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ACTA ORTOPÉDICA BRASILEIRA

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LEVELS OF EVIDENCE FOR PRIMARY RESEARCH QUESTION: Access the following link.

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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

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Original Article

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SCARF OSTEOTOMY FOR HALLUX VALGUS CORRECTION: RADIOLOGICAL AND CLINICAL ANALYSIS

OSTEOTOMIA DE SCARF PARA CORREÇÃO DO HÁLUX VALGO:ANÁLISE RADIOLÓGICA E CLÍNICA

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ABSTRACT

Objectives: This article aims to radiographically and clinically evaluate the results of the surgical correction of hallux valgus using the scarf technique. The pre- and postsurgical hallux valgus angles – metatarsophalangeal angle (MP), intermetatarsal angle (IM), and degree of dislocation of the sesamoids – were retrospectively evaluated, as well as their clinical parameters. Methods: 70 pre- and postoperative radiographs of patients undergoing surgical correction of hallux valgus by the scarf osteotomy technique were retrospectively evaluated. The American Orthopedic Foot And Ankle Society Score (AOFAS) was used for pre- and postoperative clinical evaluation. Results: There was a statistically significant improvement in the MP, IM, and sesamoid position, in addition to the clinical improvement verified by the AOFAS. Conclusion: Scarf osteotomy improves the MP and IM angles and correct the position of the sesamoid, as well as improve the AOFAS. ***Level of Evidence IV, Retrospective Comparative Study.***

Keywords: Hallux Valgus. Osteotomy. Bunion.

RESUMO

Objetivos: Analisar radiograficamente e clinicamente os resultados da correção cirúrgica do hálux valgo pela técnica de Scarf, assim como os ângulos pré e pós-cirúrgico do hálux valgo – ângulo metatarsofalângico (MTF) e ângulo intermetatarsal (IM) –, grau de luxação dos sesamoides e parâmetros clínicos. Métodos: Foram avaliadas retrospectivamente 70 radiografias com carga pré e pós-operatórias dos pacientes submetidos à correção cirúrgica do hálux valgo pela técnica de osteotomia de Scarf. Para avaliação clínica pré e pós-operatória foi utilizado a escala da American Orthopaedic Foot And Ankle Society (AOFAS). Resultados: Foi observado melhora estatisticamente significativa dos ângulos MTF e IM e posição dos sesamoides, além de melhora clínica verificada pela escala AOFAS. Conclusão: A osteotomia de Scarf é capaz de melhorar os ângulos MTF e IM e corrigir a posição dos sesamoides, acompanhado da melhora da escala AOFAS. ***Nível de Evidência IV, Estudo Retrospectivo Comparativo.***

Descritores: *Hallux Valgus. Osteotomia. Joanete.*

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INTRODUCTION

Hallux valgus – first described by Carl Heuter in 1871[1] – is a complex and progressive deformity that interferes with the forefoot aesthetics, characterized by lateral hallux deviation, varus or medial deviation of the first metatarsal, and pronation on the longitudinal axis

Treatment options range from changing shoes to surgical intervention. There are more than 130 procedures described to correct first metatarsal variance; distal osteotomies are usually indicated for mild deformities and proximal osteotomies, for more severe deformities.[2]

The Z osteotomy of the first metatarsal for the treatment of hallux valgus was described by Burutarán in 1976,[3] later revised by Gudas and Zygmunt in 1982, and modified by Weil in 1984.[4] Weil and Borelli popularized the technique in the United States while Barouk disseminated it in Europe and worldwide.[5] Since then, scarf osteotomy has become one of the options for treating hallux valgus.

Scarf osteotomy versatility lies on its ability to correct the intermetatarsal angle and the distal metatarsal joint angle simultaneously by a lateral translation and medial rotation of the plantar fragment. This osteotomy allows the health professional to lengthen or shorten the first metatarsal while correcting plantar or dorsal deviation.[5] Each correction is performed by maintaining a large contact area

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

The study was conducted at Instituo Ortopédico de Goiânia.
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<< SUMÁRIO

between the fragments, allowing an excellent consolidation when compared to other osteotomies.[6]
This retrospective study aims to evaluate the clinical and radiological results of scarf osteotomy.

METHODS

The study was submitted to Plataforma Brasil and approved by the Ethics Committee through the CAAE protocol: 29159720.1.0000.5082; all patients signed a consent term. This is a quantitative, retrospective, descriptive, and exploratory study. It was developed using radiological evaluations and the American Orthopedic Foot And Ankle Society Score (AOFAS) of patients diagnosed with hallux valgus who underwent scarf osteotomies.
The inclusion criteria were patients with clinical and radiographic diagnosis of hallux valgus who underwent scarf osteotomy with at least one year of follow-up. The exclusion criteria were: 1) patients diagnosed with rheumatological diseases and/or neurological diseases, 2) patients without radiographs after one year of follow-up, and 3) those who did not respond to the AOFAS survey.
A total of 67 patients (97 feet) who met the inclusion criteria were evaluated. Among them, nine were excluded (four patients with rheumatoid arthritis, two patients with cerebral palsy, and three patients who did not respond the AOFAS), leaving 56 patients (70 feet) for the final sample.
The mean age of patients at the time of surgery was 48.61 years (ranging from 13 to 78 years), with a higher prevalence of females, 91% (51) and five males (9%) (Table 1).
The surgeries were performed by a senior surgeon (M.B.) with the patient in the supine position with a tourniquet at ankle level , at 250 mmHg. Firstly, a medial incision was made, from the base of the proximal phalanx of the hallux to the proximal third of the diaphysis of the first metatarsal. Then, a lenticular incision was made in the joint capsule, resecting an ellipse at the level of the first metatarsal and later dorsal and medial release for visualization of the metatarsal. Subsequently, the sesamoid was released by the same access route, releasing only the lateral suspensory ligament.

Table 1. Sample characteristics

CHARACTERISTIC	MALE			FEMALE			TOTAL	
Individuals	5		9%	51		91%		56
Right foot	3		4%	38		54%	41	70
Left foot	4		6%	25		36%	29	
Minimum and maximum age	< 28	> 47		< 13	> 78		< 13	> 78
Mean age	40.40			49.41				48.61

Bone cuts were made with the aid of an appropriate guide. Firstly, a 1.0 mm Kirschener (K) wire was inserted into the medial metaphysis, at the level of the 1st metatarsal head in the dorsal third proximal to the articular cartilage. The guide was placed on the k-pin directed to the plantar third of the metatarsal proximal metaphysis.
The longitudinal cut was performed with an oscillating saw through the guide. The guide was then rotated on the K wire to make the distal cut with an angle of 70–90º in relation to the longitudinal cut. The distal cross-section was made approximately 5 mm proximal to the articular cartilage. The proximal transverse bone section is made freehand following the same direction as the K wire (Figure 1).

Figure 1. K wire with osteotomy guide.

After all the cuts were made, the plantar fragment was dislocated laterally to an ideal position (sesamoid centered on the head of the 1st metatarsus) and provisionally stabilized with forceps (Figure 2). Fixation was done with 2.7 mm headless screws, one more distal and the other proximal (Figure 3). The capsule was then sutured with 2-0 Vicryl thread and intradermal suture with 4-0 Monocryl.

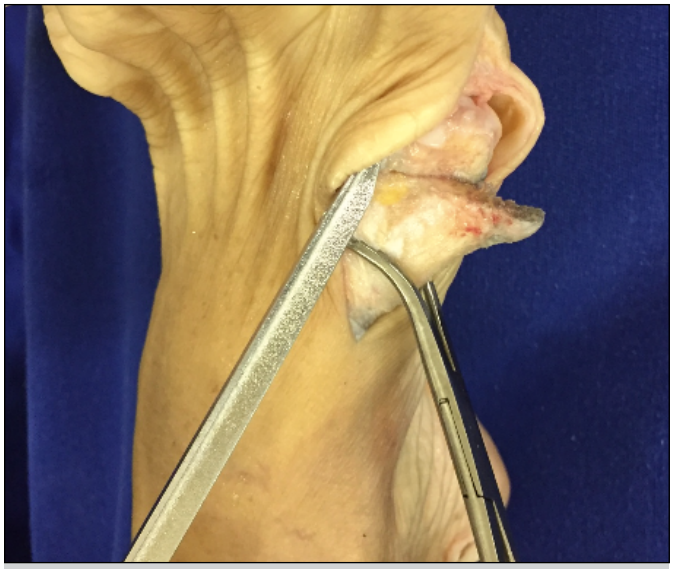

Figure 2. Lateral dislocation of plantar fragment.

Figure 3. Fixed osteotomy with two screws.

