patients according to sex and anomaly diagnosed.

Table 1. Total number and percentile of patients in the HFL according to the anomaly diagnosed and respective records in the ECLAMC.

Type of anomaly	Brazilian Federal Hospital of Lagoa - May/2015-Oct/2017		ECLAMC 1982-2006	
	Total	%	Total	%
Thumb agenesis	1	0.8	n.a	n.a
Arthrogryposis	1	0.8	n.a	n.a
Constriction band	6	4.8	n.a	n.a
Camptodactyly	8	6.3	n.a	n.a
Clinodactyly	2	1.6	n.a	n.a
Madelung's deformity	1	0.8	n.a	n.a
Kirner's deformity	1	0.8	n.a	n.a
Thumb duplication	18	14.3	n.a	n.a
Congenital trigger	17	13.5	n.a	n.a
Thumb hypoplasia	3	2.4	n.a	n.a
Split hand	3	2.4	52	0.4
Radial club hand	4	3.2	542	4.4
Ulnar club hand	2	1.6	n.a	n.a
Three phalanges thumb	3	2.4	n.a	n.a
Post-axial polydactyly	34	27.0	5,600	45.6
Pre-axial polydactyly	3	2.4	1,216	9.9
Syndactyly	22	17.5	1,392	11.3
Synostosis	1	0.8	n.a	n.a

n.a = information not available.

Table 2. Demographic and epidemiological profile of patients in the study sample.

Variable	Total	%
Sex	126	100.0
Male	71	56.3
Female	55	43.7
Age group	126	100.0
Less than 1 year	54	42.9
1 to 2 years	36	28.6
3 to 4 years	16	12.7
5 years or more	18	14.3
No information	2	1.6
Side affected	126	100.0
Unilateral	64	50.8
Right	35	27.8
Left	29	23.0
Bilateral	59	46.8
No information	3	2.4

Table 3. Total number and percentile of patients according to the IFSSH classification of the respective anomaly and the side affected.

Classification	Total	Unilateral		Bilateral	No information
		Right	Left		
Part-formation failure	9	2 (22.2%)	2 (22.2%)	5 (55.6%)	-
Part-differentiation failure	55	18 (32.7%)	14 (25.4%)	21 (38.2%)	2 (3.6%)
Duplication	58	14 (24.1%)	13 (22.4%)	30 (51.7%)	1 (1.7%)
Hypergrowth	-	-	-	-	-
Hypogrowth	-	-	-	-	-
Constriction band syndrome	6	3 (50.0%)	1 (16.7%)	2 (33.3%)	-
Generalized skeletal anomalies	2	1 (50.0%)	-	1 (50.0%)	-

DISCUSSION

Understanding the epidemiology of a medical condition or a syndrome is paramount for determining its impact on society. The existence of a database on the incidence of CAULs is of major significance for potential determination of their risk factors and the development of comparative studies based on previous analyses.[4] By comparing the malformations found in our study to the ECLAMC database, we observed that both showed post-axial polydactyly as the most prevalent malformation. This anomaly is included in the Swanson's duplication failures and, according to the literature, it is most commonly found in African and American populations; by comparing our findings to a population study carried out in Stockholm, Sweden,[5] we noticed that duplication failures rank 3rd in prevalence, something which may corroborate the incidence theory according to ethnicity.

Syndactyly appears as the second most prevalent malformation in our data, as well as in the ECLAMC data. This group also included those who had syndromes which may occur along with this anomaly (Poland, acrosyndactyly, symbrachydactyly).

In this study, thumb duplication appears as the 3rd most frequent anomaly, similarly to the ECLAMC data, where it appears in 3rd place in terms of prevalence. Although termed as duplication failures in the Swanson's classification, there is a hypothesis that this anomaly is not a real duplication; both duplicate components are smaller than a normal thumb, so this would fit more appropriately as a differentiation failure.[1]

This study poses as a drawback the fact that we have a small sample of patients, due to the short period of existence of the specific outpatient clinic for CAULs. For the continuity of this research, this bias will be minimized.

CONCLUSION

The epidemiological profile of the patients provided with care at this hospital was equivalent to that found in the ECLAMC databases, evidencing the same pattern of anomalies found in other Latin American countries.

AUTHORS' CONTRIBUTIONS: Each author made significant individual contributions to this manuscript: HBPN (0000-0001-9012-9999)*, APP (0000-0003-0405-5175)* and RBA (0000-0002-1679-8876)*: Substantial contribution to the conception or design of the work, acquisition, analysis or interpretation of data for the work. SCV (0000-0002-1068-0199)* and LRMN (0000-0001-7712-2215)*: Active participation in the discussion of results. RBA and AADM (0000-0002-6659-2112)*: Writing of the work or critical review of its intellectual content. HBPN, APP, RBA, AADM, SCV and LRMN: Review and approval of the final version of the manuscript. *ORCID (Open Researcher and Contributor ID).

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ORIGINAL ARTICLE

ARTHROSCOPIC LATARJET TECHNIQUE COMBINED WITH ENDOBUTTONS: FUNCTIONAL OUTCOMES IN 26 CASES

TÉCNICA DE LATARJET ARTROSCÓPICA COMBINADA COM ENDOBUTTONS: RESULTADO FUNCIONAL EM 26 CASOS

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ABSTRACT

Objective: The cause of anterior shoulder instability is not fully understood and surgical management remains controversial. The objective of this study was to evaluate the results of patients undergoing arthroscopic Latarjet procedure with endobuttons. Methods: A retrospective study of 26 patients undergoing arthroscopic Latarjet procedure with endobuttons to treat anterior shoulder instability. Patients with previous glenohumeral instability, failure of Bankart procedure or Instability Severity Index Score (ISIS) greater than or equal to 6, were included. Patients were assessed by: DASH, UCLA, Rowe, Visual Analog Scale (VAS) of pain and Short-Form 36 (SF36) scores. Correct position and consolidation of the graft were evaluated. Results: Mean age was 31.5 years (16 to 46). Preoperative duration of symptoms was 1.7 years (1 month to 10 years). Mean follow-up was 14.3 (6 to 24) months. Mean postoperative scores were: 10 points in DASH; 1.6 in VAS, where 23 (88%) patients experienced mild pain and 3 (12%) moderate pain; 89 in Rowe; 32 in UCLA and 78 in SF-36. Positioning of the graft was correct in 25 (96%) cases, and was consolidated in 23 (88%). We had two cases of graft fracture (7%) and postoperative migration (7%). Conclusion: Surgical treatment using arthroscopic Latarjet with endobuttons is safe and effective, producing good functional outcomes in patients. ***Level of Evidence IV, Case Series.***

Keywords: Orthopedic surgery. Shoulder injuries. Arthroscopic surgery. Tendon transfer. Rehabilitation.

RESUMO

Objetivo: A causa da instabilidade anterior do ombro não é totalmente esclarecida e o tratamento cirúrgico é controverso. O objetivo deste estudo foi avaliar o resultado dos pacientes submetidos à técnica de Latarjet artroscópica com endobuttons. Métodos: Estudo retrospectivo de 26 pacientes submetidos à técnica de Latarjet artroscópica com endobuttons para tratamento de instabilidade anterior do ombro. Foram incluídos pacientes com instabilidade glenoumeral anterior, falha no procedimento de Bankart ou Instability Severity Index Score (ISIS) maior ou igual a 6. Foram avaliados mediante DASH, UCLA, Rowe, Escala Visual Analógica de dor (EVA) e pelo Short-Form 36 (SF36). Avaliamos também a posição correta e a consolidação do enxerto. Resultados: A média de idade foi de 31,5 anos (16 a 46). Os sintomas antes da cirurgia foram de 1,7 anos (1 mês a 10 anos). Seguimento médio de 14,3 (6 – 24) meses. A média dos escores pós-operatórios foi de 10 pontos no DASH; 1,6 pontos na EVA sendo 23 (88%) dores leves e 3 (12%) dores moderadas; Rowe de 89, UCLA de 32; SF-36 de 78. O posicionamento foi correto em 25 (96%) casos e consolidou em 23 (88%). Tivemos 2 casos de fratura (7%) e de migração pós-operatória do enxerto (7%). Conclusão: A cirurgia de Latarjet artroscópica com endobuttons é eficaz e segura, produzindo bons resultados funcionas. ***Nível de Evidencia IV, Série de Casos.***

Descritores: *Cirurgia ortopédica. Lesões do ombro. Artroscopia. Transferência tendinosa. Reabilitação.*

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INTRODUCTION

Patients with chronic anterior shoulder instability may show recurrent dislocation, subluxation or pain.[1] Anterior glenoid bone deficiency has been reported in 22% of the first anterior traumatic dislocations of the shoulder and in up to 90% of the recurrent anterior shoulder instability.[2] Over the last few years, several arthroscopic shoulder stabilization techniques have been proposed. These techniques continue to evolve, but despite progressive improvement, several studies show better results in open techniques.[3] Many authors agree that plastic deformation of the capsular ligaments, ligament hyperlaxity or both, lessen the chances of success in Bankart's arthroscopic repair.[4] Open Latarjet procedure has demonstrated excellent results in the treatment of recurrent shoulder instability. However, diagnosis and treatment of several lesions of bone and soft

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Work conducted in the Orthoservice Hospital, Sao José dos Campos, SP, Brazil and in the Orthopedics and Traumatology Institute, Hospital das Clinicas HCFMUSP, Faculdade de Medicina, Universidade de Sao Paulo, Sao Paulo, SP, Brazil.
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tissue associated with instability are possible only by arthroscopy. Since the procedure became arthroscopic, the indications are clearer, the technique has evolved, and the functional results are also better. Now, this procedure is associated with the advantages of a minimally invasive surgery.[5] The positioning and fixation of the coracoid is one of the main difficulties faced during surgery. Furthermore, the long learning curve, the need for specific guides and the potential risks of injuring the normal anatomical structures, made this procedure poorly adopted.[6] General risks associated with the bone graft fixed to the antero-inferior margin of the glenoid using endobuttons, are comparable to the existing risks associated with any arthroscopic procedure to repair shoulder instability.[7]

MATERIALS AND METHODS

A retrospective study was performed after we obtained the approval from the ethical committee review board from our institute. We review 26 cases of anterior shoulder instability treated with the arthroscopic Latarjet technic combined with endobuttons. Patients with previous instability of the shoulder, previous surgery, and failure of the Bankart procedure (7 cases), or with ISIS greater than or equal to 6 (19 cases) were included in the study. Patients who needed intraoperative conversion to open surgery due to difficulty in graft fixation (2 cases) were excluded from the study. All patients were evaluated by the Rowe, UCLA, DASH, VAS, and SF-36 scores, both preoperatively and postoperatively. Statistical analysis was performed by comparing pre and postoperative measurements with Student's t-test. Two-tailed and paired tests were used in all cases, and those with $p < 0.05$ were considered significant.

Operative technique

The operative technique was based on published descriptions with adaptations.[5-7] The main steps of the surgery are shown in figure 1. The patients underwent general anesthesia, plexus block and placed in beach chair position. Surgical markings were drawn on their shoulder, including the portals J placed halfway in an arch between the axillary fold and the anterolateral portal. Portal J provides a direct view of the coracoid, while the anterolateral portal provides a better lateral view.[5] The intra-articular approach begins in the posterior portal, where intra-articular inspection takes place. The anterior portal is created above the upper edge of the subscapularis tendon using a needle. We evaluate the internal structures in search of lesions (labrum, glenoid, and tendons) using a probe in the anterior portal. Radiofrequency is used to resect the antero-inferior labrum and the medial glenohumeral ligament in the antero-inferior region of the glenoid. Following the plane of the medial glenohumeral ligament, a capsulectomy is performed to facilitate the posterior passage of the graft. After the exposion, the glenoid neck is debrided and crushed using a shaver for soft tissues and bone, preferably through the anterolateral portal. After the preparation of the glenoid bed to receive the graft, the coraco-acromial ligament is resected of its insertion in the coracoid to facilitate its superior visualization. The coracoid is then prepared using the portal J for visualization, the smaller pectoral muscle is disinserted, and its lower face is cleaned with extreme care to avoid injury to the brachial plexus. After this procedure, the soft tissues located on the anterior surface of the tendon are "loosened," and the axillary nerve is identified to avoid injury. Subsequently, a longitudinal split is made in the tendon and subscapularis muscle, to allow the passage of the coracoid graft. Then we pass the four guide wires (2 in the glenoid and 2 in the coracoid) for subsequent creation of the tunnel through which the endobuttons pass. The guidewires are placed in the glenoid using the anterior cruciate ligament (ACL) reconstruction guide, with the point of the guide placed in the anterolateral portal and the other end in the posterior portal. The guide used should have an angle of 90º to avoid invading the articular surface of the glenoid. The guide is placed in the antero-inferior region of the glenoid (Figure 2-a), where the tunnel is created, approximately 0.5 cm from the articular surface, passing the guidewire from posterior to anterior. The same process is repeated for the passage of the second guidewire in the glenoid, approximately 2 cm above the first. After the positioning of the two guidewires in the glenoid (Figure 2-b), a specific portal for allowing the passage of the tunnels and osteotomy of the coracoid (portal H)[5] is created, and then the two guidewires of the coracoid are passed freehanded, with a distance of approximately 2 cm between them (Figure 2-c). Once the four wires are positioned, tunneling is performed to allow the passage of the endobutton. We prefer to start by the lower glenoid tunnel, using a 5 mm cannulated drill. After the passage of the drill, keep it in the exit position, remove the guidewire and then pass a thread of prolene into the drill to move the endobutton from posterior to anterior position (Figure 3-a). Subsequent to the passage through the glenoid, the endobutton is provisionally retrieved

Figure 1. Steps of the surgery in mold.

Figure 2. Arthroscopic images: Endobutton passage and the final graft appearance in the glenoid.

to the anterolateral portal, while carefully passing it through the split of the subscapularis tendon. We then performed tunnelization of the coracoid using the most distal guidewire, retrieved the same endobutton placed on the glenoid using prolene wire in the same way, and directed it to the portal H, passing it through the coracoid tunnel (Figure 3 -b). Consequently, the same endobutton becomes connected from the posterior region of the glenoid to the superior cortical of the coracoid. The same process is then performed on the other guidewires, connecting another endobutton from the glenoid to the coracoid. Once the two endobuttons are connected, it is possible to perform coracoid osteotomy, and then, by tractioning the endobuttons, which are connected to a single posterior button, it is possible to move the bone graft to the antero-inferior region of the glenoid, through the split in the subscapularis tendon, to the bloodshed bed (Figure 3-c). We usually use endobuttons with self-locking wires, not requiring a subsequent knot. We believe that this way we can cause greater contact force between the graft and glenoid bed.

Postoperative

The patients should use a splint for 14 days, with movements allowed according to pain. Postoperative control radiographs are taken every week (Figure 4-a) for six week, a computed tomography is required six months after surgery (Figure 4-b). They can start physical therapy for improving range of motion after two weeks and strengthening after full movement is achieved. Return to sport is allowed three months after surgery.

RESULTS

We analyzed the functional score results of 26 cases of arthroscopic Latarjet technic combined with endobutton, of which 23 were male and two female. The mean age was 31 years (16 to 46). The mean duration of symptoms was 1.7 years, ranging from 1 month to 10 years. The mean follow-up was 14 months (6 to 24). Twelve right and 14 left shoulders were operated. The mean postoperative scores were 10 points in DASH; 2 points in VAS, of which 23 (88%) showed mild pain, and 3 (12%) moderate pain; 89 in Rowe; 32 in UCLA; 85 in SF-36. Two patients fractured their coracoids during surgery and had the graft fixed with only one endobutton. Two patients had postoperative graft migration occurring two months after surgery; none of them had further episodes of instability. The graft consolidated in 23 (88%) cases. We considered as consolidation, the existence of any bone bridge between the glenoid and the graft, evaluated through computed tomography. The mean distance between the lateral edge of the graft and the articular surface was 1.8 mm, ranging from 4.7 mm medial to 5.2 mm lateral (Table 1). Only one case had a distance from the lateral surface superior to 5 mm. In 3 cases (12%) the graft was predominantly in the glenoid equator, while in 23 cases (88%) the graft was predominantly below the glenoid equator. There were no cases of postoperative glenohumeral dislocation. The results showing the improvement of the Rowe, UCLA, AVS, and DASH scores are presented in table 2. We found tears associated with instability in 11 patients (42%), of which 7 were type II superior labral anterior and posterior (SLAP) lesion treated by tenodesis of the long head of the biceps, two cases of type I SLAP lesion treated by debridement of the superior labrum, two cases of partial tear of the subscapularis and three of partial rupture of the supraspinatus, repaired using anchors. We also found two patients with circumferential labral tear. Besides undergoing the Latarjet procedure, their posterior and superior labrum were repaired. The

Table 1. Data on the positioning of the coracoid graft.

		No. of case	%
Horizontal Position	Too Medial >5mm	0	0
	Too lateral >5mm	1	4
	At the level of the articular surface	25	96
Vertical Position	Above the glenoid equator >50% of the graft	0	0
	At the level of the glenoid equator > 25% of the midline	3	12
	Below the glenoid equator	23	88

Table 2. Results of the Rowe, DASH, UCLA, and VAS scores*.

	Rowe	DASH	UCLA	VAS
Preoperative	31 ± 12 (15 to 45)	32 ± 19 (1,7 to 70,8)	-	6 ± 1,8 (2 to 9)
Postoperative	89 ± 14 (55 to 100)	10 ± 13 (0 to 40)	32 ± 2,9 (26 to 35)	1,6 ± 1,5 (0 to 5)
p value	< 0,01	< 0,01	NA	< 0,01

*Mean and standard deviation values, with the interval between parentheses.

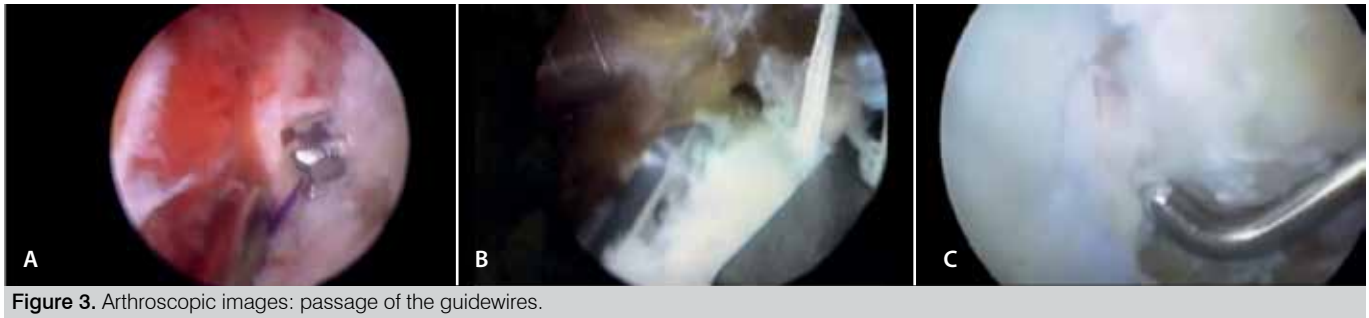

Figure 3. Arthroscopic images: passage of the guidewires.

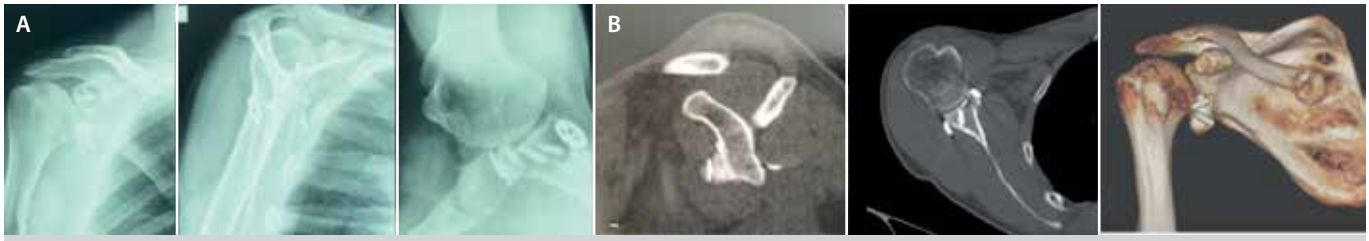

Figure 4. Complementary exams: X-rays and tomography. The patient has undergone previous Bankart repair surgery with metallic anchors.

Table 3. Pre- and postoperative comparative results of SF-36*.

	Functional capacity	Limitations due to physical aspects	Pain	General health status	Vitality	Social aspects	Limitations due to emotional aspects	Mental health
Pre-op	70 ± 17.5 (30 to 100)	26 ± 34.2 (0 to 100)	56.6 ± 25 (22 to 90)	64.8 ± 14.1 (35 to 90)	72.9 ± 11.6 (55 to 100)	78.4 ± 24.8 (6.5 to 100)	55.6 ± 43.6 (0 to 100)	71.95 ± 19.4 (0 to 96)
Post-op	89 ± 11.5 (65 to 100)	77.4 ± 37.8 (0 to 100)	74 ± 22.3 (20 to 90)	72.6 ± 13.8 (45 to 85)	82.6 ± 9.7 (55 to 100)	81.5 ± 15.6 (50 to 100)	82.5 ± 32.7 (0 to 100)	90.4 ± 7.62 (80 to 100)
p value	<0.01	<0.01	<0.01	0.2	<0.01	1	<0.01	<0.01

* Mean and standard deviation values, with the interval between parentheses.

results of Sf-36 are subdivided according to the coverage areas. The detailed results can be found in table 3. As complications, we had one case with superficial infection, showing improvement after one week of oral antibiotic therapy. Two cases had a small fracture of the coracoid at the time of osteotomy losing the fixation of the superior endobutton, however, as the inferior endobutton gave good stability to the fragment, no additional procedure was necessary. Two patients had postoperative graft migration with no progression to further instability, no need for further surgical intervention. We did not observe any neurological lesion or recurrent instability.

DISCUSSION

The results found in this study are similar to those of other publications. We observed improvement in all the functional scores and no cases of recurrent instability were reported. The procedure was effective eliminating the symptomatology and providing an early return to daily activities. Operative techniques have recently advanced so that orthopedic shoulder surgeons can successfully perform procedures aimed at correcting anterior glenohumeral instability, regardless of whether the patient needs labrum repair or bone graft.[8] Reconstruction using coracoid graft is currently recommended in Latarjet and iliac crest surgeries, for treating bone deficiency of the glenoid. Besides providing stability, the bone graft normalizes contact pressures to values similar to that of a normal shoulder.[9] Technical difficulty, specific guides for the positioning of the coracoid, and the potential risks of injuring anatomical normal structures, are the main challenges of the arthroscopic Latarjet procedure, hindering the adoption of this surgical technique in some countries.[6] We showed in our study that even using only an ACL guide, the results of glenoid graft positioning indexes can be as good as those obtained by studies using specific guides.[10]

Considering the advantages of the treatment with arthroscopic Latarjet when compared to open surgery,[11] such as lesser time of recovery and identification of intra-articular pathologies, it is fundamental to promote the diffusion of techniques that are reproducible in countries with no availability of specific instruments, mainly due to their cost. Thus, the use of endobuttons is viable in performing this procedure, allowing a correct positioning of the graft and positive results in the functional scores with significant improvement. Furthermore, it is possible to address other lesions at the time of surgery, which was necessary for 42% of the patients. The Latarjet technique combined with endobutton, uses instruments widely available in hospitals, and its easy to perform after the proper learning curve. Similarly, to other authors, we observed that some complications were associated with the learning curve, showing complications described earlier.[12] These complications may have occurred due to the wrong choice of positioning of the coracoid bone tunnel; however, with the improvement in surgical technique, this event ceased to occur. Thus, we believe that this technique with endobutton is reproducible and does not require additional
instruments. A great advantage of the Latarjet technique combined with endobuttons is that the tunnels, which are created from the posterior to the anterior region, facilitate the correct positioning in relation to vascular-nervous structures, which may cause incorrect inclination when fixation is made using screws.

CONCLUSION

Surgical treatment using the arthroscopic Latarjet technique combined with endobuttons for the treatment of anterior instability of the shoulder showed good results in terms of functional outcomes. The technique is effective, safe, and provides early rehabilitation.

AUTHORS' CONTRIBUTIONS: Each author made significant individual contributions to this manuscript. ATN (0000-0003-3044-959X)*, GKC (0000-0002-9830-754X)*, PBR (0000-0001-5089-1022)*, JPZ (0000-0001-5941-7714)*, OPC (0000-0002-1128-7292)*, were the main contributors in writing this work. ATN participated in: research, design, writing and data collection; GKC participated in: concept, research, writing and data collection; PBR participated in: concept, research, writing and data collection; JPZ participated in: writing, concept, design, and analysis; OPC participated in: concept, writing and analysis. *ORCID (Open Researcher and Contributor ID).

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ORIGINAL ARTICLE

ASSESSMENT OF THE RESULTS OF ACCESSORY TO SUPRASCAPULAR NERVE TRANSFER

AVALIAÇÃO DOS RESULTADOS DA TRANSFERÊNCIA DO NERVO ACESSÓRIO PARA O SUPRAESCAPULAR

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ABSTRACT

Objective: Nerve transfers are an alternative in the reconstruction of traumatic brachial plexus injuries. In this study, we report the results of branchial plexus reconstruction using accessory to suprascapular nerve transfer. Methods: Thirty-three patients with traumatic brachial plexus injuries underwent surgical reconstruction with accessory to suprascapular nerve transfers. The patients were divided into groups in which surgery was performed either within 6 months after the injury or more than 6 months after the injury. Results were assessed using the Constant score. Results: There was no significant difference between the groups with respect to the Constant score. Conclusion: Accessory to suprascapular nerve transfer was not an efficient method for recovering active ROM or strength in the shoulder. However, it effectively improved pain control and shoulder stability. ***Level of evidence II, Retrospective Study.***

Keywords: Brachial plexus. Nerve transfer. Accessory nerve. Shoulder.

RESUMO

Objetivo: A transferência de nervos é uma alternativa na reconstrução das lesões traumáticas do plexo braquial. Neste estudo, relatamos os resultados da reconstrução do plexo braquial com a transferência do nervo acessório para o nervo supraescapular. Métodos: Trinta e três pacientes com lesões traumáticas do plexo braquial foram submetidos à reconstrução cirúrgica com transferência do nervo acessório para o nervo supraescapular. Os pacientes foram divididos em grupos em que a cirurgia foi realizada dentro de 6 meses a partir da lesão ou mais de 6 meses depois da lesão. Os resultados foram avaliados com o escore Constant. Resultados: Não houve diferença significante entre os grupos com relação ao escore Constant. Conclusão: A transferência do nervo acessório para o nervo supraescapular não foi um método eficiente para recuperar a ADM ativa ou a força no ombro. No entanto, foi eficiente para melhorar o controle da dor e a estabilização do ombro. ***Nível de evidência II, Estudo Retrospectivo.***

Descritores: *Plexo braquial. Transferência de nervo. Nervo acessório. Ombro.*

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INTRODUCTION

Traumatic brachial plexus injuries represent a severe, debilitating condition. They are frequent among young adults, and 75% of the time, there is a compromise of the supraclavicular portion of the plexus.[1] Shoulder motor innervation is provided by the superior trunk of the brachial plexus through the axillar and suprascapular nerves. Patients presenting with a proximal injury of the brachial plexus are usually unable to flex, abduct or externally rotate their shoulder.[2] When microsurgical reconstruction is feasible, nerve grafts or transfers are employed to repair nerve damage.[3,4] The cranial accessory nerve was the first to be employed as a donor for brachial plexus injuries and was frequently transferred to the suprascapular nerve to stabilize the shoulder and improve its function through reinnervation of the supraspinal, infraspinal and teres minor muscles.[5]

Currently, unreliable results from previous reports have made the efficacy of the accessory to supraspinal nerve transfer inconclusive.[6-8] A functional score, therefore, is necessary to objectively assess the results of one of the most commonly performed surgical reconstructions of the brachial plexus.

In 1987, Constant and Murley[9] presented a functional, easily applicable score for the shoulder that proved to be reproducible by many observers and was sensitive enough to detect even minor functional deficits. The Constant score is a scale from 0 to 100 points that evaluates objective and subjective criteria and has become a mainstream assessment tool for shoulder function among European orthopedic surgeons.

In this study, we assessed the results obtained from accessory to suprascapular nerve transfer, including shoulder joint stability, active

All authors declare no potential conflict of interest related to this article.

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ROM recovery and overall shoulder strength, and we compared the results from surgical procedures performed up to 6 months after the traumatic event to the results of surgery performed more than 6 months after the trauma.

MATERIALS AND METHODS

This study was performed by the Hand Surgery Department in the Orthopaedics and Trauma Center. In this retrospective cohort, 33 patients were selected who all suffered a traumatic brachial plexus injury and underwent accessory to suprascapular nerve transfer in the period between the years 2010 to 2015.

The average patient age was 36.7 years. The average time between the traumatic event and surgery ranged from three to 17 months, with an average of 7.6 months. In this study, the patients were distributed into two groups. Group one (15 patients) comprised patients who underwent surgery within 6 months after the traumatic event. Group two (18 patients) comprised patients who underwent surgery more than 6 months after the traumatic event.

The brachial plexus injury presented as an isolated C5-C6 root injury in 78% of the patients. An Erb-Plus pattern (C5-C6-C7) was encountered in 12% of the patients. Pan-plexus injuries were observed in 6% of the patients, and only one patient sustained a complete C5-C6 root injury and a partial C7-C8-T1 root injury.

All surgical procedures included accessory nerve transfer to the suprascapular nerve, except for one patient who had an accessory nerve that could not be located. This patient was excluded from our study.

All remaining patients were evaluated using the Constant score, which included both subjective and objective criteria. First, the following were evaluated: pain, activities of daily living and global hand positioning. Second, shoulder ROM and shoulder strength were assessed. A standard goniometer was used during the measurements, whereas strength was evaluated subjectively. The differences in points between the injured member and the contralateral shoulder were classified as excellent (less than 11 points difference), good (11 to 20 points difference), regular (21 to 30 points difference) and poor (more than 30 points difference). All of the patients were evaluated by the senior surgeon of the group.

A descriptive statistical analysis was performed for the population under investigation. Following that analysis, both time from trauma to surgery and the Constant score were evaluated.

A Spearman rank correlation coefficient was obtained for all compiled data, and two proportions tests were performed using Minitab 16 software. Only P-values lower than 0.05 were considered statistically significant.

The study was approved by the local institutional ethics review board (approval number: 1.089.394) and all patients signed an informed consent form before inclusion in the study.