>> SUMÁRIO

During the first postoperative week, weightbearing was authorized, with therapeutic sandals, limited to essential activities (going to the bathroom, getting food). In the second week, patients were allowed to walk with a rigid sole tennis shoes, without crutches.
Physical therapy is initiated in the second week with passive movements of the metatarsophalangeal joint of the hallux and resistance exercises to strengthen the hallux flexors. After three months, patients were allowed to participate in any type of physical activity and use any type of footwear.
The angles between the first and second metatarsus (IM), the angle between the first metatarsus and the proximal phalanx of the hallux (MTP),[7] and the position of the medial sesamoid were measured, which were graduated from 0 to 3 in relation to the anatomical axis of the first metatarsal according to a technique by Smith et al.[8] The radiographs evaluated were those from the preoperative period and one year after surgery.
The AOFAS[9] was applied in the preoperative consultation and one year after the surgical procedure.

RESULTS

The mean values of the MTP and IM angles in the preoperative were 29.60° and 16.79°, respectively. Both decreased significantly in the postoperative period ($p < 0.00001$).We found a statistically considerable increase ($p < 0.00001$) in the AOFAS score (Table 2).

Table 2. Radiographic and clinics parameter.

EVALUATION	Preoperative	Postoperative	
	MEAN	MEAN	p-Value
Intermetatarsal angle I-II	16.79º (11-20)	7.19º (5-11)	< 0.00001
Metatarsophalangeal angle	29.60º (18-41)	13.07º (12-20)	< 0.00001
AOFAS	51.3 (32-68)	89.6 (68-97)	< 0.00001

When assessing the position of the sesamoid in the preoperative period we noticed that 99% of the evaluated feet had some degree of displacement of the medial sesamoid. In the postoperative period, 83.3% of the cases presented complete correction of the medial sesamoid in relation to the head of the first metatarsus.

DISCUSSION

The scarf osteotomy is a versatile procedure, it allows for an accelerated recovery while preserving the mobility of the MTP joint of the hallux. Its versatility lies in the potential to correct the distal joint angle by lengthening or shortening the first ray and correcting the plantar deviation of the head of the first metatarsus in a single osteotomy. Additionally, due to the stability provided by its "z" configuration and the large bone contact area, the procedure provides more security for a more aggressive rehabilitation and weightbearing, factors that help maintain the mobility of the hallux MTP.[10]
The objective of this osteotomy is to obtain a congruent joint, free of pain and deformity, allowing patients to use closed shoes. Radiological correction is one of the parameters to achieve such objectives.[11]
The potential of radiological correction and clinical improvement has been demonstrated over the years. Perugia et al. showed a 9.9° correction of the IM angle, 21.1° of MTP angle, improvement in the position of the medial sesamoid by 2.3 points and improvement of the AOFAS scale by 54.1 points. According to these authors, the improvement of these parameters is strongly related to the patient's clinical improvement.[12] These results corroborate ours since the improvement was significant in all evaluated parameters. In the work of Perugia et al.[12] only severe cases (IM > 16°) were included, which explains a greater variation in the AOFAS scale (54.1 × 38.3) and in the MTF angle (21.1 × 16.53).
The study by Aminian et al.[13] found results similar to ours. They demonstrated an improvement in the AOFAS score (pre-op. 54.5 and post-op. 86.5), decreased IM angle (pre-op. 15.4 and post-op. 10.1), and decreased MTP angle (pre-op. 34.5 and post-op 16.9). Notably, they did not evaluate the position of the sesamoid.[13] Other studies evaluated the same parameters and found results that corroborate ours.[14-16] This reinforces the corrective potential of the scarf osteotomy and the clinical improvement following the procedure.
Nery et al.[17] emphasized the technical difficulty of the procedure, with a long learning curve and a complication rate of 17%. The author notes that complications occur in the first 26 patients, with another 43 feet operated in the sequence having no complications. The most common complications were dorsal fracture of the proximal fragment (10%) and shortening of the first metatarsus (6%). In our study, we did not observe any of these complications, but we agree that the learning curve of the technique is long. One factor that can justify our low complication rate is that all surgeries were performed by a senior surgeon, who has been performing the procedure since 2012. The cases evaluated were from 2017, thus the surgeon had over five years of experience with this technique.
Despite a considerable number of cases, the limiting factor of this study is the short follow-up of patients. The 1-year follow-up is not able to rule out a possible late recurrence. Studies have observed that recurrences can occur even in the first 1.5-2.8 years.[18]

CONCLUSION

Scarf osteotomy improves MTP, IM angles, and corrects the position of the sesamoid, as well as improves the AOFAS score of patients.

AUTHORS' CONTRIBUTIONS: Each author contributed individually and significantly to the development of this article. BAM: contributed substantially to the conception and design of the study, data analysis and interpretation, writing of the article, and approval of the final draft; DAZ: writing of the article, data collection, study concept and design; DBS: data collection, analysis and interpretation; RAAJ: data collection, analysis, and interpretation

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DOES PERICAPSULAR ANESTHETIC BLOCK IMPROVE THE POSTOPERATIVE PERIOD IN TRANSTROCHANTERIC FRACTURES?

BLOQUEIO ANESTÉSICO PERICAPSULAR MELHORA O PÓS OPERATÓRIO EM FRATURAS TRANSTROCANTÉRICAS?

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ABSTRACT

Objective: To evaluate pain and mobility in patients with transtrochanteric fractures subjected to osteosynthesis with pericapsular nerve group (PENG) block and compare with patients who did not receive the block. Methods: The medical records of 49 patients were analyzed and data were collected regarding: age, gender, anesthetic evaluation, cause of trauma, locomotion, fracture classification, type of anesthesia used, anesthetic technique, pain, opioid administration and mobility with partial load. Results: Out of 49 patients, 17 (34.7 %) received PENG block. After surgery, most patients complained of pain and opioids were administered (67.3 %), with greatest frequency in the group without PENG block (93.3 %). Most patients who received PENG block walked within 6 h after surgery (52.9 %) and all recovered the ability to walk until hospital discharge (48 h), different from the group that did not receive PENG block ($p = 0.012$). The groups showed a significant difference between them regarding the frequency of reports of moderate to severe pain ($p = 0.003$). Conclusion: The use of PENG block in patients with transtrochanteric fractures subjected to osteosynthesis can help to reduce postoperative pain, early mobility with partial load and less use of opioids. ***Level of Evidence III, Retrospective Comparative Study.***

Keywords: Hip Fractures. Femoral Fractures. Early Mobility. Analgesia.

RESUMO

Objetivo: Avaliar a dor e a mobilidade em pacientes com fraturas transtrocantéricas submetidos à osteossíntese com bloqueio do grupo de nervos pericapsulares (PENG) e comparar a pacientes que não receberam o bloqueio. Métodos: Foram analisados os prontuários de 49 pacientes e coletados dados referentes a: idade, sexo, avaliação anestésica, causa do trauma, locomoção, classificação da fratura, tipo de anestesia utilizada, técnica anestésica, dor, administração de opioide e deambulação com carga parcial. Resultados: Dos 49 pacientes, 17 (34,7%) receberam o bloqueio PENG. Após a cirurgia, a maioria dos pacientes queixou-se de dor e foi administrado opioide (67,3%), sendo a maior frequência no grupo sem o bloqueio PENG (93,3%). A maioria dos pacientes que receberam bloqueio PENG deambularam em até 6h após a cirurgia (52,9%) e todos recuperaram a capacidade de deambular até a alta hospitalar (48h), diferindo do grupo que não recebeu o bloqueio PENG ($p = 0,012$). Houve diferença significativa entre os grupos em relação à frequência de relatos de dor moderada a forte ($p = 0,003$). Conclusão: O uso de bloqueio PENG em pacientes com fraturas transtrocantéricas submetidos à osteossíntese pode auxiliar na diminuição da dor pós-operatória, deambulação precoce com carga parcial e menor necessidade de uso de opioides. ***Nível de Evidência III, Estudo Retrospectivo Comparativo.***

Descritores: *Fraturas do Quadril. Fraturas do Fêmur. Deambulação Precoce. Analgesia.*

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INTRODUCTION

Proximal femoral fractures are increasing proportionally to the population's life expectancy, since this trauma is more common in older adults. Advanced ages associated with the presence of comorbidities increase morbidity and mortality and hospital costs due to this type of fracture.[1] The fractures that occur in the area from the extracapsular region of the base of the femoral neck to a proximal region in the lesser trochanter are called transtrochanteric, the most common ones due to the association between osteoporosis and the low-energy trauma.[2]

Unstable femoral fractures are surgically treated using osteosynthesis methods, with internal fixation[3] being the most common technique for transtrochanteric fractures, showing advantages such as: pain relief, fast recovery of mobility, fast rehabilitation and