RESULTS

The statistical analysis showed no significant difference between the groups with respect to the total Constant score (Table 1). We also did not encounter statistically significant differences between the groups when evaluating the individual tests for the scores (Tables 2 - 6).

Table 1. Correlation between Constant scores according to time from injury to surgery.

Time from injury to surgery (months)	Correlation (r)	P-value
≤ 6	-22.7%	0.456
> 6	-44.9%	0.081

Table 2. Pain intensity after the procedure.

Pain after the procedure	≤ 6 m		> 6 m		P-value
	N	%	N	%	
Severe	2	15.4%	3	18.8%	0.811
Moderate	3	23.1%	2	12.5%	0.453
Low	2	15.4%	2	12.5%	0.823
None	6	46.2%	9	56.3%	0.588

Table 3. Most functional shoulder position after the procedure.

Shoulder Functional Position	≤ 6 m		> 6 m		P-value
	N	%	N	%	
Waist	7	53.8%	7	43.8%	0.588
Xyphoid	4	30.8%	8	50.0%	0.296
Neck	1	7.7%	1	6.3%	0.879
Head	1	7.7%	0	0.0%	0.259

Table 4. Maximum active shoulder flexion obtained after the procedure.

Shoulder Flexion	≤ 6 m		> 6 m		P-value
	N	%	N	%	
31-60°	6	46.2%	12	75.0%	0.111
61-90°	4	30.8%	2	12.5%	0.227
91-120°	2	15.4%	2	12.5%	0.823
121-150°	1	7.7%	0	0.0%	0.259

Table 5. Maximum active shoulder elevation obtained after the procedure.

Shoulder Elevation	≤ 6 m		> 6 m		P-value
	N	%	N	%	
31-60°	8	61.5%	11	68.8%	0.684
61-90°	4	30.8%	3	18.8%	0.452
91-120°	1	7.7%	2	12.5%	0.672

Table 6. Maximum active shoulder external rotation obtained after the procedure.

Shoulder External Rotation	≤ 6 m		> 6 m		P-value
	N	%	N	%	
Hand behind head, elbow forward	10	76.9%	12	75.0%	0.904
Hand behind head, elbow backwards	3	23.1%	4	25.0%	

DISCUSSION

The results following accessory nerve to suprascapular nerve transfer vary between studies. In a study including 21 patients, Malessy[7] observed supraspinal and infraspinal muscle reinnervation in 85 and 75% of patients, respectively, through electromyographic examination. However, active shoulder abduction and external rotation with muscle strength equal to or greater than 3 were present in only 24 and 14% of patients, respectively. Conversely, Terzis et al[8] observed good to excellent results regarding shoulder abduction and external rotation in 79 and 55% of patients, respectively. The best results were encountered when surgery was performed within 6 months after the injury and no nerve grafting was used. Our results were closer to the results of Malessy[7] than to those of Terzis: we did observe supraspinal muscle reinnervation indirectly through shoulder stability improvements, but only three patients had a shoulder abduction ROM greater than 90 degrees. There was no statistically

significant difference between the patients who were operated on within six months of their injury and those who were operated on more than six months after injury in our study.

In a study of 30 patients, Bertelli and Ghizoni[6] observed that shoulder abduction active ROM recovery occurred in patients subjected to accessory nerve to suprascapular nerve transfer, although the best results were achieved with partial injuries (45 vs 105 degrees). Regarding external rotation active ROM, no improvement was observed for the total injuries, whereas partial injuries had an average of 105 degrees of active ROM. In that study, however, partial injuries were treated with an additional motor branch transfer from the triceps to the axillary nerve. Our study did not evaluate partial and total injuries because of the limited number of patients with total brachial plexus injuries.

Souza et al[10] evaluated 20 patients who were subjected to accessory nerve to suprascapular nerve neurotization through both anterior and posterior approaches, and they concluded that the best results were obtained through the latter, possibly due to a shorter reinnervation distance and because the suture was performed distally to the suprascapular notch, where there might be a secondary injury. In our study, all procedures were performed through the anterior approach, and only the accessory nerve transfer was included. A double neurotization, including a radial nerve branch to the axillary nerve transfer, would bias the accessory nerve transfer evaluation. We found no reports that included a functional score evaluation in addition to active ROM measurements, which sets our study apart from the others.

In our study, although abduction and external rotation active ROM did not change when both groups were compared, shoulder stability and pain showed statistically significant improvements when surgery was performed within 6 months after the injury. We found that pain relief was linked to shoulder inferior subluxation correction after supraspinal muscle reinnervation.

Shoulder anterior articular contracture may play a role in residual external rotation and abduction ROM limitations. However, there was no statistically significant difference in ROM between both groups in our study. An early rehabilitation program started soon after the injury itself may help achieve better post-operative results.

In our context of a tertiary public health center, we found that most patients came to us later. Therefore, many patients are not operated on in a timely manner, which may have diminished our post-operative results. Additionally, because this was a retrospective study, time between injury and surgical treatment could not be defined beforehand.

CONCLUSION

Accessory to suprascapular nerve transfer was not efficient for recovering active ROM or strength in the shoulder. It did, however, help with stabilizing the shoulder and improving pain and a statistically significant difference was observed between the results of surgeries performed within 6 months of the injury and those performed more than 6 months after the injury for these two variables.

AUTHORS' CONTRIBUTIONS: Each author contributed individually and significantly to the development of this manuscript. YAA (0000-0003-0752-5128)* performed all surgeries and along with HCSF (0000-0003-0327-7905)* and GFC (0000 -0002-9707-5353)* performed follow-up of the patients and gathered clinical data. The study was designed by YAA and PMMBF (0000-0001-7081-987X)*. HCSF, GFC and ACC (0000-0002-5039-8884)* carried out the bibliographic research and evaluated the data of the statistical analysis. YAA and ACC were the main contributors in the writing of the manuscript and the review was done by PMMBF and IC (0000-0003-3870-0523)*. *ORCID (Open Researcher and Contributor ID).

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RELIABILITY OF A BRAZILIAN PORTUGUESE TRANSLATED AND CROSS-CULTURALLY ADAPTED VERSION OF THE MJOA SCALE

REPRODUTIBILIDADE DA VERSÃO TRADUZIDA E ADAPTADA CULTURALMENTE PARA O PORTUGUÊS BRASILEIRO DA ESCALA MJOA

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ABSTRACT

Objective: To assess the intra- and inter-observer reliability of a Brazilian Portuguese translated and cross-culturally adapted version of the mJOA questionnaire. Methods: The reliability of the Brazilian Portuguese version of the mJOA scale was assessed through the evaluation of a sample of patients with cervical myelopathy by two independent experienced spine surgeon examiners. Inter-observer reliability was defined by the Intraclass Correlation Coefficient (ICC) between the evaluations of the two examiners, and intra-observer reliability was assessed by the ICC between the two evaluations of one examiner. Results: Fifty-five patients were included in the study (mean age 58.7 years). The ICC for inter-observer reliability of the Brazilian Portuguese version of the mJOA was 0.967, and the ICC for intra-observer reliability was 0.869, both classified as "almost perfect" (> 0.81). Conclusion: The Brazilian Portuguese translated and cross-culturally adapted version of the mJOA questionnaire appears to be valid and reliable. ***Level of evidence I, Diagnostic Studies, Investigating a Diagnostic Test.***

Keywords: Spinal cord compression. Questionnaires. Translating.

RESUMO

Objetivo: Avaliar a confiabilidade intra e interobservador da versão do questionário mJOA traduzida e adaptada culturalmente para o português brasileiro. Métodos: A confiabilidade da versão em português da escala mJOA foi avaliada em uma amostra de pacientes com mielopatia cervical por dois examinadores com experiência em cirurgia da coluna vertebral. A confiabilidade interobservador foi definida pelo Coeficiente de Correlação Intraclasse (CCI) entre as avaliações dos dois examinadores e a confiabilidade intraobservador pelo CCI entre duas avaliações de um examinador. Resultados: Cinquenta e cinco pacientes foram incluídos no estudo (média de idade: 58,7 anos). O CCI para confiabilidade interobservador da versão brasileira do mJOA foi 0,967 e o CCI para a confiabilidade intraobservador foi 0,869, ambas classificadas como "quase perfeita" (> 0,81). Conclusão: A versão do questionário mJOA traduzida e adaptada culturalmente para o português brasileiro demonstrou-se válida e confiável. ***Nível de Evidência I, Estudos diagnósticos, Investigação de um Exame para Diagnóstico.***

Descritores: *Compressão da medula espinal. Questionários. Tradução.*

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INTRODUCTION

Cervical myelopathy is a common source of disability associated with spinal disease, especially in the elderly population. Spondylotic spinal cord compression is the primary cause of cervical myelopathy[1-3] and may present with different degrees of neurological compromise, leading to a range of levels of disability.[4] Due to such variation in the degree of neurological involvement and severity of incapacity, grading scales have been developed to objectively evaluate the neurological compromise and the severity of the disease, as well as the outcomes of surgical treatment.[5]

The scale proposed by the Japanese Orthopaedic Association (JOA) to assess the severity of cervical myelopathy has been translated into English and cross-culturally adapted to a Western population, including replacing references to chopsticks to spoons.[6] As a means of broadening the global adoption of spine outcomes tools originally developed in English, the modified Japanese Orthopaedic Association (mJOA) questionnaire was translated and adapted into Dutch.[7] Recently, the same protocol was applied to produce a version of the mJOA translated and cross-culturally adapted to Brazilian Portuguese.[8] Such translations are important since they

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enable application of this objective clinical instrument to broader populations of patients.
The aim of the present study was to assess the intra- and inter-observer reliability of the Brazilian Portuguese version of the mJOA questionnaire.

MATERIALS AND METHODS

Design, participants, and ethics

This is a cross-sectional study. Prior to study initiation, the protocol was approved by the Institutional Review Board (CAAE: 52578015.1.0000.5463). Written consent was obtained from all study subjects prior to enrollment. In order to analyze the validity of the Brazilian Portuguese translated and cross-culturally adapted version of the mJOA, the intra- and inter-observer reliabilities were assessed by applying this version to a series of patients with cervical spondylotic myelopathy (CSM). Patients presenting for clinical evaluation in the authors' spine clinics in Brazil between August of 2016 and October of 2016 were considered eligible for study participation if their clinical complaint or abnormality was suggestive of cervical myelopathy. The exclusion criteria were any factors that could compromise effective communication, the presence of any other known neurologic or psychiatric condition that could affect the clinical presentation, and those who declined study participation. Based on previously reported study with similar design,[7] it was estimated that evaluation of 50 patients would be sufficient for the present study.

Variables and measurements

Initially, each patient was independently evaluated and scored based on the translated version of the mJOA by two experienced spine surgeons (RRP and CFPSH). In a second appointment, each patient was re-evaluated and scored by one of the spine surgeons (RRP). The total overall score of the mJOA and the individual scores for each of the four questions were assessed. The intra-observer reliability was determined by comparing the scores obtained in the two evaluations by examiner RRP, and the inter-observer reliability was calculated by comparing the scores of the two examiners (RRP and CFPSH) at the initial evaluation.

Statistical Analysis

The intra- and inter-observer reliability of the Brazilian version of the mJOA were quantified using the Intraclass Correlation Coefficient (ICC), with a confidence interval (CI) of 95%. ICC values of 0.00 to 0.20 were considered slight agreement, 0.21 to 0.40 fair agreement, 0.41 to 0.60 moderate agreement, 0.61 to 0.80 substantial agreement, and 0.81 to 1.00 almost perfect agreement.[9] To assess for possible trends on the examiner evaluations, the investigators also evaluated the Bland-Altman plot of total score values. The statistical analysis was performed with IBM SPSS Statistics software program, version 20 (SPSS, Inc., Somers, NY, USA).

RESULTS

55 patients met criteria and were included in the present study, including 22 women and 33 men. All patients screened and found to be eligible for the study consented to participate and were included in the analysis, with no missing data. The mean patient age was 58.7 years (standard deviation: ±9.3 years; median: 58 years and range: 31-76 years). Table 1 provides a summary of the values obtained for the total mJOA score and each question of the mJOA, including the two evaluations of investigator 1 and the evaluation of investigator 2.

Inter-observer Reliability

For the Brazilian version of the mJOA, both the reliability for the total score and for each question were classified as "almost perfect" (> 0.81) (Figure 1). The ICC obtained for the mJOA total score was 0.967 (95% CI: 0.944–0.981), 0.943 (95% CI: 0.904–0.966) for "Motor dysfunction score of the upper extremities", 0.943 (95% CI: 0.903–0.966) for "Motor dysfunction score of the lower extremities", 0.868 (95% CI: 0.784–0.921) for "Sensory dysfunction score of the upper extremities" and 0.961 (95% CI: 0.933–0.977) for "Sphincter dysfunction score". The Bland-Altman plot for the total score did not suggest any trends between the evaluations of the two examiners (Figure 1).

Intra-observer reliability

The intra-observer reliability for the mJOA total score was also classified as "almost perfect," with an ICC of 0.869 (95% CI: 0.784–0.921) (Table 2). Each question of the mJOA had at least "substantial" (> 0.70) intra-observer reliability. The ICC was 0.786 (95% CI: 0.657–0.870) for "Motor dysfunction score of the upper extremities", 0.897 (95% CI: 0.829–0.939) for

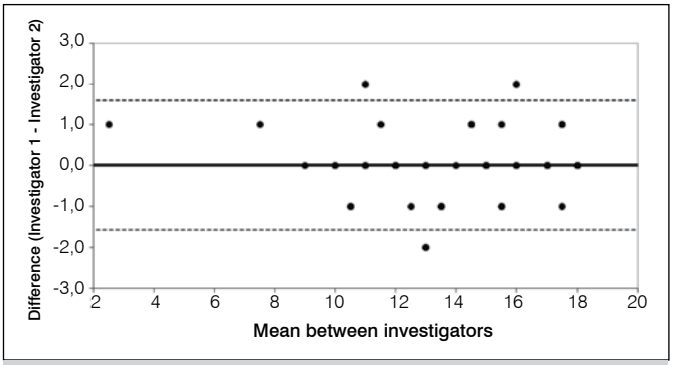

Figure 1. Bland-Altman plot for the total score between the evaluations of the two examiners (inter-observer reliability).

Table 1. Summary of the values obtained for the total mJOA score and each question of the mJOA, including the two evaluations of investigator 1 and the evaluation of investigator 2.

mJOA values	Investigator 1		Investigator 2
	1st Evaluation	2nd Evaluation	
Total			
Mean (SD)	14,1 (3,1)	14,4 (2,8)	14,1 (3,1)
Median (min.; max.)	15 (3; 18)	15 (6; 18)	14 (2; 18)
Motor Dysfunction Score of Upper Extremities			
Mean (SD)	4,1 (1,1)	4,3 (0,9)	4,1 (1)
Median (min.; max.)	4 (1; 5)	5 (2; 5)	4 (1; 5)
Motor Dysfunction Score of Lower Extremities			
Mean (SD)	5 (1,6)	5,2 (1,6)	5,1 (1,6)
Median (min.; max.)	5 (0; 7)	6 (1; 7)	5 (0; 7)
Sensation			
Mean (SD)	2,2 (0,8)	2,2 (0,7)	2,2 (0,8)
Median (min.; max.)	2 (0; 3)	2 (0; 3)	2 (0; 3)
Sphincter Dysfunction Score			
Mean (SD)	2,7 (0,7)	2,7 (0,7)	2,7 (0,7)
Median (min.; max.)	3 (0; 3)	3 (0; 3)	3 (0; 3)

"Motor dysfunction score of the lower extremities", 0.726 (95% CI: 0.572–0.830) for "Sensory dysfunction score of the upper extremities" and 0.775 (95% CI: 0.643–0.863) for "Sphincter dysfunction score". The Bland-Altman plot for the total score did not suggest any trends between the different evaluations by the same examiner (Figure 2).