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The study was conducted at Serviço de Ortopedia e Traumatologia do Hospital Estadual de Urgências da Região Noroeste de Goiânia Governador Otávio.
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the patient's motor independence, who walked freely before the trauma.[4] The use of new intramedullary synthesis materials such as the gamma-type pin and the cephalomedullary nail offer a more rigid and safe fixation, which guarantees the patient a lower level of mechanical complications in the postoperative period and earlier mobility recovery.[4]

Despite advances in surgical procedures and anesthesia, patients subjected to femoral osteosynthesis have higher risks of functional disability and mortality than patients subjected to other surgeries of lower limbs and hip.[5] The type of anesthesia has been related to postoperative mortality in patients with femoral and hip fractures. Regional anesthesia (spinal or epidural anesthesia) and general anesthesia are the most used techniques, but application is limited in cases of severe comorbidities and anticoagulant administration, common in older patients with femoral and hip fractures.[6]

The literature lacks studies comparing the effect of different types of anesthetic blocks on femoral fractures. However, when comparing the effects of peripheral nerve block (PNB) and spinal anesthesia on mortality and mobility of older patients with hip fracture after hip arthroplasty, Fu et al.[7] observed a reduction in mortality between 30 and 90 days after surgery and a higher cost with hospitalization of older adults after hip arthroplasty with the use of PNB. However, the type of anesthesia was not associated with mortality, walking capacity, major complications within one year and length of hospital stay.

Thus, we aimed to evaluate pain and mobility in patients with transtrochanteric fractures subjected to osteosynthesis of the cephalomedullary nail type with pericapsular nerve group (PENG) block and compare with patients who did not receive PENG block.

METHODS

This study was approved by Plataforma Brasil (CAEE: 48664121.5.0000.5082). A retrospective and descriptive study was conducted with 49 patients with transtrochanteric fracture subjected to osteosynthesis of the cephalomedullary nail type in a public hospital between June and August 2021. The patients' medical records were analyzed and data on age, gender, and preoperative anesthetic evaluation were collected according to the American Society of Anesthesiologists (ASA), cause of trauma, autonomy prior to trauma and classification of walking patterns in five levels: 1) community walker without assistance, 2) community walker with assistance, 3) home walker without assistance, 4) home walker with assistance, 5) non-walker or wheelchair user.[1]

Information on surgical procedure was collected: classification of the fracture according to the Orthopaedic Trauma Association and the *Arbeitsgemeinschaft für Osteosynthesefragen* (AO)[8] – defining transtrochanteric fractures of simple fracture trait as AO 31 A1 and multifragmented fracture trait as AO 31 A2 – , type of anesthesia used and the anesthesiologist's technical ability to perform PENG block. The time until hospital discharge and the number of times the patient complained of pain was also collected from the patients' medical records and opioids were administered. After signing the informed consent form (TCLE), the patients who consented were interviewed for pain assessment by the Visual Analog Scale (VAS) within 2, 4, 6, 12, 24 and 48 h after surgery and questioned about the partial load support capacity at the same moments. The VAS criterion[9] classifies pain as a 10 cm line, in which zero is absence of pain and 10 is severe pain, and the patient is asked to mark the pain level and measure it. Absent (0 cm), Mild (1-3 cm), Moderate (4-6 cm), Severe intensity (7-9 cm) and Unbearable (10 cm). The collected data were evaluated in the software Statistical Package for the Social Sciences (SPSS®), version 17.0. Statistical analyses were performed at 5 % significance level.

Inclusion criteria

Patients who showed AO 31 A1 and AO 31 A2 transtrochanteric fractures surgically treated with cephalomedullary nail in the first 72 hours since hospitalization.

Exclusion criteria

- Other fractures associated with transtrochanteric fracture;
- Chronic neuropathic pain;
- Previous diagnosis of dementia;
- AO 31 A3 fractures (due to the severity and complexity of the fracture trait and increased surgical time that could compromise the evaluation of postoperative pain);
- Postoperative clinical and/or hemodynamic instability;
- Postoperative death;
- Implants other than the cephalomedullary nail;
- Cephalomedullary nails from different manufacturers;
- Non-walking patients prior to the fractures;
- Patients with hospital stay > 48 hours, from the postoperative.

RESULTS

Within three months, 49 patients with transtrochanteric fracture were subjected to osteosynthesis of the cephalomedullary nail type in a public hospital. A total of 17 (34.7 %) received spinal anesthesia and sedation associated with pericapsular nerve group block (PENG group) and 32 (65.3 %) received only spinal anesthesia and sedation (SEM group).

The mean age of the patients (Table 1) was 70 years old (± 17.9, 95 % CI: 65.82-75.90), ranging from 34 to 93 years old, higher for women (79.2 ± 14.9) compared to men (65.1 ± 17.9) and significantly different from each other ($p = 0.004$). The PENG group and the SEM group showed no significant difference regarding age ($p = 0.233$).

Table 1. Characteristics of patients with transtrochanteric fractures subjected to osteosynthesis with (PENG) and without (SEM) pericapsular nerve group block.

Variable	Total	Groups*		*p*
		PENG (n = 17)	SEM (n = 32)	
Age (mean SD)	70.4 17.9	74.8 14.7	68.8 19.4	0.272
Gender (n, %)				
Men	29 (59.2 %)	11 (64.7 %)	18 (56.25 %)	0.566
Women	20 (40.8 %)	6 (35.3 %)	14 (43.75 %)	
Classification				
31-A1	11 (22.4 %)	6 (35.3 %)	5 (15.6 %)	0.117
31-A2	38 (77.6 %)	11 (64.7 %)	27 (84.4 %)	
ASA (n, %)				
I and II	19 (38.8 %)	6 (35.3 %)	13 (40.6 %)	0.714
III and IV	30 (61.2 %)	11 (64.7 %)	19 (59.4 %)	
Postoperative analgesia				
Yes	33 (67.3 %)	3 (17.6 %)	30 (93.3 %)	<0.001
No	16 (32.7 %)	14 (82.4 %)	2 (6.7 %)	

*PENG: group with use of pericapsular nerve group block; SEM: group without use of pericapsular nerve group block.

Although most patients were men (59.2 %, n = 29), the proportion of surgical procedures to treat proximal femoral fracture did not differ between men and women in the sample evaluated ($p = 0.199$). Regarding the classification (Table 1), 38 patients (77.6 %) showed multifragmented transtrochanteric fracture (31-A2). Regarding the preoperative anesthetic evaluation, most patients obtained a score III (61.2 %), without significant difference between the PENG and

SEM groups. Most patients complained of pain after surgery and opioids were administered (67.3 %), with greatest frequency in the SEM group (93.3 %), in which the anesthesiologist was unable to use pericapsular anesthetic block, significantly differing from the PENG group ($p < 0.001$).
Most fractures occurred on the right side (69.4 %, n = 34). Regarding the preoperative evaluation of mobility, 47 patients (95.9 %) were community walkers without assistance and only two (4.1 %) were home walkers with assistance. The main cause of trauma was the fall from one's own height in 29 patients (Figure 1).

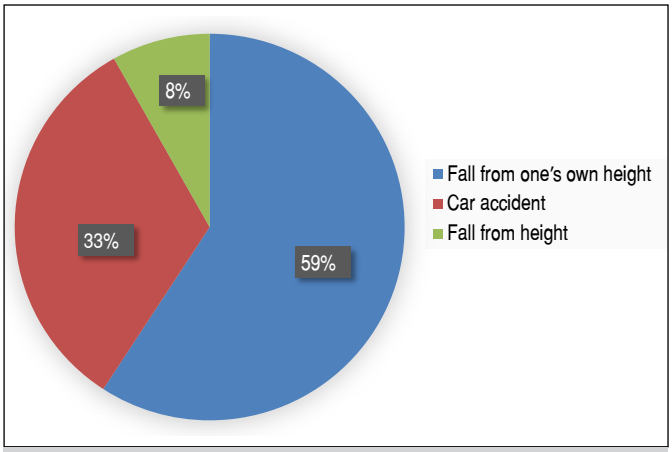

Figure 1. Frequency of the cause of trauma in patients with transtrochanteric fractures subjected to osteosynthesis with and without pericapsular anesthetic block.

Most patients in the PENG group (52.9 %, n = 09) recovered the ability to walk by the bed with partial load within 6 hours after surgery (Figure 2), while those in the SEM group walked within > 8 h (75 %, n = 24) and 15.6 % (n = 5) of patients in this group did not recover the ability to walk until hospital discharge (48 h). All patients who received PENG block recovered the ability to walk until hospital discharge (48 h), significantly different (p = 0.012) from the SEM group.