DISCUSSION

The value of translating and cross-culturally adapting a clinical assessment scale into different languages is to encourage broader application[7] and to help standardize and facilitate the exchange of information within the clinical and scientific communities.[10] To help stimulate the global adoption of the mJOA cervical myelopathy score assessment tool, it was translated and adapted to Dutch.[7] Following a similar systematic, standardized approach as was used to generate the Dutch version, the mJOA was recently translated and cross-culturally adapted to Brazilian Portuguese.[8] However, after translating a clinical assessment tool to a different language, it is important to assess the reliability of the new version.[7,8,10]
The present study provides the reliability assessment of the translated and cross-culturally adapted to Brazilian Portuguese mJOA questionnaire, demonstrating strong intra- and inter-observer reliability. This translated version was tested in a sample of patients with a clinical complaint or abnormality suggestive of cervical myelopathy and two experienced spine surgeons scored these patients. For the Brazilian mJOA overall score, the reliability obtained in the present study could be considered as "almost perfect" and is at least as favorable as that reported for the Dutch version.[7] The high degree of reliability suggests that the Brazilian version is a consistent measurement tool for severity in cervical myelopathy.
One major advantage of the mJOA is that motor function of the legs, motor function of the arms, sensation of the hands, and micturition are scored separately through four different questions. In addition to the total score (sum of the scores for each of the four questions), the present study also assessed the reliability for each question. Although the questions on the mJOA could have the potential for subjective interpretation, there was strong reliability for the overall score and for each question. That the mJOA is scored by physicians based on patient evaluation, instead of being a patient-reported measure, may help to explain the strong reliability found in the study. Despite being classified as "substantial", the intra-observer reliabilities for both the total score and for each question were somewhat lower than for the inter-observer reliabilities. It is possible that during the time interval between the two evaluations for the intra-observer reliability assessment, the patients' complaints and findings may have progressed or changed. It is also possible that the examiners' subjective interpretation of the patients' complaints and findings may have differed between the two evaluations. This influence of the natural symptom fluctuation associated with the time memory effect has been previously discussed in the literature.[11]
The major limitation of the present study was that it only assesses the reliability of the translated and cross-culturally adapted to Brazilian Portuguese version of the mJOA score. There remains a lack of validation for the mJOA questionnaire in general, regardless of language, with regard to its effectiveness as a health-related quality of life instrument, despite its general recognition and acceptance as a cervical myelopathy severity tool.

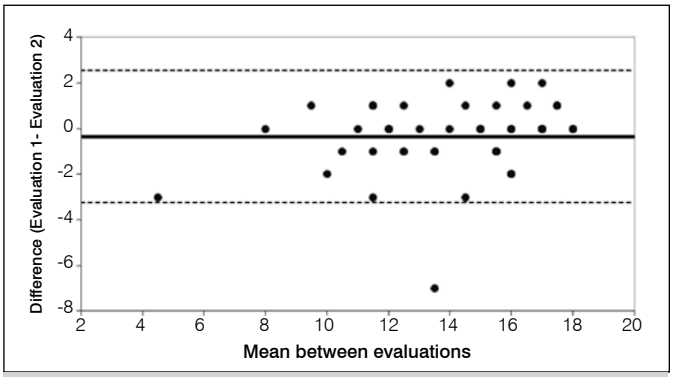

Figure 2. Bland-Altman plot for the total score between the different evaluations by the same examiner (intra-observer reliability).

CONCLUSION

In line with the need for international standardization of spine outcomes instruments, the present study demonstrated that the translated and cross-culturally adapted to Brazilian Portuguese version of the mJOA questionnaire is reliable as a cervical myelopathy severity tool.

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ORIGINAL ARTICLE

ORTHOPEDIC INJURIES IN MEN'S PROFESSIONAL SOCCER IN BRAZIL: PROSPECTIVE COMPARISON OF TWO CONSECUTIVE SEASONS 2017/2016

LESÕES ORTOPÉDICAS NO FUTEBOL PROFISSIONAL MASCULINO NO BRASIL: COMPARAÇÃO PROSPECTIVA DE DUAS TEMPORADAS CONSECUTIVAS 2017/2016

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ABSTRACT

Purpose: The purpose is to compare the incidence and characteristics of injuries sustained in two consecutive seasons of the São Paulo State Football Championship. Methods: Prospective study performed using an electronic form previously developed by the Medical Committee of the São Paulo State Football Federation, sent to the physicians responsible for the tournament's series A1 and A2 teams, after each round. Results: 17.63 injuries sustained per 1000 hours of matches in the A1 series and 14.91 injuries sustained per 1000 hours of matches in the A2 series. Incidence of injuries per 1000 hours of matches decreased from 24.16 to 17.63 in the A1 series ($p<0.037$) and from 19.10 to 14.01 in the A2 series ($p<0.064$). External defenders suffered most injuries, while muscular injuries were most common and lower limbs, the most affected areas. Most injuries occurred between 30 and 45 minutes of the match and only 11.9% of the injuries required surgery. Conclusions: Prevalence and frequency of injuries decreased between seasons. Most injuries were sustained in the lower limbs; strains were the most common injuries, followed by strains and contusions; MRIs were the most frequently requested exams and most injuries were classified as moderate (8-28 days). ***Level of evidence III, Cross-Sectional Study.***

Key-words: Soccer. Athletes. Injuries. Epidemiology

RESUMO

Objetivo: Comparar a incidência e características das lesões ocorridas em duas temporadas consecutivas no campeonato Paulista de Futebol. Métodos: Realizamos um estudo prospectivo, através de questionário eletrônico previamente desenvolvido pelo Comitê Médico da Federação Paulista de Futebol e enviado aos médicos dos times das séries A1 e A2 do Campeonato Paulista de Futebol após cada rodada. Resultados: A série A1 apresentou 17,63 lesões por 1000 horas de jogo e a série A2 14,91 lesões por 1000 horas de jogo. A incidência de lesões por 1000h de jogo caiu de 24,16 para 17,63 na serie A1 ($p<0,037$) e de 19,10 para 14,01 na serie A2 ($p<0,064$). Os laterais foram os mais acometidos, as lesões musculares as mais frequentes e os membros inferiores os mais acometidos. A maioria das lesões ocorreu entre 30 e 45 minutos de jogo e somente 11,9% das lesões necessitaram de cirurgia. Conclusão: Houve uma queda da prevalência e da incidência de lesões entre as temporadas. A maioria das lesões ocorreu nos membros inferiores, o tipo mais comum de lesão foi o estiramento, seguido de entorse e contusão, o exame mais pedido foi a ressonância magnética e a maioria das lesões foi classificada como moderada (8-28 dias). ***Nível de evidência III, Estudo Transversal Descritivo.***

Descritores: *Futebol. Atletas. Lesões. Epidemiologia.*

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NTRODUCTION

Playing football is complex and involves considerable risk of injury, associated to material economic and sports-related impact. Benching a professional starting athlete, due to injury, for one month, translates in the average loss of € 500,000.00 for the club, and also compromises the success of the team on the pitch[1]. Moreover, because of the combination of physical and emotional stress, professional soccer is a sport with high risk of injury[2].

Epidemiological studies reveal the incidence rate of 16 to 28 injuries in matches and 2 to 11 injuries at practices for every 1,000 hours of exposure, at the professional level[3]. According to other European

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and American studies on professional men's football, the average injury rate is of 6-8 injuries per 1000 hours of exposure.[2,]
Football injuries affect especially the lower limbs – more specifically, the ankles, knees and thighs[4].
Susceptibility to given types of specific injuries nevertheless varies depending on each athlete's position on field. Significant differences found in the injury incidence rates possibly occur for changes to game style and intensity, and the mood of the match also plays an important role in the specificities of each injury[5].
A study performed with elite athletes suggests that the different roles involved in each position require specific technical, physiological and tactical demands from the players. Central defense players, for instance, are more likely to jump for the ball than external defenders, whereas external midfielders generally cover greater distances when running than central midfielders[6].
Professional men's football injuries largely influence the final results of the teams in both national leagues and European cups and leagues. Such findings reveal the importance of preventing injuries to increase the teams' chances of success and titles[7].
Implementing prevention strategies for a given population requires understanding and obtaining evidence on the specific pattern of said sample. As such, several epidemiological investigations have been conducted worldwide, and is common practice in the main leagues, world tournaments[2,8] and World Cups.[9,10]
Though football is the most popular sport in Brazil and the country is a global reference in the practice, there are few epidemiological studies and data on the regional and national leagues. The purpose of this investigation is to compare the incidence and specificities of injuries occurred in two consecutive seasons to better understand the pattern of such injuries, in order to establish prevention measures to avoid them.

METHODOLOGY

This research project was approved by the Ethics Committee of the Federal University of São Paulo /Escola Paulista de Medicina. (Number 1.660.701)
This is a prospective study performed by means of an electronic form previously developed by the Medical Committee of the São Paulo Football Federation (Federação Paulista de Futebol), sent to the physicians in charge of the teams of the A1 and A2 series of the São Paulo State Football Championship, after each round of the 2017 São Paulo State Football Championship. Data was compared to a prior similar study conducted during the last season, following data collection and statistical analysis[11].
The above mentioned form was sent after each round to analyze the incidence of the injuries and characteristics thereof. The form was comprised of 15 questions on the specificities of the match, athlete and injury (Appendix 1). As this was an electronic questionnaire there was no consent form.
The definition used to determine a football injury was the consensus statement set out by Fuller et al.[12] for the 2005 FIFA consensus, described as: "Any physical complaint sustained by a player that results from a football match or football training, irrespective of the need for medical attention or time loss from football activities".
A form was sent for each injury occurred to analyze the outcome of each reported injury, filled out after the athlete returned to both training and matches. There are eight questions in the form, to indicate the complementary tests and exams and the final diagnosis (Appendix 2).
The São Paulo Football Federation was asked to provide the records on the different matches to obtain the time of each match, classified as follows: morning (matches beginning before 12 p.m.), afternoon (matches before 6 p.m.) and night (matches after 6 p.m.).
Incidence of injuries was calculated to assess injury risk, expressed as the number of injuries per 1000 hours of exposure .[12,13] The following formula was used to calculate exposure:
Exposure = number of matches x number of players starting the match (22) x duration of the match in minutes (90) / 60
The following formula was used to calculate incidence at matches:

Incidence = number of injuries at matches x 1000 hours/time of exposure

Statistical Analysis

Parametric statistics was used for data is both quantitative and uninterrupted. The Two-Proportions Test was used to characterize the distribution of the relative frequency of the qualitative variables. Differences with $p<0.05$ were deemed statistically relevant. Software SPSS V17 was used to perform the analysis.

RESULTS

Mapping of the Injuries

The average age of the injured players was 27.5 years, whereas the average time loss caused by injuries was of 23.5 days. Most matches occurred in the afternoon (39.9%), 11.3% matches were held in the morning and 48.8%, at night.
A total of 160 injuries were described during all 305 matches, with an average of 0.52 injuries per game. As for playing position, 32.1% of the injuries were sustained by external defenders, 29% by forwards, 22.1% by central defenders, 18.3% by external midfielders, 16% by central midfielders and 4.6% by goalkeepers. Most injuries occurred at the end of the first half of the match, between 31-45 minutes (25,6%). (Figure 1)
In what concerns the location of injury, the most common injuries were: lower limbs (73.8%), head (17.5%), upper limbs (6.3%) and trunk (1.9%). Injuries occurred most often on the right side (47.5%), and the side did not apply in 13.1% of the cases. There was contact in 51.9% of the injuries. As for the type of injury, the most common injuries were muscle strains (34.4%), followed by sprains (18.1%) and contusions (13.1%). (Figure 2) With respect to final diagnosis, the most frequent diagnoses were: hamstring strain (16.5%), adductor muscle strains (12.7%), crush/laceration injury to the face (10.8%) and concussion, Medial Collateral Ligament (MCL) injury, Anterior Cruciate Ligament (ACL) injury and quadriceps injury (4.4%). (Figure 3)
There were 17.63 injuries per 1000 hours of matches in the A1 Series, and 14.91 injuries per 1000 hours of matches in the A2 Series. When grouped, 15.89 injuries occurred in 1000 hours of matches in both series.

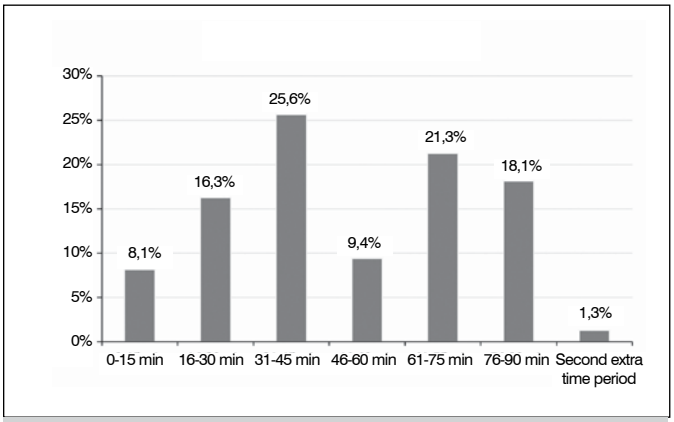

Figure 1. Time distribuition.

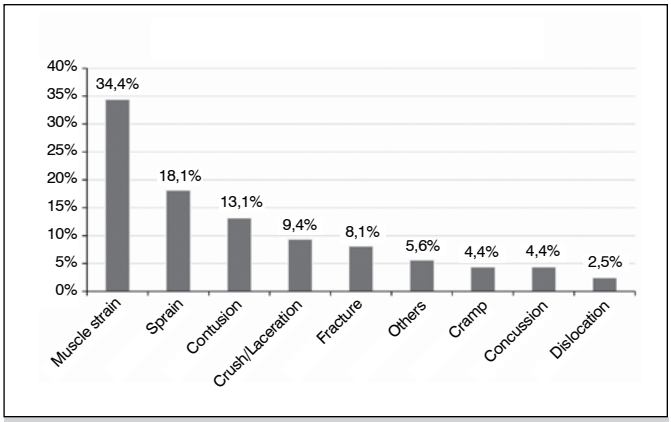

Figure 2. Type of Lesion.

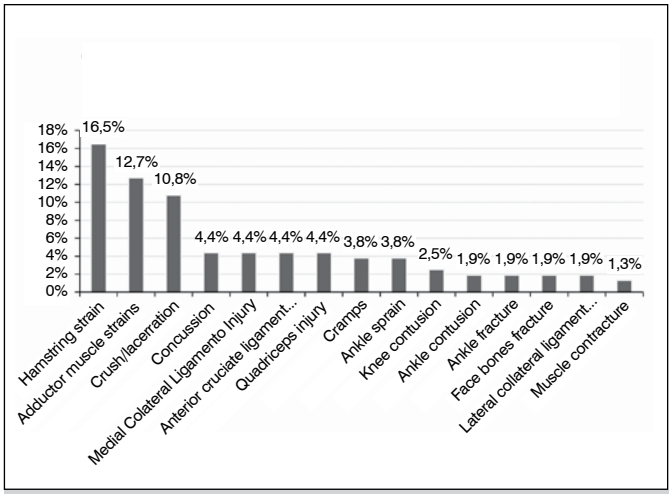

Figure 3. "Final Diagnosis" Distribution (15 Most Frequent Injuries).