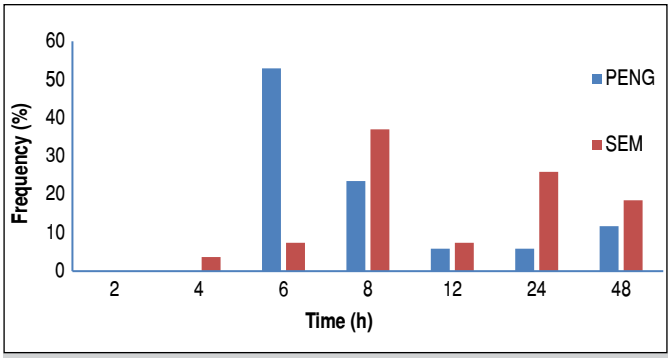

Figure 2. Frequency of patients able to walk by the bed with partial load according to the length of hospital stay after osteosynthesis with (PENG) and without (SEM) pericapsular nerve group block.

Regarding pain intensity, we observed a significant difference between the groups regarding the frequency of reports of moderate to severe pain (p = 0.003). The group that received PENG block showed greater frequency of reports of mild pain between 4 and 48 h after surgery (Figure 3). The SEM group showed greater frequency of reports of moderate to severe pain between 4 and 48 h after surgery (Figure 4).

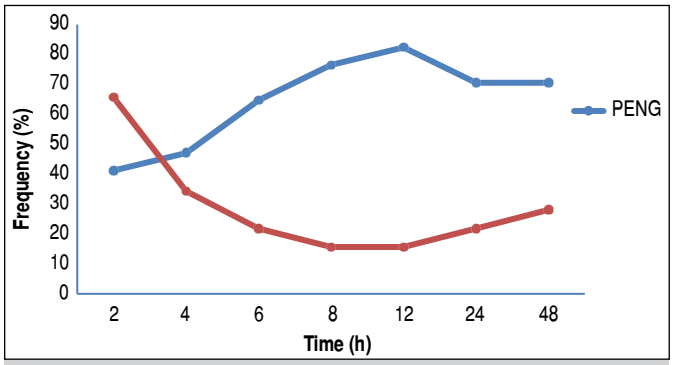

Figure 3. Frequency of reports of mild pain in patients with transtrochanteric fractures subjected to osteosynthesis with (PENG) and without (SEM) pericapsular nerve group block.

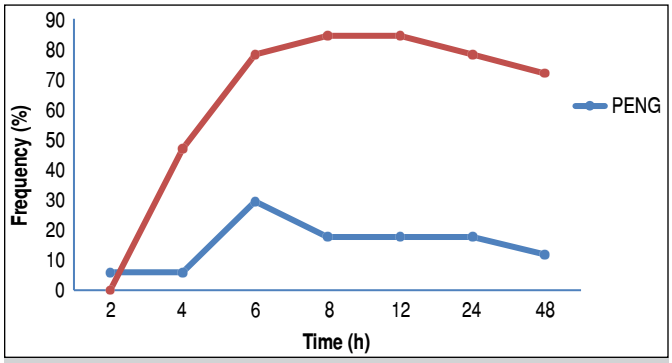

Figura 4. Frequency of reports of moderate to severe pain in patients with transtrochanteric fractures subjected to osteosynthesis with (PENG) and without (SEM) pericapsular nerve group block.

DISCUSSION

Transtrochanteric fractures of the femur are more frequent in older adults, which are associated with low-energy trauma, which is the main cause of the fall of their own height. Car accidents represent the main cause of this type of fracture in young adults. Treatment has a high cost and difficult recovery, besides a high mortality rate and postoperative functional dependence.[1] Most patients subjected to surgery do not fully recover and most do not recover their previous ability to walk.[10]
Our study shows that the main cause of transtrochanteric fractures of the femur was the fall from one's own height, which can be explained by the high mean age of the studied population (Table 1), a fact commonly reported in the literature.[11-14] Rocha et al.[15] observed a greater incidence of transtrochanteric fractures of the femur at older age (mean of 72 years), a data similar to our study (Table 1), but the authors reported a greater prevalence in women (56.3 %). Garcia, Leme and Garcez-Leme[16] observed a greater incidence in men (84 %) when evaluating the epidemiological profile, mortality and functional evolution of older adults with hip fracture, aged ≥ 60 years. Our study shows that the use of PENG block significantly reduced pain intensity and the request for stronger analgesia in the immediate postoperative period of the patients studied (Table 1 and Figures 3 and 4).
Peripheral nerve block can reduce morbidity and mortality in patients with femoral and hip fractures. Allard et al.[17] evaluated morphine consumption within 48 hours of postoperative using PENG block in patients with femoral neck fracture and observed a significant improvement in the mobility of the operated limb, although they did not observe a significant change in postoperative morphine consumption.

<< SUMÁRIO

Our study shows that the use of PENG block seems to significantly improve the ability to walk after surgery, and all patients who received PENG block recovered the ability to walk until hospital discharge (48 h). The recovery was faster in this group and occurred earlier (within 6 h) for most patients (Figure 2). Regarding Tramadol consumption (postoperative analgesia), only 17.6 % (n = 03) of patients in the PENG group requested it, differing significantly from the SEM group, in which 93.3 % (n = 30) requested stronger analgesia.

Lin et al.[18] compared the use of femoral nerve block (FNB) and PENG block in patients with hip fracture. The authors concluded that patients receiving PENG block felt less postoperative pain, but without difference regarding opioid use.

The literature lacks data on the request for stronger analgesia, ability to walk and postoperative pain from 2 h to 48 h after osteosynthesis, in patients with transtrochanteric fractures with and without the use of pericapsular nerve group block. However, studies in which regional nerve block techniques are used in hip fractures show essential results in reducing perioperative pain and better postoperative recovery.[19-20] The benefits of using PENG block include patient positioning for the procedure, no significant motor weakness (potential motor sparing effect) and analgesic efficacy.[18] We were able to establish a significant relationship between the use of PENG block and a better postoperative evolution. The ability to walk in the immediate postoperative period is essential for postoperative recovery and to reduce morbidity and mortality after surgical discharge, since the lack of walking may lead to a new hospitalization due to complications such as arterial occlusion and venous thrombosis.[19]

Despite the relevance of our findings, we emphasize that it has limitations because it is a unicentric retrospective study with a relatively small sample size. Besides, the use of PENG block in femoral fractures is a challenging procedure with many stages, and the anesthesiologist's bias is inevitable.

CONCLUSION

The use of pericapsular anesthetic block in patients with transtrochanteric fractures subjected to osteosynthesis of the cephalomedullary nail type may help to reduce postoperative pain, early mobility with partial load and less use of opioids, thus, a lower probability of immediate postoperative comorbidities in the medium term.

AUTHORS' CONTRIBUTIONS: Each author contributed individually and significantly to the development of this article. BST: preparation of the entire research project and review; RAM: data analysis and statistical analysis; UTA: writing of the article and performing the surgeries; LAO: performing the surgeries and review.

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<< SUMÁRIO

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FEMORAL HEAD DECOMPRESSION AND GRAFT: TECHNIQUE WITH NEW INSTRUMENTS

DESCOMPRESSÃO DA CABEÇA FEMORAL E ENXERTIA: TÉCNICA COM NOVO INSTRUMENTAL

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ABSTRACT

Introduction: Osteonecrosis of the femoral head (ONFH) is a pathology that can be treated with many approaches by the hip surgeon. Advanced decompression is a technique that aims to prevent the collapse of the femoral head and the arthrosis process of the joint, a technique already widespread and used by hip surgeons. In this study, we performed the technique with a new retractable blade and a new bone substitute as graft for the femoral head. Objective: To evaluate the technique with new instruments (EasyCore Hip®) and a calcium phosphate bone substitute (Graftys® HBS). Methods: Patients with osteonecrosis of the femoral head without major degenerative changes, such as femoral head collapse, were selected. Femoral head decompression was performed using the EasyCore Hip® retractable blade along with the calcium phosphate bone substitute as graft (Graftys® HBS). Results: The instruments proved to be reliable and reproducible, and the bone substitute presented good mechanical resistance, maintaining its temperature during the surgery. The disposable retractable blade presents variation in size and angle, which is an advantage in the removal of necrotic bone. However, we must take some precautions in order to achieve a better result. Conclusion: using EasyCore Hip® instruments and a calcium phosphate bone substitute (Graftys® HBS) is safe; however, some precautions must be taken during the use of the technique. ***Level of Evidence IV, Case Series.***

Keywords: Decompression. Grafts. Osteonecrosis. Hip. Bone Substitutes.

RESUMO

Introdução: A osteonecrose da cabeça femoral (ONCF) é uma patologia que pode ser tratada com diversas abordagens pelo cirurgião de quadril. A descompressão avançada é uma técnica que busca evitar o colapso da cabeça femoral e o processo de artrose da articulação, técnica já bastante difundida e utilizada entre os cirurgiões de quadril. Neste estudo, foi realizada a técnica com uma nova lâmina retrátil e um novo substituto ósseo como enxerto para a cabeça femoral. Objetivo: Avaliação da técnica com novo instrumental EasyCore Hip® e substituto ósseo de fosfato de cálcio (Graftys® HBS). Métodos: Foram selecionados pacientes com osteonecrose da cabeça femoral sem alterações degenerativas importantes, como o colapso da cabeça femoral. Foi realizada a descompressão da cabeça com a lâmina retrátil EasyCore Hip® associada à enxertia com o substituto ósseo de fosfato de cálcio (Graftys® HBS). Resultados: O instrumental mostrou-se confiável e de aplicação reprodutível, e o substituto ósseo apresentou boa resistência mecânica e isotermia durante o procedimento. Conclusão: em nossa série de casos, verificamos segurança na utilização do EasyCore Hip® e substituto ósseo de fosfato de cálcio (Graftys® HBS), porém alertamos para cuidados que devem ser tomados durante a realização da técnica. ***Nível de Evidência IV, Série de Casos.***

Descritores: *Descompressão. Enxertos. Osteonecrose. Quadril. Substitutos Ósseos.*

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INTRODUCTION

Osteonecrosis of the femoral head (ONFH) is a complicated pathology for hip surgeons. This pathology results from the death of bone cells due to impaired blood supply, and inevitably causes a secondary arthrosis of the coxofemoral joint, which can lead to a total hip arthroplasty (THA), since it reduces the quality of life of patients.[1–4]

Despite several studies, its multifactorial pathophysiology hinders the establishment of the ideal treatment for various groups of patients.[5] This ideal treatment—whether surgical, medical, or behavioral—is especially controversial in less advanced cases, in which the joint is still preserved, as these patients usually do not present femoral head collapse or subchondral fracture yet.[5] Rest, load removal, oral medications, change in physical activity, core decompression or

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The study was conducted at Instituto de Ortopedia e Traumatologia do Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo.
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decompression associated with adjuvant methods, derotation osteotomies, and arthrodesis are treatment options for this early stage.[3,6] Advanced decompression—the process of grafting a synthetic bone after removing the necrotic area—is a technique that, besides mitigating the patients' pain symptoms, aims at enabling a mechanical framework in the necrotic area and preventing the collapse of the femoral head, reducing the risk of progression to arthrosis. Cases of small lesions located outside the weight-bearing area of the femoral head, without subchondral fracture and with adequate removal of the necrotic area at surgery, present better results in the literature.[7,8] In this study, we addressed cases operated by the technique of decompression of the femoral head using a new blade to remove the necrotic bone, new graft materials (EasyCore Hip®), and a calcium phosphate bone substitute (Graftys® HBS). As advantages, this blade enables the removal of more or less amount of bone and allows a curvature as it is expanded, and the bone substitute proved to be biocompatible and isothermal during the surgery, presenting good mechanical resistance.

MATERIALS AND METHODS

A total of eight patients were evaluated, all diagnosed with ONFH, under follow-up at the hip surgery outpatient clinic of the *Instituto de Ortopedia e Traumatologia do Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo* (IOT HC-FMUSP). All participants signed the informed consent form. This study was approved by the Research Committee of the IOT-HCFMUSP, under no. 16321, CAAE 67588417.7.0000.0068.

This study presents the surgical technique of femoral head decompression, removal of the necrotic area, and synthetic graft with calcium phosphate step by step:

1) The patient is placed in supine position in a traditional X-ray transparent table to facilitate anteroposterior views and frog position. The use of an orthopedic traction table is also possible. A small longitudinal incision is made in the patient's thigh, in the region of the greater trochanter, and a guidewire is passed through the femoral neck with the aid of an image intensifier, which is inserted through the lateral femoral cortex up to 5 mm from the subchondral bone of the femoral head, in an area predetermined by imaging tests (area where the lesion is located), to ensure that the guidewire is correctly placed.
2) The cortical and spongy bone is punctured by a 10-mm cannulated drill (Figure 1).
3) After removing the drill and the guidewire, a curette can be used to initiate the removal of the necrotic bone (Figure 2).
4) Then, the Easycore Hip® disposable retractable blade is inserted and the handle is rotated until the intended amount of necrotic bone is removed (Figures 3 and 4).
5) After removing the bone from the lesion area, the Graftys® HBS calcium phosphate bone substitute is inserted (Figure 5).
6) Characterization of the Graftys® HBS bone substitute:

Figure 1. Cortical and spongy bone drilling by a cannulated drill.

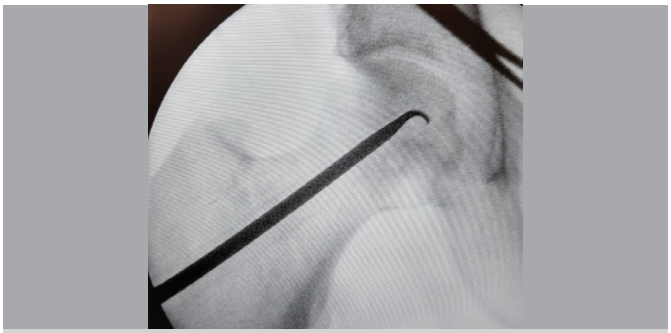

Figure 2. Curettage and removal of the necrotic bone.

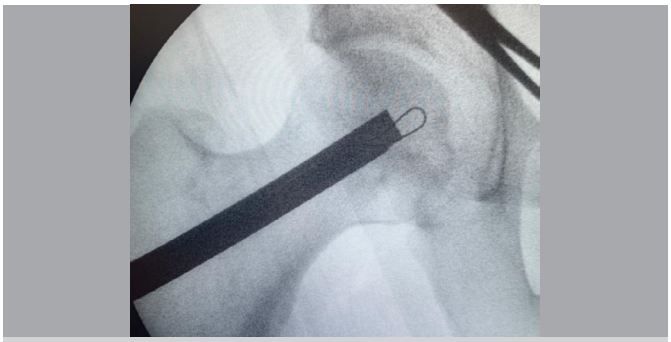

Figure 3. EasyCore Hip® retractable blade insertion.

Figure 4. Removed necrotic bone.

Figure 5. Insertion of the Graftys® HBS calcium phosphate bone substitute.

- CE-marked product approved by the Brazilian Health Regulatory Agency (ANVISA) and Food and Drug Administration (FDA). Certified by: ISSO 9001:2000 and ISSO 13485:2003.
- Composition: calcium phosphate formed by mixing calcium phosphate salts and polysaccharides in powder form (solid part) and an aqueous solution of sodium phosphate (liquid part).

- Characteristics: biocompatible with tissues, isothermal (the handling and implantation steps maintain neutral pH and do not generate heat); osteoinductive, and osteoconductive, with adequate mechanical resistance.

7) The product starts crystallizing in 15 minutes and hardening in 30 minutes, being necessary to wait for the crystallization time.
8) The soft tissue is washed with saline solution and the lesion is sutured.

RESULTS AND DISCUSSION

Considering all the aspects presented and the experience of using these materials in surgeries, the following precautions must be taken:
1) As the disposable retractable blade has a certain degree of fragility, we recommend starting with smaller sizes and advance gradually.
2) The disposable blade must not be used on the contralateral hip during the same surgery, exactly because of the aforementioned fragility.
3) A learning curve establishes the ability of removing the ideal amount of necrotic bone in the exact location; however, the advantage of an instrument with varying sizes and angles is exactly trying to remove the correct amount of necrotic bone.
4) If this removal is not ideal, the graft may not be properly inserted, impairing the expected result.
5) For an adequate hardening of the graft, pressurize the graft as it is placed. This process can be repeated a few times.

CONCLUSION

The use of the EasyCore Hip® disposable retractable blade and the Graftys® HBS bone substitute proved to be safe, reproducible, and useful in removing the necrotic bone and filling the resected cavity. In this study, we warned about some precautions that should be taken during surgery. Medium- and long-term studies are necessary to evaluate the patients' follow-up and the effectiveness of the method.

AUTHORS' CONTRIBUTIONS: Each author contributed individually and significantly to the development of this article. HSM: study concept and design, data collection, analysis, and interpretation; BAR: writing and critical review of intellectual content; LVR: writing and critical review of intellectual content; LE: study concept and design, data collection, analysis, and interpretation; JRNV: final draft approval; HM CG: final draft approval.