Treatment of the Injuries

When requested, the most common complementary tests and exams were: Magnetic Resonance Imaging (MRIs) (38.9%) and ultrasonography (14.3%), followed by Radiography (6.8%) and Computed Tomography scans (CT) (6.8%). No tests were necessary for 29.5% of the injuries. Surgery was required in 11.9% of the total recorded injuries. Most injuries were deemed moderate according to the severity scale, with time loss ranging from 8 to 28 days (41.9%). (Figure 4)

Comparison: 2016 and 2017 Seasons

The incidence of injuries per 1000h of match dropped from 24.16 to 17,63 in the A1 Series ($p<0.037$), from 19.10 to 14.01 in the A2 Series ($p<0.064$), and, when grouped (A1 + A2), from 21.32 to 15.89 from the 2016 to the 2017 season ($p<0.003$).

The prevalence of injuries also dropped from 35.0% to 26.4% ($p<0.001$) when the two consecutive seasons were compared.

With respect to the complementary tests and exams requested, the number of cases in which no tests were requested increased from 23.2% to 29.4%, whereas the request for radiographies dropped from 15.4% to 6.9% and for ultrasound exams decreased from 28.2% to 14.4%.

The relationship between surgery and type of injury was also investigated, and strains generally do not require surgery, while fractures are likely to evolve into surgery.

There is also a relationship between the type of injury sustained and the requested tests and exams. MRIs are generally requested for sprains, while ultrasound exams are requested for strains. No tests or exams were requested for crush/laceration injuries and radiographies are generally requested for fractures.

The severity of the injury seems to be related to the requested tests or exams; in general, no tests or exams are requested for slight severity, minimal severity is generally associated to Computed Tomography scans. Ultrasound exams are generally requested for major severity and Magnetic Resonance Imaging are likely to be requested for severe severity.

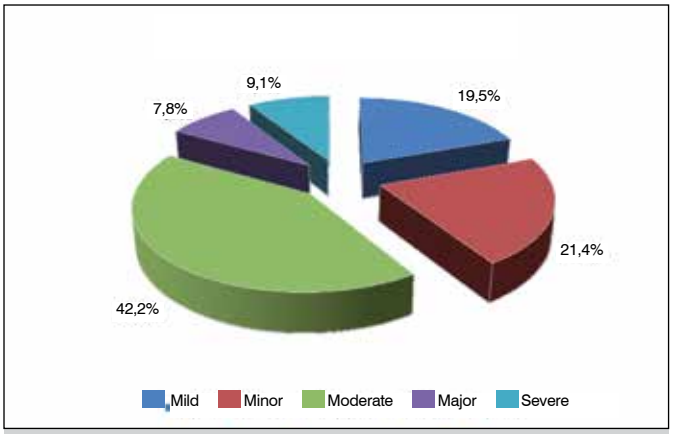

Figure 4. Severity of lesion.

DISCUSSION

This investigation essentially focused on the analysis of orthopedic injuries sustained in the São Paulo State Championship of Series A1 and A2, of the 2017 season, which was compared to the 2016 season[11]. The incidence and characteristics of the injuries of the 2017 season are similar to data available in the literature[3,14], though both the incidence and distribution of the injuries of the injuries dropped when compared to the previous season.

Such difference is likely attributable to the decreased exposure of the athletes, considering the number of matches fell from 261 to 305 matches, especially in the number of games of the A1 Series. The decrease in the number of matches allowed for more time between the matches, whereby athletes had a longer recovery period during the 2017 season.

In addition to decreased exposure, other factors may have also contributed to the drop in the incidence and prevalence of injuries, such as the preventive measures clubs implemented and improved pitch conditions.

Strains, sprains and contusions were the most prevalent types of injuries in this study, as was the case of several other investigations available in the literature[2,15-17]. Only 11.9% of the injuries required surgery, and most diagnoses related to non-surgical treatment. Fractures and severe ligament injuries were generally operated on. MRIs were the most commonly requested tests; A1 Series clubs had the highest rate of MRI requests, likely due to the costs involved, for AI Series clubs have higher financial support.

The age of the athletes did not affect the type of injury sustained or the respective time loss, both with respect to the comparison between two seasons and between series, as seen in previous studies[15].

Most injuries occurred during the last 15 minutes of the first half of the matches, as was the case of the previous season, unlike the previous studies, in which incidence was higher in the last 30 minutes of the match[18,19]. However, the tournament in one of such studies was organized as a single-elimination system, which may have translated into greater dedication by the athletes during the last portion of the match.

The greatest limitation of this study from the methodological standpoint is the reliability of the information provided by the clubs' medical personnel, as well as the lack of official records on injuries sustained during the matches. Moreover, it is not possible to accurately measure each athlete's exposure.

CONCLUSION

The incidence and prevalence in the number of injuries sustained in the 2017 season decreased when compared to the 2016 season.

Most injuries occurred in the lower limbs; strains were the most common type of injury, followed by sprains and contusions. MRIs were the most commonly requested test, and most injuries were classified as moderate. Approximately 12% of the injuries evolved into surgery. Results similar to those available in current literature.

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ORIGINAL ARTICLE

FACTORS RELATED TO AMPUTATION LEVEL AND WOUND HEALING IN DIABETIC PATIENTS

FATORES RELACIONADOS AO NÍVEL DE AMPUTAÇÃO E À CICATRIZAÇÃO DE FERIDAS EM PACIENTE DIABÉTICOS

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ABSTRACT

Objective: There are no specific criteria that define the level of amputation in diabetic patients. The objective of this study was to assess the influence of clinical and laboratory parameters in determining the level of amputation and the wound healing time. Methods: One hundred and thirty-nine diabetic patients were retrospectively assessed. They underwent surgical procedures due to infection and/or ischemic necrosis. Type of surgery, antibiotic use, laboratory parameters and length of hospital stay were evaluated in this study. Results: The most common amputation level was transmetatarsal, occurring in 26 patients (28.9%). The wound healing time increased with statistical significance in individuals undergoing debridement, who did not receive preoperative antibiotics and did not undergo vascular intervention. Higher levels of amputation were statistically related to limb ischemia, previous amputation and non-use of preoperative antibiotics. Conclusion: Patients with minor amputations undergo stump revision surgery more often, but the act of always targeting the most distal stump possible decreases energy expenditure while walking, allowing patients to achieve better quality of life. Risk factors for major amputations were ischemia and previous amputations. A protective factor was preoperative antibiotic therapy. ***Level of Evidence III, Retrospective Study.***

Keywords: Diabetic foot. Amputation. Antibiotics. Wound healing. Risk factors. Protective factors.

RESUMO

Objetivos: Não há critérios específicos que definam o nível de amputação em pacientes diabéticos. O objetivo deste estudo foi avaliar a influência de parâmetros clínicos e laboratoriais na determinação do nível de amputação e do tempo de cicatrização da ferida. Métodos: Centro e trinta e nove pacientes diabéticos foram avaliados retrospectivamente. Eles foram submetidos a procedimentos cirúrgicos devido a infecção e/ou necrose isquêmica. Este estudo avaliou tipo de cirurgia, uso de antibióticos, parâmetros laboratoriais e tempo de internação. Resultados: O nível de amputação mais comum foi o transmetatarsal, ocorrendo em 26 pacientes (28,9%). O tempo de cicatrização das feridas aumentou com significância estatística em indivíduos submetidos a desbridamento que não usaram antibióticos pré-operatórios e que não foram submetidos à intervenção vascular. Os níveis mais altos de amputação foram estatisticamente relacionados a isquemia do membro, amputação prévia e ausência de antibiótico no pré-operatório. Conclusão: Os pacientes com amputações menores são submetidos à revisão do coto com maior frequência, porém, visar sempre o coto mais distal possível diminui o gasto de energia durante a marcha, possibilitando melhor qualidade de vida aos pacientes. Os fatores de risco de amputação maior foram isquemia e amputações prévias. Um fator de proteção foi a antibioticoterapia no pré-operatório. ***Nível de evidência III, Estudo Retrospectivo.***

Descritores: *Pé diabético. Amputação. Antibióticos. Cicatrização. Fatores de risco. Fatores de proteção.*

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INTRODUCTION

Diabetes Mellitus is an extremely debilitating chronic disease that has taken an epidemic pattern in recent decades, becoming a real public health problem. In 2012, the diabetic population in the US was estimated at 29.1 millions of Americans, with 1.4 million diagnosis per year, which generated a 245 billion dollars cost in that same year.[1] Peripheral neuropathy is a late complication observed especially in the lower limbs and is the main cause of ulcerations on feet.[2] Secondary infection of neuropathic ulcers is the main cause of hospitalization and amputation of the lower limbs in the diabetic patient.[2,3] In addition, 2/3 of diabetic patients

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who underwent lower limb amputation died in 5 years due to bed immobilization, inadequate psychologically counseling and uncontrolled food intake.[4] According to the Brazilian Diabetes Society, every minute in the world, an amputation is performed due to diabetes. In Brazil, the real incidence of diabetes is still unknown. It is estimated that there is something around 8 million diabetics and at least another 3 million that do not have their disease diagnosed.[5] There is no statistical data that provides any criteria for indicating the correct level of amputation; however, it is known that advanced kidney disease and absence of distal pulse are factors that negatively influence the healing prognosis of diabetic amputated patients.[6]

The objective of this study was to trace the epidemiological profile of persons with diabetes treated at two tertiary orthopedic hospitals and evaluate the influence of clinical and laboratory parameters in the final amputation level of the lower limbs and in the wounds' healing time.

MATERIALS AND METHODS

Between April 2007 and December 2012, 139 patients were hospitalized due to complications of diabetic foot in two tertiary orthopedic hospitals. All of them were submitted to a debridement or an amputation due to infection and/or ischemic necrosis in that affected limb. Epidemiological data from the 139 patients was retrospectively collected from medical records, consisting in: age, gender, diagnosis, type of surgical procedure, amputation level, wound healing time, culture results, antibiotic usage, need of vascular procedures and hospital length stay. The laboratory tests collected were: White Blood Cell Count (WBC), Erythrocyte Sedimentation Rate (ESR), C-Reactive Protein (CRP), Serum Albumin (SA), Creatinine and Urea. All Patients signed an informed consent. This study was aprooved by our institution ethics committee with the number 078/2015.

Mann-Whitney and Fisher tests were used, according to each analysis, to correlate the studied variables. We adopted the significance level of 5% ($p<0.05$) for the application of statistical tests. We used the SPSS software (Statistical Package for Social Science), in its 17.0 version, for analysis of results.

RESULTS

Descriptive Analysis

From the 139 patients studied, 106 (76.3%) were male and 33 (23.7%) were female. The average age was 64 years, ranging from 23 to 100 years. The average hospital stay was 23 days, with a minimum stay of 1 day and up to 150 days.

The most prevalent diagnoses were: ischemia, occurring in 63 cases (33.3%); osteomyelitis in 62 patients (32.8%); and infected ischemia in 34 cases (18%). We had 187 diagnoses for the 139 patients, with an average of 1.4 diagnoses per patient.

Regarding the surgeries, we had an average of 1.2 surgeries per patient, with 162 procedures. The most prevalent procedure was amputation, performed 90 times (54.9%), followed by debridement, performed 70 times (42.7%).

The most frequent amputation level were the transmetatarsal, performed in 28 patients (31.1%) and the amputation of one toe, performed in 25 patients (27.7%) (Table 1).

Regardless of the number of surgeries that each patient was submitted, each one of them had the final wound healing time evaluated. The time between the first surgery and the complete closure of the wound had an average of 35 days, with a minimum of 14 days and up to 730 days, in 138 patients that had this information recorded. Twenty-six patients (18.7%) did not have the final wound closure time recorded and, in three of them, this information was not recorded because the patients died.

With respect to the use of antibiotics (ATB), 89 (64.0%) patients used it before admission, 55 (40.0%) in the postoperative period and 39 (28.1%) did not use ATB. In 11 medical records this information was not found. About the ATB used before the admission, most part of the patients used Amoxicillin-Clavulanate (24.7%), followed by Ampicillin-Sulbactam (23.6%) and the combination of Ciprofloxacin and Clindamycin (18.0%). In relation to the ATBs used postoperatively, after adjustment by the culture results, most part of the patients used Amoxicillin-Clavulanate (20.0%), followed by Ampicillin-Sulbactam (11.3%) and the combination of Ciprofloxacin and Clindamycin (8.7%).

Most part of the collected cultures were positive (74.1 %), while 18.0 % had no microorganisms growth. In 7.9 % of the patients this result was not informed. The average number of bacteria found per patient was two. The greater number of bacteria found was three. The most prevalent microorganisms were: *Staphylococcus aureus*, occurring in 24 cultures (15.6%), *Pseudomonas aeruginosa*, occurring in 18 cultures (11.7 %) and *Enteroccus faecalis* occurring in 15 cultures (9.7%) (Table 2). The most common association between bacterias was *Staphylococcus aureus* + *Enteroccus faecalis* (7 cultures) and *Pseudomonas aeruginosa* + *Enterobacter cloacae* (4 cultures). Five cultures were positive for multidrug-resistant *Staphylococcus aureus* (MRSA). Four of these patients with MRSA had used antibiotics (Amoxicillin-Clavulanate) before admission.

Of the 139 patients evaluated, 49 (35.3%) underwent some attempt of surgical revascularization of the lower limb. Three patients did not have any records about vascular approach.

Table 1. Level of Amputation.

Level of Amputation	Frequency	%
Chopart joint	2	2.2
Metatarsophalangeal	4	4.5
Ray	6	6.6
Transfemoral	6	6.6
Transtibial	19	21.1
Toe	25	27.7
Transmetatarsal	28	31.1
Total	90	100.0

Table 2. Most common bacterias found in positive culture results.

Bateria	N	%
Staphylococcus aureus	24	15,6
Pseudomonas aeruginosa	18	11,7
Enterococcus faecalis	15	9,7
Proteus mirabilis	12	7,8
Escherichia coli	12	7,8
Enterobacter cloacae	10	6,5
Klebsiella Pneumoniae	9	5,8
Serratia marcens	7	4,5

Comparative Analysis

The statistical analysis showed that the wound healing time was impacted by several factors (Table 3). The wound healing time was longer in those patients in whom preservation of the limb was attempted through serial debridement (p=0.005) or through vascular approach (p=0.003). The wound healing time decreased in those patients in whom the amputation was the first choice of treatment (p=0.001) and in those patients that used ATB before admission (p=0.000).

Laboratory parameters were also studied in relation to the wound healing time (Table 4). The only statistically related factor were preoperative WBC (p = 0.032 and r = 0.209), that were bigger in those patients with longer wound healing time.