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ORIGINAL ARTICLE
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SPINOPELVIC MOBILITY IN PATIENTS WITH HIP OSTEOARTHRITIS AND TOTAL HIP ARTHROPLASTY INDICATION

MOBILIDADE ESPINOPÉLVICA NOS PACIENTES COM ARTROSE DO QUADRIL E INDICAÇÃO DE ARTROPLASTIA TOTAL

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ABSTRACT

Introduction: Reduction of spinopelvic mobility is associated with an increased dislocation of total hip arthroplasty (THA). Objective: To assess 1) spinopelvic mobility in patients with primary hip osteoarthritis and THA indication and 2) the influence of hip flexion contracture on spinopelvic mobility. Methods: Thirty adult patients with primary hip osteoarthritis and THA indication were evaluated using radiographic parameters (pelvic incidence, pelvic tilt, sacral slope, lumbar flexibility, and spinopelvic mobility). Results: Spinopelvic mobility ranged from 6.90 a 54.50° (mean 32.79 ± 11.42) and the group of patients with hip flexion contracture had higher mobility. Spinopelvic mobility was correlated with pelvic tilt as well as with lumbar flexibility. Conclusion: Around 13.4% of patients had spinopelvic mobility under 20° , indicating reduced spinopelvic mobility and risk of THA dislocation. ***Level of Evidence III, Retrospective Comparative Study.***

RESUMO

*Introdução: A redução da mobilidade espinopélvica tem sido associada com o risco de luxação da prótese total do quadril. Objetivos: Avaliar a mobilidade espinopélvica nos pacientes com artrose primária da articulação do quadril e com indicação de artroplastia total do quadril (ATQ), e a influência da contratura em flexão do quadril sobre a mobilidade espinopélvica. Métodos: Trinta pacientes adultos com artrose primária do quadril e indicação de ATQ foram avaliados por meio de parâmetros radiográficos (incidência pélvica, versão pélvica, inclinação do sacro, mobilidade da coluna lombar e mobilidade espinopélvica). Resultados: A mobilidade espinopélvica variou de 6,90 a 54,50 graus (média 32,79 ± 11,42), e foi estatisticamente maior no grupo de pacientes com contratura em flexão do quadril. Foi observado correlação entre a mobilidade espinopélvica e a versão pélvica e flexibilidade da coluna lombar. Conclusão: A mobilidade espinopélvica abaixo de 20 graus, que caracteriza a redução da mobilidade espinopélvica e risco aumentado de luxação ou impacto dos componentes da prótese total foi observada em 13,4% dos pacientes. **Nível de Evidência III, Estudo Retrospectivo Comparativo.***

Keywords: Spine. Hip. Hip Contracture.

Descritores: *Coluna Vertebral. Quadril. Contratura Quadril.*

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INTRODUCTION

Patients with spinal arthrodesis, degenerative disease, or spinal deformity have a higher rate of late dislocation after total hip arthroplasty (THA) (8-20%) compared to traditionally described rates (0.3-3%). This aroused the interest of researchers for studying spinopelvic mobility and parameters.[1,2]

The transition from orthostatic to sitting position occurs with posterior sacral slope, lumbar lordosis reduction, and pelvic retroversion with increased acetabular anteversion to accommodate the head of the flexed femur (Figure 1).[3,4] When changing from standing to sitting, each degree of pelvic retroversion increases acetabular anteversion in 0.8°.[2,3,5] The inability of posterior sacral slope and pelvic retroversion prevent a good accommodation of the femoral head, leading to its dislocation or acetabular shock.[2,3]

The orientation of the acetabulum is different in the orthostatic, sitting, and supine positions. However, the supine position has been classically used to perform imaging and positioning tests of the acetabular component during surgery.[5,6] Prosthesis dislocation has been reported in patients with correct positioning of implants in the "Lewinnek safe zone," which uses radiographs and anatomical references in the supine position.[2,7]

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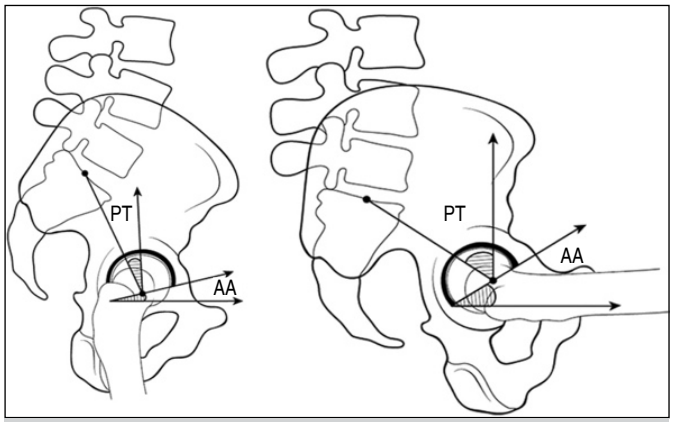

Figure 1. Drawing illustrating the positioning of the lumbar spine, sacrum, acetabulum, and femur in the orthostatic position (left) and sitting position (right).

In these patients, dislocation was caused by acetabular positioning, which has different orientation in the orthostatic, sitting, or supine positions along with the pelvis.[2,5,6] Most hip prosthesis dislocations occur while sitting[7] and variations in spinopelvic parameters in this position have become the subject of study and interest.[2,6,7]

The preoperative assessment of spinopelvic complex mobility and the behavior of the acetabular anteversion in the sitting position guides the positioning of the acetabular component during THA to avoid dislocation or shock of the prosthesis components.[5,6] Different anatomical references of the sacrum, pelvis bones, and femur have been used for angular measurement in the standing and sitting positions. The sacral slope (SS) between the orthostatic and sitting position on profile radiographs has been considered normal for 20-40° angular variation. Other parameters such as acetabular anteversion, sacro-acetabular angle, proximal femoral angle, and spinopelvic parameters have also been used to assess spinopelvic mobility and the positioning of the acetabulum or the acetabular component of the prostheses.[2,5,8]

This study was conducted to analyze the influence of spinopelvic mobility on the results of total hip arthroplasty. The study aimed to (a) assess preoperative spinopelvic mobility in patients with primary arthrosis of the hip joint and with indication of THA and (b) assess the influence of hip flexion contracture on spinopelvic mobility and its correlation with spinopelvic parameters (pelvic incidence, pelvic tilt, lumbar lordosis, lumbar lordosis flexibility).

MATERIAL AND METHODS

This observational and retrospective study was approved by the Research Ethics Committee of HCFMRP-USP no. 1515/2021. The study included 30 adults (over 18 years old) of both sexes with hip arthrosis, subjected to THA, and with no lumbar spine deformity or any previous lumbar or hip surgery.

Patients were evaluated preoperatively using clinical and radiological parameters. The Thomas test was used to assess hip flexion contracture. The radiographic parameters selected for the study were pelvic incidence (PI), pelvic tilt (PT), sacral slope (SS), lumbar lordosis (LL), spinopelvic mobility, and lumbar flexibility (Figure 2). Spinopelvic mobility was assessed by different values of sacral slope (SS) on profile radiographs in the orthostatic and sitting positions. Lumbar spine flexibility was measured by different lumbar lordosis values in the orthostatic and sitting positions.

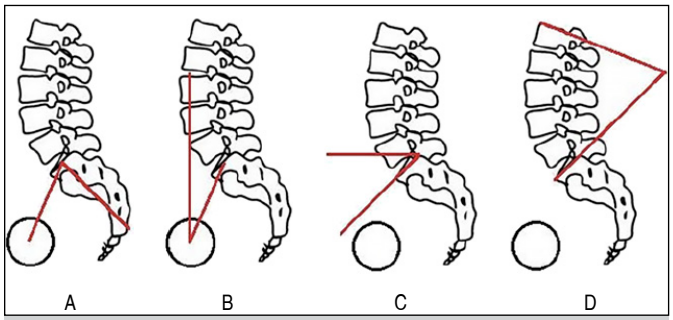

Figure 2. Spinopelvic parameters (A: pelvic incidence; B: pelvic tilt; C: sacral slope; D: lumbar lordosis).

The panoramic radiographs were taken in a standardized manner with patients in a comfortable standing position with the upper limbs flexed on top of a support. Sitting radiographs were taken with patients in a comfortable sitting position with knees flexed at 90°, feet resting on the ground, and without forcedly flexing the lumbar spine.

Radiographic parameters were measured using a program for image analysis (Surgimap – New York, USA). Two evaluators conducted the measurements (Figure 3).

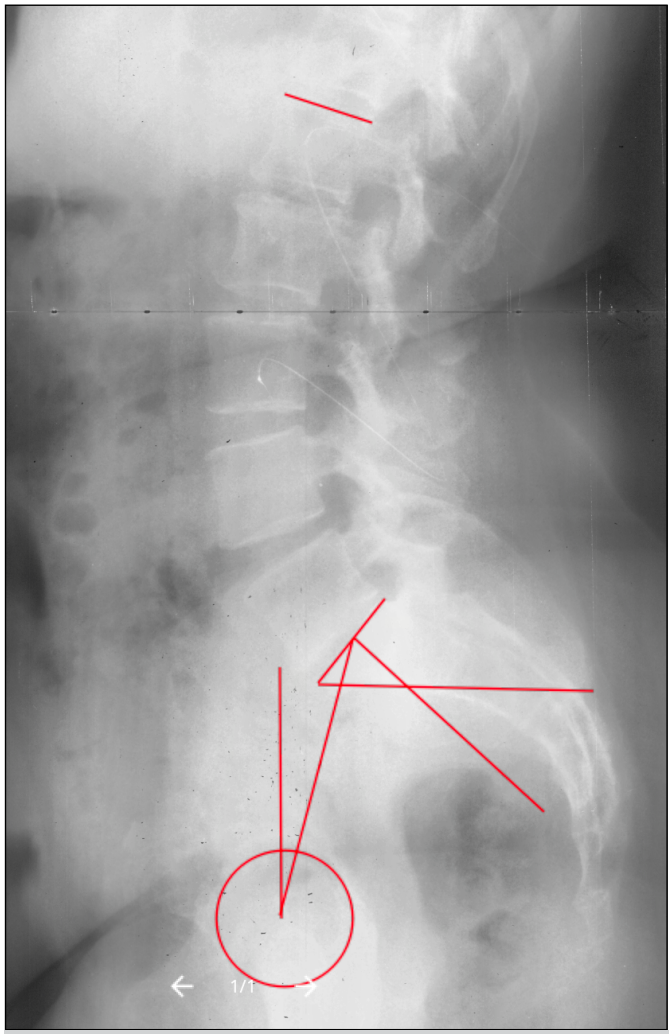

Figure 3. Profile radiographs illustrating references and measurements of spinopelvic parameters (pelvic incidence, pelvic tilt, sacral slope, and lumbar lordosis)

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Descriptive statistics were performed for the quantitative variables (mean, standard deviation) and the Anderson-Darling test was conducted to assess sample normality. Group comparison was performed by Student's *t*-test for the parametric distribution groups. The reliability of the measures among the observers was estimated using Pearson's coefficient. The statistical tests adopted a significance level of 5% ($p < 0.05$).

RESULTS

Table 1 shows the demographic data and assessed parameters. The age of the patients ranged from 48 to 87 years (64.90 ± 10.19 years). Eighteen (60%) patients were male and 12 (40%) were female. The preoperative assessment conducted by Thomas test found that 14 patients had hip flexion contracture, ranging from 10 to 30° (Table 1).

A high degree of correlation (> 0.9) (Pearson's Coefficient) was observed between the radiographic parameter measurements of the two evaluators using the SURGIMAP software (Surgimap – New York, USA).

Table 1. Demographic data of patients and assessed parameters.

Patient	Sex	Age	Flexion contracture	PI	PT	SS	LL	Llorto-sem	ΔSS
1	Fem	70	30 and 30	58.6	11	47.6	55.8	61.9	41.1
2	Male	61	10 and 10	79.9	34.9	45	46.9	23.9	24.2
3	Fem	64	15 and 15	60.6	7.4	53.6	57	28.1	47.4
4	Fem	81	15 and 15	62.1	13.5	48.6	71.6	29.3	33.6
5	Fem	68	10 and 10	70.8	18.7	52.1	80.2	44.8	37.1
6	Male	76	20 and 20	50.9	-7.5	58.4	78.9	67.7	48.2
7	Fem	55	20 and 20	30.5	-12.3	42.8	61.3	47.6	41.5
8	Fem	56	10 and 10	77.6	20.5	57	75.6	48.4	38.6
9	Male	64	20 and 20	61.8	10.5	51.3	66.5	52	45.1
10	Fem	84	15 and 20	52.5	22.7	29.9	42	26.9	28.4
11	Male	64	15 and 15	52.1	14.3	37.8	64.9	54.7	37.4
12	Male	52	20 and 20	76.4	38.1	38.3	42.3	10.7	14.1
13	Male	62	20 and 20	59.9	11.7	48.2	73.7	41.7	31.1
14	Male	69	10 and 10-	53.2	19.9	33.2	48.4	35.1	54.5
15	Male	74	no	59	10.7	48.3	67.3	12.1	6.9
16	Fem	64	no	82.5	37.9	44.6	65.1	30.6	30.7
17	Male	66	no	56.7	6.9	49.8	65.6	38.1	30.4
18	Fem	87	no	43.4	22.9	20.5	-8.6	6.2	30.7
19	Male	52	no	75	28.3	46.7	48.5	13.8	21.6
20	Fem	76	no	67.3	21.3	46	74.3	42	27.6
21	Male	53	no	71.9	22.6	49.3	59.6	45.8	42.3
22	Fem	71	no	52	5.3	46.8	80.3	35.3	24.1
23	Male	68	no	57.4	2.7	54.7	69	63.4	48.3
24	Male	66	no	60.8	11.7	49.1	67.9	45.2	34.1
25	Male	50	no	65.2	22	43.1	49.6	23	14.4
26	Male	52	no	42.4	-4.8	47.2	50.4	34	38
27	Male	72	no	51.5	13.6	7.9	59.9	39.5	34.5
28	Male	48	no	74	24	50	72.4	48.4	33.8
29	Fem	65	no	54.6	9.1	45.5	67.6	24.8	12.1
30	Male	57	no	55.5	7.8	37.6	38.2	22.6	31.9

Spinopelvic mobility assessed by sacral slope (SS) variation in the orthostatic and sitting position ranged from 6.90 to 54.50° (mean 32.79 ± 11.42). Patients with and without hip flexion contracture had statistical differences in spinopelvic mobility values. Patients with hip flexion contracture (Thomas +) presented higher spinopelvic mobility ($p = 0.0404$ – Student's *t*-test) (Figures 4 and 5).

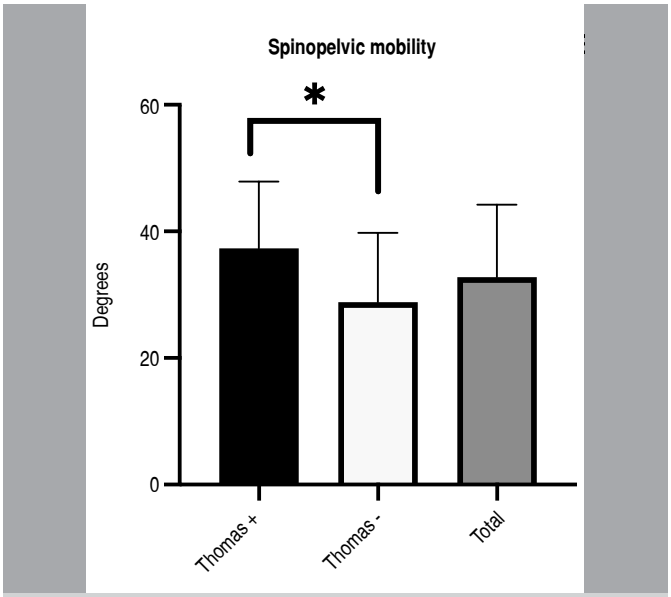

Figure 4. Graph illustrating the mean and standard deviation of spinopelvic mobility in patients with hip flexion contracture (Thomas +), without contracture (Thomas −), and in all patients. The asterisk (*) indicates statistical difference between groups (Student's *t*-test).

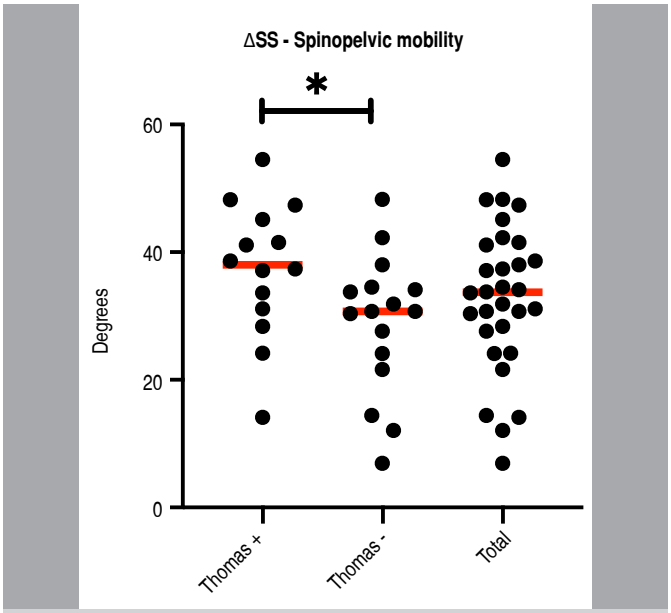

Figure 5. Graph illustrating the mean and standard deviation of spinopelvic mobility in patients with hip flexion contracture (Thomas +), without contracture (Thomas −), and in all patients. The asterisk (*) indicates statistical difference between groups (Student's *t*-test).