Regarding the level of amputation, it was observed that individuals who had higher level of amputation (above the ankle level) were those with associated ischemia diagnosis (p = 0.002) and who had already undergone previous amputation (p = 0.010). The individuals who had lower levels of amputation (at the foot level) were those who used ATB preoperatively (p = 0.004). Patients who underwent minor amputations had more surgical procedures than those who underwent major amputation (p = 0.002), an expected relationship, as a distal limb preservation require more wound care. There was no significant correlation between the length of hospital stay and the results of cultures (p = 0.311). In addition, there was no statistical relationship between length of hospital stay and wound healing time (p = 0.621).

Table 3. Evaluated factors Vs. Time between the first surgery and the final wound closure time.

Factors influencing in the wound closure time	Category	N	Average time (days)	p value
Amputation	Yes	76	47.1	0.001*
	No	30	69.8	
Debridment	Yes	53	62.4	0.005*
	No	54	45.8	
Antibiotic (before adimission)	Yes	69	42.7	0.000*
	No	29	65.8	
Vascular approach	Yes	30	67.7	0.003*
	No	76	47.9	
Saved limb	Yes	83	49.9	0.038*
	No	22	64.9	

*P<0,05

Table 4. Laboratory parameters correlation with wound healing time.

Pre operative exam	Average	Correlation coefficient	p value
WBC (/ml)	5932	0.209	0.032*
SA (g/dL)	2.82	-0.077	0.456
Creatinine (mg/dL)	1,85	-0.017	0.862
Urea (mg/dL)	56	-0.056	0.576
CRP (mg/dL)	122	-0.043	0.665
ESR (mm/h)	47	-0.214	0.073

*p<0,05.

DISCUSSION

Infection, associated to ulceration and neuropathy is the main cause of lower limb amputation in persons with diabetes.[2] The relevance of wounds in the lower limb of those patients is extremely important, since it can reach around 10-65/1000 patients per year, which is more than the rate of amputation, which can vary between 3.7 to 12.5/1000 patients per year.[7] In our study population, infection was present in 50.8 % of patients (osteomyelitis or infected ischemia), corroborating with the worldwide literature. It is also known that the risk of amputation in a diabetic patient is 10 to 15 times higher than in general population.[8] The mortality of patients with late complications of diabetes is extremely high and is related to age, poor glycemic control and depression.[9] Major amputations (ankle, transtibial or transfemoral) are associated with a lower survival rate than minor amputations (midfoot, rays or toes)[10] which lead orthopedic surgeons to continually look for factors that may influence on the level of amputation to be selected.

On this study, minor amputations (80,6%) were more frequent than major amputations (18.4%). Despite the findings of Dillinghan et al,[9] that patients with minor amputation are more often submitted to amputation revisions for a more proximal level, increasing the cost to the health system, we believe that the search for the most distal stump possible, regardless the healing time and the number of interventions necessary for such, decreases energy expenditure during walking, increasing the quality of life of post-amputated patients. It is believed that treating the patient in an early stage of neuropathy, allied to a multidisciplinary approach, positively influences limb preservation.[11] All patients with ischemic injury, infected or not, in the lower limbs should receive clinical assessment by a general practitioner or endocrinologist, a vascular surgeon, an orthopedic surgeon, an infectious disease specialist, a plastic surgeon and a curative commissioner nurse, optimizing care and establishing priorities for the medical team.

Patients undergoing major amputations were those with more severe injuries indicated by a greater statistical frequency of associated ischemia and previous amputations.[12,13] According to Pollard et al.,[6] patients with palpable dorsalis pedis pulse have better healing and do not require further amputation in most cases. Santos et al.[14] found that patients with chronic arterial insufficiency without possibility of revascularization have a higher risk of a major amputation.

It should be noted that the use of ATB before surgery was a protective factor for major amputation, which may indicate that the use of empirical ATB can prevent the evolution of a simple to a severe injury, allowing smaller ablations.

Also related to ATB 's, it is noteworthy that the antibiotics used empirically followed the same frequency of use of the antibiotics oriented by the culture, being the use of Amoxicillin-Clavulanate the most frequent, followed by Ampicillin-Sulbactam and the combination of Ciprofloxacin and Clindamycin. Furthermore, it was observed that the use of preoperative ATB was a factor that decreased the patients wound closing time.

The type of intervention also affected the wounds closing time. Therefore, it should be attempted that, if the surgeon chooses to preserve the limb with vascular interventions and debridement, the wound closure time will be longer compared to a patient in which it is opted for ablative therapy.

Several laboratorial parameters influence the frequency of amputations. The nutritional status and patient immunocompetence are important factors when planning to perform an amputation in an individual with diabetes. It is known that SA levels below 3.0 g / dl and total lymphocyte count less than 1,500 / mm3 are considered poor prognostic factors leading to early progression of the amputation level.[4] Furthermore, the presence of advanced kidney disease is an independent risk factor for major amputations.[6,10] In this study, the

only laboratorial parameter that presented statistical correlation was the number of preoperative leukocytes. The increase in leukocytes number was a predictor of a longer wound healing time, which is clearly explained by the fact that infected wounds present major challenges to the healing process.

CONCLUSION

This study shows that major amputations have as risk factors ischemia and previous amputations and as a protective factor the use ATB preoperatively. The wound healing time declines with the use of preoperative ATB and increases if the patient underwent vascular intervention or has higher Leukocyte levels preoperatively and / or had their member preserved, demanding multiple debridement.

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ORIGINAL ARTICLE

NEUROMUSCULAR ELECTRICAL STIMULATION OF MEDIUM AND LOW FREQUENCY ON THE QUADRICEPS FEMORIS

ESTIMULAÇÃO ELÉTRICA NEUROMUSCULAR DE MÉDIA E BAIXA FREQUÊNCIA NO MÚSCULO QUADRÍCEPS FEMORAL

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ABSTRACT

Objective: The purpose of this study was to investigate the effects of neuromuscular electrical stimulation (NMES) in different frequencies on the quadriceps femoris. A randomized, controlled, blind cross-sectional study. Methods: Thirty subjects (12 men and 18 women), with an average age of 24.67 years, weight of 65.62 kg and height of 1.69 m were evaluated. Three random test conditions were applied: maximum voluntary isometric contraction (MVIC), maximum voluntary isometric contraction with medium frequency current (MVIC-MF) and maximum voluntary isometric contraction with low frequency current (MVIC-LF). Four MVICs were applied in each situation. The time between different isometric contraction types was 90 seconds while the time between the same conditions of contraction was 10 seconds. Results: Two-way ANOVA test showed that MVIC-MF had higher values for peak torque than MVIC-LF (p=0.02). Significant statistical results were found when comparing MVIC-MF and MVIC (p=0.03), but not for MVIC and MVIC-LF (p=0.52). Conclusion: Maximum voluntary isometric contraction associated with medium-frequency electrical stimulation was more effective than other NMES conditions. ***Level of Evidence II, Therapeutic Studies - Investigation of treatment results.***

Keywords: Quadriceps Muscles. Transcutaneous electrical nerve stimulation. Isometric contraction. Torque.

RESUMO

Objetivo: A finalidade deste estudo foi investigar os efeitos da estimulação elétrica neuromuscular (EENM) em diferentes frequências sobre o músculo quadríceps femoral. Estudo randomizado, transversal, controlado e cego. Métodos: Foram avaliados trinta indivíduos de ambos os sexos (12 homens e 18 mulheres) com média de idade de 24,67 anos, peso 65,62 kg e altura 1,69 m. Os indivíduos foram submetidos a três condições de testes randomizados: contração voluntária isométrica máxima (CVIM), contração voluntária isométrica máxima associada à corrente de média frequência (CVIMMF) e contração voluntária isométrica máxima associada à baixa frequência (CVIMBF), sendo realizadas quatro repetições de CVIM em cada situação. O tempo entre as diferentes condições de contrações isométricas foi de 90 segundos e o tempo entre as contrações isométricas das mesmas condições foi de 10 segundos. Resultados: O teste ANOVA mostrou que a CVIMMF obteve valores de pico de torque maiores do que a CVIMBF (p = 0,02), com diferença significativa. Foram encontrados resultados com significância estatística ao comparar CVIMMF e CVIM (p = 0,03), mas não entre CVIM e CVIMBF (p = 0,52). Conclusões: A contração voluntária isométrica máxima associada a EENM de média frequência foi mais efetiva do que as outras situações de EENM. ***Nível de evidência II, Estudos Terapêuticos – Investigação dos resultados do tratamento.***

Descritores: *Músculo quadríceps. Estimulação elétrica nervosa transcutânea. Contração isométrica. Torque.*

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INTRODUCTION

Neuromuscular stimulators can produce electrical pulses, which can cause excitation of peripheral nerves and, consequently contraction of muscular tissue. Therewith, the use of electrical stimulation by physical therapists to increase or maintain muscle performance has gained popularity.

Some factors like well-being of patient, location of electrodes, frequency and current intensity, encouraged researchers to investigate medium and low frequency currents in an attempt to minimize the discomforting as a result of the use of neuromuscular electrical stimulation (NMES).[1]

Recruitment of motor units during voluntary contraction follows the principles of that the cell body size of motor neurons determines the order in which motor units are activated. Typically, type I (slow-twitch) fibers are recruited before the type II (fast-twitch) fibers according to the increasing in muscular contraction. Additionally, the order

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of recruitment of type II fibers occurs in the following order: First type IIa fibers and after type IIb fibers.

Studies involving electrical stimulation have suggested a selective recruitment and preferred the fast-twitch fibers (type II). This hypothesis, however, is based on the results of fatigue studies in humans, demonstrating limited scientific evidence.

The force of contraction produced by NMES has been reported, in some studies, as being higher than the maximum voluntary contraction.[2] However; some studies report that use of NMES produces a significantly lower contraction force or equal force to the maximum voluntary contraction (MVC). Therefore, in untrained individuals can generate greater force than the MVC by electrical stimulation.[3]

The low-frequency electric current is that less than 1000Hz and are generally used for muscle contraction below 100Hz. The stimulation frequency of 50Hz is fast enough to cause muscular contraction even in motor units of rapidly contraction. Nevertheless, some studies using lower frequencies (30- 35Hz) achieved positive results.[4]

In other investigated the influence of NMES in producing muscular force using low-frequency current (70Hz, 250μs).[5] The torque generated by the electrical current was 45.05% of the maximum voluntary contraction and superposition of electrical stimulation to the MVC showed no significant increase in the knee extensor torque in the individuals analyzed.

The medium-frequency alternating current is defined as current frequency between 1 and 10,000Hz. Interferential current (4.000Hz) and Russian current (2.500 Hz) are the most popular NMES utilized. The reason to use higher frequency than 1000Hz is that the skin works as a barrier to capacitive current flow. As the current frequency applied increases, the skin impedance decreases.[6] Above 1.000 Hz skin impedance is low, less energy is dissipated to the surface of epidermis and a larger proportion of energy is intended to stimulate deeper tissues.[7] Thus, it is expected that the devices provide medium frequency current (1-10.000Hz) may be able to produce higher levels of muscle contraction with less discomfort than the low frequency stimulators.

It is important to considered well-being of patient during training with electrical stimulation because the discomfort is considered one of the limiting factors in the use of NMES in promoting increased muscle strength.[8] An ideal electrical stimulator should be able to increase muscle strength with the least possible discomfort during stimulation.[9] A Russian physiologist[10] indicated that using frequency of 2.500Hz; he was able to increase the strength of the subjects by 30-40% in 20 stimulation sessions. Each session is consisted of 10 contractions in 10 seconds each with 50 seconds rest.[11,12]

Taking into account the physical and physiological differences of electric current in low and medium frequency and the lack of studies, this research aimed to verify the effect of neuromuscular electrical stimulation of medium and low frequency in the generation of torque in quadriceps femoral muscle in healthy subjects.

MATERIALS AND METHODS

This is a cross-sectional randomized controlled blind study. Thirty healthy individuals of both sexes (12 male, 18 female) where selected, average age of 24.67 year (SD 3.70), weight 65.62Kg (SD 15.21) and height 1.69m (SD 0.11). Potential participants were excluded if they presented muscular recent lesion, knee injury, sensory changes, neuromuscular disease, morbid obesity and pregnancy. The project was cleared by the Institution's Ethics Committee (CEP 2.178.833) and all patients signed an Informed Consent Form. The choice of dominant lower limb was randomized with sealed envelopes. Thus, 16 right lower limbs and 14 left were selected (53.3% and 46.7%, respectively). Before being submitted to isokinetic evaluation, the volunteers performed the following protocol: 10 minutes by bicycle without load for warming, quadriceps and hamstring stretching muscles with 3 repetitions series of 30 seconds each. All individuals where familiarized with the protocol test that consisted of 4 seconds of submaximal isometric contraction (50-75%), 4 seconds of isometric contraction associated with electrical stimulation (medium and low frequency). The aim of this familiarization session was to minimize any misunderstanding with the test, especially in relation to contraction associated with electrical stimulation.

This study was conducted at Cohen Orthopedic Institute, Rehabilitation and Sports Medicine - São Paulo - Brazil. KLD (Endophasis R) and Compex were used for NMES with medium and low frequency, respectively. We used two self-adhesive electrodes with dimensions of 4.5cm X 9.3cm. The evaluation of muscle strength was performed using the isokinetic dynamometer REV 9000 Technogym, Gambettola - Italy.

The patient was placed in a sitting position, hip at 90° flexion, knee at 60° of flexion. The upper body was supported by the backrest with 2 crossed belts to stabilize the trunk and one pelvic belt. Final adjustments were made by alignment of the dynamometer rotating axis with knee joint axis. The resistance of lever arm was placed in the distal leg above the malleolus (Figure 1).

Individuals were submitted to the following 3 randomized test conditions:

- Four maximal voluntary isometric contractions (MVIC) of the femoral quadriceps muscle: 4 seconds each.
- Four MIVC of femoral quadriceps muscle (4 seconds each), associated with low frequency electrical stimulation (MIVC-LF). 75Hz frequency, 400 μs pulse width; time on = 4s; time off 10s.
- Four MVIC of the femoral quadriceps muscle (4 seconds each), associated with medium frequency electrical stimulation (MVIC-MF), with the following characteristics: 75 burst 2500Hz/s; time on=4s; time off=10 seconds.

Current intensity modulation took into account the maximum tolerance of the patient without any pain. Cathode electrodes were placed on the vastus medialis muscle and the anode in the rectus femoris muscle (Figure 2).

The time between different conditions of isometric contractions was 90 seconds for adequate replacement of ATP[13] and the time between isometric contractions in same conditions was 10 seconds. Randomized contractions sequence was applied with sealed envelopes and the volunteers were not aware by which electrical stimulation was being used. The examiner knew about the study because it required practice and knowledge with electrical stimulator.

Figure 1. The patient is positioning in the isokinetic dynamometer with 60° of knee flexion to evaluate isometric torque of femoral quadriceps.

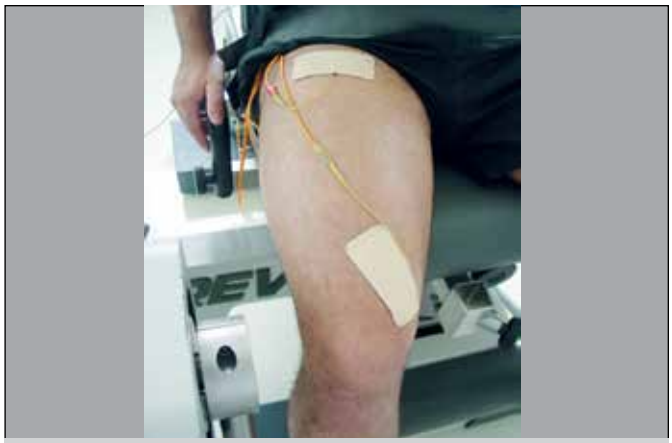

Figure 2. Placement of electrodes for neuromuscular electrical stimulation. Cathode in the vastus medialis muscle and anode in the rectus femoris muscle.

RESULTS

The measures of the variables of interest (MVIC) were obtained from the same person in three evaluations. This fact highlights the association between data collected in different frequencies. In view of this, to study the behavior of the MVIC variable in each situation considered, we apply analysis of variance (ANOVA).

It was found that there is difference between three measurements performed (Table 1). Statistically significant difference was found when compared MVIC-MF measures with MVIC-LF ($p=0.02$) measures. When compare MVIC-MF with MVIC, the values for the average frequency was higher ($p=0.03$), resulting statistically significant difference. Finally, comparing MVIC-LF with MVIC, there were no statistically significant difference ($p=0.52$).

DISCUSSION

The use of NMES to gain muscle strength or performance in high-level athletes has been employed with frequencies by physiotherapists who work in sports. It was found that the medium frequency current is more comfortable and is able to generate a peak torque significantly higher than the low-frequency current.

Our findings may be based on the explanation that the higher the frequency, the lower the impedance to current flow and therefore more comfortable perception thereof. Thus, a larger current magnitude is permitted using the medium frequency current.

Another hypothesis for the increasing of peak torque with the medium frequency current is that current has been generated by a clinical device, as portable devices (battery) are not displayed when the goal is the strength of recovery femoral quadriceps muscle in patients undergoing reconstruction of the anterior cruciate ligament.[14]

Difficulties were found when comparing the results of this study to another works in literature because of differences in isokinetic evaluation protocols. In this study we choose the angle 60° of knee flexion, because in this angulation the isometric muscle contraction reaches its maximum peak torque.

The sequence of NMES application was randomized to minimize the bias of muscle fatigue when generated by the medium current, low frequency or MVIC.

The electrodes positioning was based on the direction of quadriceps muscle fibers, with the focus on the rectus femoral and vastus medialis oblique. The placement of the electrodes can interfere with the extensor torque of the quadriceps muscle and that this type of placement is effective in producing a significant peak torque.[15] Moreover, this parameter must be considered when using electrical stimulation or during interpretation studies.

The fact of the medium frequency current generate a peak torque average greater than the low frequency does not necessarily imply its effectiveness when introduced into a strengthening muscular program. In other study evaluated the isokinetic strength of the quadriceps muscle in healthy subjects after 3 weeks of training with medium and low-frequency current, finding a significant increase after training in both groups, but there was no difference between them.[16] However, medium frequency current can lead to increasing muscle fatigue when compared with the low frequency current.[17]

This study was conducted in healthy and young adults. Thus, we cannot extrapolate our results to individuals who have a muscular deficit due to some involvement of the lower limb, as well as in patients undergoing knee surgery. A systematic review[18] concluded that in healthy volunteers, exercises can be equally or more effective than electrical stimulation and the realization of an associated contraction appears to be relevant to the effectiveness of neuromuscular electrical stimulation. However, reports that more research is needed to quantify and establish the optimal parameters of electric current.

Authors investigated muscle biopsy before and immediately after medium frequency electrical stimulation (2500Hz, 50Hz to 80% of maximum isometric torque).[1] A decrease in glycogen of type II fibers was found, which according to the authors support the use of medium frequency electrical stimulation as a viable technique to be used in patients with impairment of type II fibers.

In the other study, author reports that electrical stimulation of 2500Hz was applied to the triceps and biceps, with a 10-second contraction time and standby time of 50 seconds.[12] This study evaluated strength, endurance, perimetry and fat percentage. These findings suggest that electrical stimulation alone is not an appropriate form of strength training in healthy subjects. In addition, to gain strength voluntary exercise should be worked with.

In other study, authors evaluated that electrical stimulation (2500Hz) is able to increase strength compared to an isometric exercise protocol.[19] After 25 sessions, there was no significant difference in increasing strength in the group of isometric exercises and the group stimulated electrically.

Although the present study did not have done any training to gain muscle strength, it may be suggested that the electrical stimulation with medium frequency promotes higher muscle fiber recruitment to gain muscle strength, because of the significant peak torque measurements increase.

Although the present study did not have done any training to gain muscle strength, it may be suggested that the electrical stimulation with medium frequency promotes higher muscle fiber recruitment to gain muscle strength, because of the significant peak torque measurements increase.

CONCLUSION

Individuals when submitted to MVIC-MF showed higher peak torque than when subjected to MVIC-BF and MVIC alone. Thus it can be concluded that maximal voluntary isometric contraction associated with medium frequency NMES was more effectiveness than other situations of MVIC.

AUTHORS' CONTRIBUTIONS: Each author made significant individual contributions to this manuscript. CEP (0000-0002-6111-7195)*, RACA (0000-0002-3849-0872)*, LMI (0000-0001-6710-1998)* and RPP (0000-0002-5934-2991)* were the main contributors to the writing of the manuscript. CEP and RPP performed the data collections, monitored the subjects and gathered the clinical data. RACA and LMI performed the statistical data analysis. CEP, RACA, LMI and RPP reviewed the manuscript and contributed to the intellectual concept of the study. *ORCID (Open Researcher and Contributor ID).

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Review Article

SPORTS ACTIVITY AND HIP, KNEE, SHOULDER AND INTERVERTEBRAL DISC ARTHROPLASTIES

PRÁTICA DESPORTIVA E ARTROPLASTIA DE QUADRIL, JOELHO, OMBRO E DISCO INTERVERTEBRAL

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ABSTRACT

The success of joint replacement surgery has been responsible for raising patients' expectations regarding the procedure. Many of these procedures are currently designed not only to relive the pain caused by arthrosis, but also to enable patients to achieve functional recovery and to engage in some degree of physical activity and sports. However, as physical exercise causes an increase in forces exercised through the articular prosthesis, it can be an important risk factor for its early failure. Scientific literature on sports after arthroplasty is limited to small-scale retrospective studies with short-term follow-up, which are mostly insufficient to evaluate articular prosthesis durability. This article presents a review of the literature on sports in the context of hip, knee, shoulder and intervertebral disc arthroplasty, and puts forward general recommendations based on the current scientific evidence. ***Systematic Review, Level of Evidence III.***

Keywords: Sports. Arthroplasty. Prostheses and implants. Hip.

RESUMO

O sucesso da artroplastia tem sido responsável pelo aumento das expectativas dos pacientes, sendo que, atualmente, muitos pretendem não apenas o alívio da dor causada pela artrose, mas também a recuperação funcional e praticar algum grau de atividade física e esportiva. No entanto, a prática de exercício físico, ao provocar um aumento das forças exercidas através da prótese articular, pode ser um importante fator de risco para a falha precoce. A literatura científica sobre esportes depois de artroplastia é limitada a pequenos estudos retrospectivos com pouco tempo de acompanhamento, na maioria insuficiente para a avaliação da duração da prótese articular. Este artigo apresenta uma revisão da literatura sobre prática desportiva no contexto de artroplastia do quadril, joelho, ombro e isco intervertebral e propõe recomendações gerais com base na evidência científica atual. ***Nível de Evidência III, Revisão Sistemática/Atualização.***

Descritores: *Esportes. Artroplastia. Próteses e Implantes. Quadril.*

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INTRODUCTION

Prosthetic joint replacement is among the most successful types of surgery in medical practice. According to Learmonth et al., total hip arthroplasty is the surgery of the century.[1,2] The benefits of replacing a joint in an advanced stage of degeneration, particularly of the hip, knee, and shoulder, have been clearly demonstrated in terms of pain relief, improvement of function, correction of deformities, and improvement of quality of life.[1,3,4] An aging population with higher functional requirements and lower tolerance to joint symptomatology requires joint replacement at a younger age and at less advanced stages of joint degeneration. These factors have been responsible for the worldwide increase in joint replacement surgery.[1,4]

METHODS

A search of the scientific literature on the association between sports and arthroplasty of the hip, knee, and shoulder, as well as intervertebral disk surgery, was performed using the PubMed/Medline database. The search focused on the following terms: "Arthroplasty", "Joint Replacement", "Sports" and "Physical exercise", yielding 76 articles. The inclusion criteria included original and review articles published in English in peer-reviewed journals, yielding 38 studies.

Arthroplasty and exercise

The effects of exercise on health are well known, with physical and mental benefits in all age groups.[1,5] Given the success of arthroplastic surgery, patient expectations have increased, and many desire not only symptomatic relief of osteoarthritis pain, but also functional recovery, seeking to overcome the limitations caused by osteoarthritis and even to perform some degree of physical and sports activity.[1,4] Some patients aim to return to a sport that they have been prevented from practicing due to degenerative osteoarthritis.[6] The current scientific literature on sports after arthroplasty is limited to small retrospective studies with little follow-up time, mostly

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insufficient for assessment of the longevity of a joint prosthesis.[1] Current total hip and knee prostheses (Figure 1) have a mean longevity of more than 90% at 10-20 years after implantation; therefore, it is assumed that the minimum follow-up time for assessment of the longevity of an arthroplastic procedure is 10 years, at which point complications begin to appear.[7,8,9,10]

Physical exercise induces an increase in the forces exerted through the prosthesis, and can be an important risk factor for early failure. A high level of physical activity increases the risk of stress and wear between the prosthesis components and the prosthesis-bone interface, leading to early loosening and prosthesis instability. Physical exercise and decreased proprioception and pain are protective of the artificial joint, and are also responsible for an increased risk of traumatic lesions in a new joint.[1,4-12] According to a Swedish registry that analyzed 92,675 hip arthroplasties and 30,003 knee arthroplasties, the 10-year surgical revision rates were significantly higher in patients aged less than 55 and 65 years (20% and 18%, respectively) than in older patients (5% and 6%, respectively), which may be attributable to a higher level of activity in younger patients.[13,14] There is also some evidence that physical inactivity increases the risk of early loosening (in less than 10 years) due to osteopenia and insufficient osseointegration of noncemented prostheses, whereas increased physical activity increases the risk of component wear (usually polyethylene) and delayed loosening (over 10 years), caused by reactive osteolysis in association with particle release.[5,8,15,16,17,18] Nevertheless, there is no scientific evidence for the type and level of activity that should be recommended or avoided after arthroplasty, with respect to the longevity of a new joint.[1,10,14,19] Thus, the goal is to find a balance that guarantees the benefits of physical activity and at the same time does not reduce the longevity of the prosthesis.

Hip arthroplasty and physical exercise

The fixation technique and mechanical type and properties of the joint surfaces of a prosthesis are critical factors for longevity.[10] As a general rule, noncemented fixation is preferable for young and active patients who play sports, as it allows dynamic osseointegration of the prosthesis and adaptation to functional demands, leading to lower rates of loosening than those with cemented prostheses.[10,20] In hip arthroplasty, despite extensive experience and good results with metal-polyethylene joint combinations, ceramic and particularly ceramic-polyethylene combinations have been increasingly employed, mainly due to their lower susceptibility to wear and less particle release and osteolysis, leading to lower complication rates than with other materials. The higher strength of the latest generation of polyethylenes has also provided the orthopedic surgeon with greater confidence in the use of a total hip prosthesis in active patients.[21-24] The rates of return to active sports after total hip arthroplasty range from 29% to 56% and are lower for high-impact sports.[16,20,25] The main reasons for not returning to sports practice are pain, insufficient joint mobility, medical recommendation, and fear of damaging the replaced joint.[26] Ritter and Meding[25] and Dubs et al.[16] demonstrated a decrease in sports practice from 78% in the preoperative period to 56% after hip arthroplasty. In contrast, Visuri and Honkanen[27] reported an increase in recreational sports activity from 2 to 55% for walking, 7% to 29% for cycling, and 13% to 30% for swimming. Another study also found a slight increase (80% to 83%) in recreational sports activity after total hip arthroplasty.[28] Currently, most orthopedists advise patients who undergo arthroplasty of weight-bearing joints, particularly the hip and knee, to avoid high impact and contact sports, as they involve higher loads on the joint prosthesis and have a theoretically higher risk of component wear, loosening of the prosthesis, and traumatic injury.[1, 4,5,10] Therefore, sports such as football, basketball, handball, tennis, volleyball, hockey, athletics, gymnastics, martial arts, and others are strongly discouraged, and sports with reduced impact such as cycling, swimming, water aerobics, dance , rowing, golf, and bowling, among others, are encouraged.[1,4,5,18,19] Some authors allow the practice of high-impact exercise only on a recreational level with low intensity, and advise against competitive practice.[5] In spite of this advice, some studies have demonstrated excellent functional results in patients with load-bearing prostheses in high-impact sports, even at a competitive level.[16,29,31] Mont et al.[29,30] demonstrated that all professional tennis players in their sample who underwent hip or knee arthroplasty (with 8 and 7 years of mean follow-up time, respectively) returned to competition. Surgical revision rates were 6% at 8 years for hip arthroplasty and 5 years for knee arthroplasty. Nevertheless, the duration of follow-up in these studies (less than 10 years) does not allow one to advise their practice, since it the duration insufficient to provide information about the status of the prosthesis.[1,8] However, even with this limited scientific evidence, there has been growing acceptance of sports practice after arthroplasty among orthopedic doctors, probably due to the greater degree of function required by patients and the increased confidence among surgeons regarding surgical technique in joint reconstruction and innovation and improvements in the quality and durability of joint implants.[1,10,18,19]

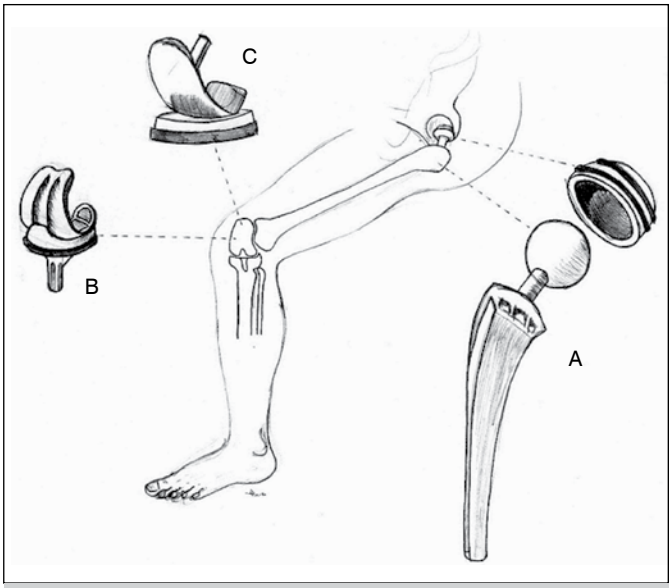

Figure 1. Total hip arthroplasty (A), total knee arthroplasty (B), unicompartmental knee arthroplasty (C).

Knee arthroplasty and physical exercise

In theory, noncemented fixation ensures dynamic osseointegration of a total knee prosthesis that is more favorable for sports practice, and the preservation of the posterior cruciate ligament allows higher levels of proprioception and consequently better functional results; however, these findings require validation, as results are similar with cemented fixation and techniques that sacrifice the posterior cruciate ligament.[4,10] A study of 160 patients who underwent total knee arthroplasty, with a mean follow-up time of 5 years, revealed that 65% of those who practiced regular physical exercise before surgery and 35% of those who were inactive in the year prior to surgery returned to sports practice.[32] The return rate was significantly higher for low-impact sports compared to high-impact sports (91% vs 20%). In a series of 144 total knee arthroplasties, Chatterji et al. found that 85% of patients practiced at least 1 recreational sport.[33] Another study in golfers who underwent total knee arthroplasty reported

that they all returned to the sport; however, after a minimum of 3 years, they reported significant pain during and after sports practice (16% and 36%, respectively), and signs of osteolysis were present in 53.7% of the prostheses.[34] Osteolysis was more common in cemented prosthesis fixation, reaching a rate of 79.1%, compared with 45% in the noncemented type. The hip and knee joints are weight-bearing; however the forces exerted on each are different, even at different times during the same sports activity. Unlike the hip prosthesis, in which the articular surface is always high, the congruence between the femoral and tibial components in knee prostheses is greatest in extension, and precarious at 40-60° of knee flexion. This minimum contact between the joint surfaces in flexion is responsible for a substantial increase in contact stress, which favors destructive wear and delamination of the polyethylene insert.[5,35,36] The peak force on the prosthesis increases when the activity involves high-amplitude knee flexion. In theory, the manner in which these movements occur with greater frequency have more detrimental effects on the knee prosthesis, in particular greater risk of loosening of the tibial component.[7,37,38] Thus, patients with a total knee prosthesis should avoid, in addition to the sports already mentioned for weight-bearing joints, high-impact knee flexion activities, such as high-speed running, mountaineering, and slope walking, among others.[5,7,37]

The popularity of unicompartmental knee arthroplasty (Figure 1-C) has increased in recent years, emerging as an effective alternative to classic total arthroplasty (bi or tricompartmental) in patients with isolated osteoarthritis of medial or lateral femoral-tibial compartments.[39,40] Its indications have led to increasing use at a very early age, resulting in higher functional levels and expectations in comparison with total knee arthroplasty. As such, its use has been increasing in individuals who play sports, despite limited evidence in this population.[41,42,43] As with a total joint prosthesis, the unicompartmental prosthesis will also be subject to the injurious effect of excessive axial loads for any sports activities; however, the joint biomechanics are different. The preservation of both cruciate ligaments allows one to retain a large part of the physiological kinematics of the knee and maintain anteroposterior and rotational stability of the native joint, leading to less contact stress in these directions. Thus, in theory, these prostheses may be less likely to wear and loosening caused by excessive loads resulting from sports activities, thereby reducing the sports restrictions of their recipients.[41,43-45] Furthermore, a mobile insert, often used in an attempt to replicate physiological meniscal function, ensures greater congruence between the prosthetic articular surfaces at various degrees of knee range of motion, and can also contribute to minimize shear forces that are potentially harmful to the new joint.[46] In turn, greater articular anatomical preservation allows a higher level of proprioception in comparison with that for a total joint prosthesis, and may lead to more effective protection of the artificial joint and reduced risk of traumatic injuries.[1,4] However, these theories remain to be proven and most orthopedists also apply the sports recommendations for total knee arthroplasty to unicompartmental arthroplasty.[5,7,37,41] Walker et al.[42] retrospectively studied 101 patients who underwent medial unicompartmental arthroplasty, with a mean follow-up of 4.4 ± 1.6 years, and found a rate of return to sports practice of 93%, mostly for low-impact sports activities. Specifically, 27% of the patients returned to physical activity in 1 month, 56% returned in 3 months, 77% returned in 6 months, and the remaining 23% needed longer than 6 months or remained inactive. The mean University of California at Los Angeles (UCLA) score improved significantly between preoperative and final assessments (3.3±1.5 vs. 6.8±1.5, $p<0.001$). Approximately 62% of patients played sports with a high physical activity score (defined as UCLA score ≥7) after arthroplasty, with cycling (85%), walking (57%), and swimming (52%) being the most practiced sports. Of this group, 29% practiced high-impact activities, such as football (10%), skiing (9%), tennis (5%), and athletics (5%). Approximately 57% of the patients did not report any pain during sports practice, 17% had pain in the operated knee, and 26% had pain in other joints. Five revisions were performed for persistent pain; however, none was associated with sport practice. Naal et al.[41] retrospectively studied 83 patients with unicompartmental arthroplasty over an average period of 18 months and found that the mean Knee Society Score improved from 129.9±24.8 preoperatively to 186.9±18.3 at the last evaluation, corresponding to a rate of return to sports practice of 94.8%. Among these patients, 45.8% returned to physical activity in 3 months, 68.6% in 6 months, and the remaining 31.4% needed longer than 6 months. During sports practice, 47% of the patients did not report any pain, 28.9% had pain in the operated knee, and 26.5% had pain in other joints. Only 1 prosthesis showed signs of progressive radiolucency at the level of the femoral component; however, the patient was asymptomatic. Finally, a prospective study of 159 patients who underwent medial unicompartmental arthroplasty found a significant increase in the frequency of sports practice after arthroplasty (74% versus 84%) after a mean follow-up of 2±1.47 years, with hiking, swimming, and cycling being the most practiced sports.[43] Despite the satisfactory results reported in available studies and lack of an association between sports practice and complications in the neo-joint, the follow-up period is still insufficient to assess the longevity of the joint prosthesis.[1,41,42,44]

Shoulder arthroplasty and physical exercise

Arthroplasty of the glenohumeral joint (Figure 2) differs from hip and knee arthroplasty to the extent that is not a weight-bearing joint. Furthermore, the shoulder has the greatest range of motion in the human body but less congruency between its articular surfaces. As such, the main risks of arthroplastic surgery are early wear and loosening, particularly of the glenoid component, and joint instability.[10] Although Poppen and Walker[47] verified that the force perpendicular to the glenohumeral joint (abduction arm) could be close to that of body weight, Collins et al.[48] concluded that the main cause of loosening of the glenoid component is eccentric load, which often occurs in some sports. As with hip and knee arthroplasty, noncemented fixation appears to have an advantage in young and active patients compared to that with cemented fixation.[10] The ideal shoulder prosthesis for active patients depends on several factors, including the integrity of the rotator cuff. There has recently been an increase in indications and a growing trend toward the application of inverted glenohumeral arthroplasty compared with anatomic arthroplasty and hemi-arthroplasty.[10,47-49] In theory,

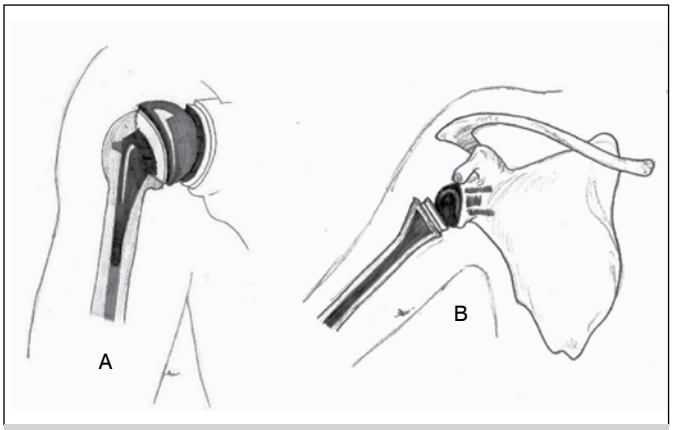

Figure 2. Anatomical glenohumeral arthroplasty (A) and reverse glenohumeral arthroplasty (B).

contact sports and sports that require greater range of motion of the shoulder, such as weightlifting, handball, volleyball, tennis, hockey, golf, and gymnastics, among others, have increased risk of more pronounced wear, loosening, and injury of the arthroplastic shoulder, with ensuing need for a second early surgery, and should not be recommended.[9,10,50,51] There are few studies on sports practice in patients with glenohumeral arthroplasty. Jensen and Rockwood[50] showed that 96% of 24 patients in their study returned to recreational golf, the majority with better performance after arthroplastic shoulder replacement (anatomical and hemiarthroplasty). No significant differences were identified in the prevalence of radiographic signs of prosthetic loosening in comparison with those in a non-sports practicing control group during an average follow-up of 53.4 months. With an average follow-up of 3.7 years, a study of 75 athletes who underwent anatomical arthroplasty or hemiarthroplasty of the shoulder found that 71% showed improved sports performance, 50% showed increased frequency of sports activity in comparison with preoperative activity, and 19% did not return to sports practice after arthroplastic surgery of the shoulder.[51] Only 4 of these patients underwent a second surgery, 3 of whom underwent arthroscopic debridement, with removal of the glenoid component secondary to loosening in 1 patient. Despite these figures, the authors do not guarantee that the rate of loosening will be lower, to the extent that many patients are initially asymptomatic, despite early radiographic signs of loosening.[51,52] A prospective study of 100 patients who underwent total anatomical shoulder arthroplasty, with a mean follow-up of 2.8 years, found that only 6% of those who practiced sports previously did not return to physical exercise after arthroplastic surgery.[53] Of the patients who returned to sports practice, 69.4% resumed the same modality and the same level of intensity, while the remaining patients changed to another sport, due to limitations related to the shoulder, particularly range of motion and strength. Another study of 67 patients (mean age 74.8 years) who practiced at least 1 sport preoperatively and who underwent inverted arthroplasty of the shoulder, with a mean follow-up time of 31.6 months, revealed that 85.5% returned to sports practice. Significantly fewer patients over the age of 70 years returned to a sport.[49] Although these studies show that the frequency, level, and intensity of sports practice after shoulder arthroplasty, even in sports with high shoulder demands (for example, tennis and golf), are equivalent to those seen before the onset of osteoarthritis, none reported follow-up time and number of cases sufficient to assess the risk factors that affect the longevity of a joint prosthesis.[49,50,51,52,53]

Disk arthroplasty and physical exercise

Disk arthroplasty was developed to circumvent the loss of mobility of a vertebral segment and the risk of involvement of an adjacent disk that occurs in intersomatic arthrodesis as a treatment for advanced degenerative disk disease (Figure 3). With arthroplasty, the increased mobility and recreation of biomechanics, functionality, and distribution of loads closer to normal in the affected segment could in theory lead to lower rates of disk degeneration at adjacent levels.[54] Disk arthroplasty should be applied in isolated symptomatic degenerative disk disease that does not respond to 6 months of conservative treatment, and generally only in patients without structural deformity or spinal instability, particularly interfacet osteoarthritis, and with acceptable bone quality. Given the high prevalence of contraindications associated with advancing age, the majority of arthroplasties are performed in young patients, many of whom have a need for increased activity and expectations of a high functional level.[54-56] Although disk arthroplasties are still very new and medium- and long-term studies are limited, the promising results in the general population have led to growing popularity, with increasing use in younger patients who are more active and have higher functional expectations.[56,57] Despite this trend, few studies have assessed the limitations and potential risks of these arthroplasties in sports practice; therefore, the level of permissible activity for patients with these implants to avoid compromising the longevity of the prosthesis remains unclear.[56] During sports, an athlete can potentially experience excessive loads on an intervertebral prosthesis, which can lead to failure and early dysfunction.[1,56] In theory, high-impact contact sports and those with intensive activity may be associated with a higher risk of periprosthetic osteolysis, migration, and implant wear due to more frequently repeated axial and/or rotational loading on the column and the intervertebral implant, with consequent early failure of the prosthesis.[55,56] Siepe et al.[58] prospectively studied 39 practitioners of various contact sports or high-impact and professional level sports (mean age 39.8) who underwent lumbar disk arthroplasty, and verified significant symptomatic improvement in all patients after an average follow-up time of 26.3 months (average decrease of 5.7 on the visual analogue pain scale and 30% decrease in the Oswestry Disability Index). Return to sports practice was observed in 95% of the athletes, occurring within the first 3 months in 38.5% and at 3 and 6 months in 30.7% of the sample, with maximum sports performance reached after a mean time of 5.2 months after surgery. Approximately 85% of the sample showed significantly improved sports performance; however, 8% showed a reduced level of sports activity. The average frequency of sports practice increased 194%, from 1.7 times per week in the preoperative period to 3.3 times in the postoperative period. One-third of the sample developed subsidence of the implant (migration of less than 5 mm), with maintenance of function and always within the first 3 months after implantation; however, there was no association with sports practice. Progression of migration only occurred in 1 of these patients, but without functional impairment of the prosthesis and no radiographic signs of artificial disk wear. Tumialán et al.[56] retrospectively studied soldiers, all of whom performed demanding or high-impact physical activity. Twelve soldiers underwent cervical disk arthroplasty and all returned to the same level of previous physical activity at an average time of 10.3 weeks. Another 12 men underwent lumbar disk arthroplasty and 83% returned to the previous activity level at an average time of 22.6 weeks. One patient left the military due to persistent symptoms, while another returned to physical activity with limitations. One of the patients with a cervical disk prosthesis developed osteolysis and needed implant removal and conversion to intersomatic arthrodesis, while another with a lumbar

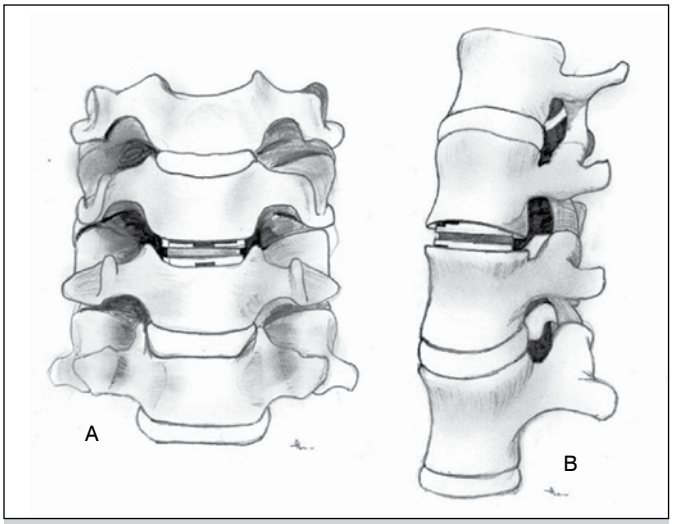

Figure 3. Cervical disk arthroplasty (A) and lumbar disk arthroplasty (B).

disk prosthesis developed an S1 radiculopathy, requiring surgical decompression. The mean follow-up times were only 12.2 months for cervical arthroplasty and 10.7 months for lumbar arthroplasty.

Current General Recommendations

The absence of prospective randomized studies that assessed the longevity of joint prostheses means that the current recommendations for sports practice in patients with arthroplasties are only based on the opinion of experts, and there is therefore a reduced level of scientific evidence.[1,19] Case-by-case analysis and preoperative discussion of patient goals and expectations are needed to ensure that the type and technique of arthroplasty and rehabilitation conform to the final results.[4,5] Patients should be encouraged to remain physically active, and the practice of low-impact sports in patients with prosthetic weight-bearing joints should be encouraged.[4,5,10] Those who wish to practice a high-impact sport must understand the risks that are theoretically associated with that specific sport, particularly in terms of wear, loosening, instability and fractures in the region of the articular prosthesis, with consequent need for surgery or early revision. The decision to practice a sport must be made by the patient after weighing the risks and benefits.[1,4,9,10] Before initiating sports practice, joint and trunk rehabilitation is recommended, in order to strengthen and protect the neo-joint, reduce the incidence of prosthetic failure, and prevent joint lesions.[1,9,10] Additionally, these patients should have thorough clinical-radiological monitoring of the arthroplasty to enable detection and early intervention for complications that may arise.[4]

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