Spinopelvic mobility under 20°, considered as the lower limit and classified as spinopelvic stiffness, was observed in one (7.15%) patient with hip flexion contracture and in three (18.75%) patients with no contracture (Table 2).

Table 3 and Figures 6, 7, and 8 show the correlations of spinopelvic mobility with the assessed parameters. No correlation was observed between pelvic incidence (PI) and spinopelvic mobility (Pearson's coefficient $r = -0.2445$, $p = 0.1928$). Lumbar lordosis was also not correlated with spinopelvic mobility (Spearman's coefficient $r = 0.1273$, $p = 0.5027$).

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Table 2. Distribution of the number and percentage of patients with hip contracture (Thomas +), without hip contracture (Thomas −), and of all patients according to spinopelvic mobility (orthostatic ΔSS and sitting SS).

	Thomas + pre-op. n (%)	Thomas - pre-op. n (%)	Total pre-op. n (%)
< 20°	1 (7.15)	3 (18.75)	4 (13.34)
20-40°	8 (57.14)	11 (68.75)	19 (63.33)
> 40°	5 (35.71)	2 (12.50)	7 (23.33)
Total	14 (100%)	16 (100%)	30 (100%)

Table 3. Correlation between spinopelvic mobility (Δ SS) and spinopelvic parameters.

Measure	PI	PT	LL	Δ LL
ΔΔ SS	r = □0.2445	r = □0.3791*	r = 0.1273	r = 0.6877*

The asterisk (*) indicates statistical significance (p < 0.05).
PI: pelvic incidence; PT: pelvic tilt; LL: lumbar lordosis; Δ LL: lumbar lordosis flexibility.

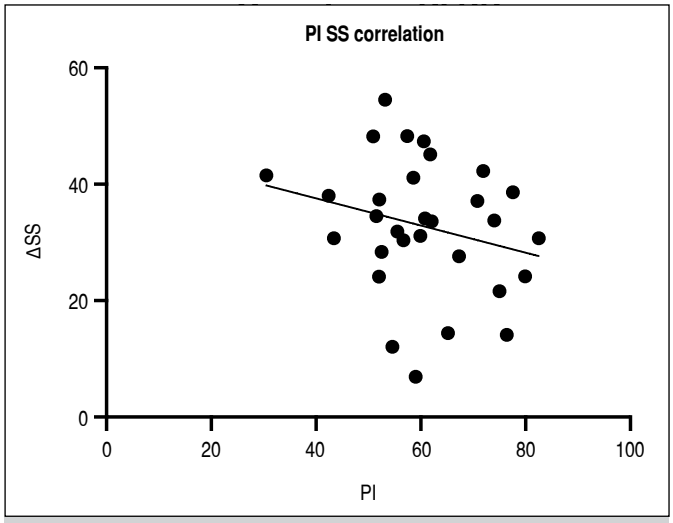

Figure 6. Graph illustrating the linear regression between spinopelvic mobility and pelvic incidence. No correlation was observed between pelvic incidence and spinopelvic mobility (Pearson's coefficient – r = −0.2445 – p > 0.05). Δ SS – spinopelvic mobility/ PI – pelvic incidence.

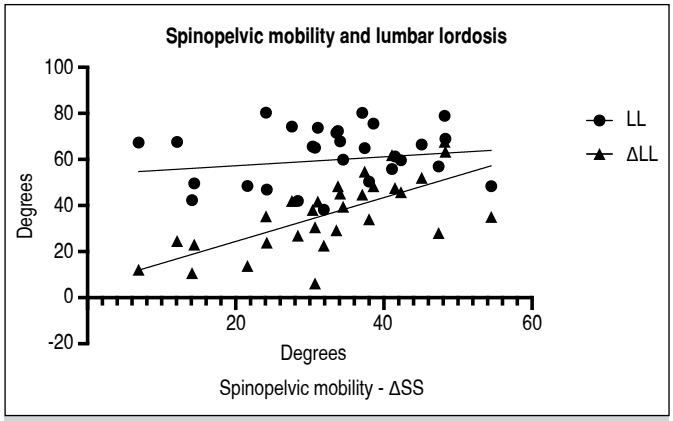

Figure 7. Graph illustrating the linear regression between spinopelvic mobility and lumbar lordosis (LL) and spinopelvic mobility and lumbar lordosis flexibility. Correlation was observed between spinopelvic mobility and lumbar lordosis flexibility (Pearson's coefficient – r = 0.6877, p < 0.0001). However, no correlation was observed between spinopelvic mobility and lumbar lordosis (Spearman coefficient – r = 0.1273-0.5027). LL – lumbar lordosis/ΔLL./ΔSS – spinopelvic mobility).

Correlation was observed between spinopelvic mobility and lumbar lordosis flexibility (Pearson's coefficient r = 0.6877, p < 0.0001) and pelvic tilt (Pearson's coefficient r = −0.3791, p = 0.0388) (Figures 7 and 8).

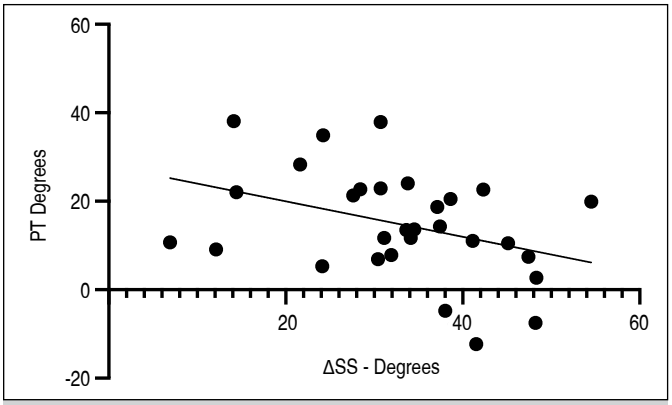

Figure 8. Graph illustrating the linear regression between spinopelvic mobility and pelvic tilt (PT). Correlation was observed between spinopelvic mobility and pelvic tilt (PT) (Pearson's coefficient – r = −0.3791, p = 0.0388). ΔSS – spinopelvic mobility.

DISCUSSION

Preoperative spinopelvic mobility varied significantly. Most patients (63%) presented mobility values between 20-40°, considered the physiological range;[5,6] about 13.4% of patients; however, they had spinopelvic mobility below 20°, which has been classified as stiffness. This percentage of patients with reduced spinopelvic mobility corroborates the reports in the literature, emphasizing the importance of mobility assessment before performing total hip arthroplasty.[2,4,5,9] The latter group of patients did not undergo lumbar spine surgery but had reduced spinopelvic mobility. The lumbar spine, pelvis, and hip present complex kinematic interaction. The inability of anterior rotation of the pelvis when changing from standing to sitting limits acetabular anteversion in these patients, inducing a greater flexion of the femur, which may dislocate or impact prosthesis components.[2,10]

Understanding how spinopelvic mobility affects the positioning of the acetabular component of the total hip prosthesis has shown that the "Lewinnek safe zone" (inclination of 40° ± 10° and anteversion of 15° ± 10°) does not consider acetabular positioning in different postures and its relationship with spinopelvic mobility.[8,11] Image assessment and arthroplasty conducted with the hip in supine position do not allow identifying changes in acetabular inclination in different positions. In dorsal decubitus with the lower limbs extended, the sacral slope (SS) increases in relation to the orthostatic and sitting positions, reducing acetabular anteversion.[2,3] To understand different acetabular positioning, the spinopelvic mobility and parameters obtained in the orthostatic and sitting positions must be assessed.[2,5,11]

Similarly to other studies,[2,10] our study assessed spinopelvic mobility using the difference of sacral slope (SS) in panoramic radiographs of the spine in the orthostatic and relaxed sitting positions. Some authors, however, argue that the forced sitting position, simulating the position of tying shoelaces, would be more sensitive for identifying changes not identified in the relaxed sitting position.[10] The literature diverges regarding the best assessment method of spinopelvic mobility; more sophisticated methods, such as biplanar stereoradiography, have also been used.[2,5,6]

To date, no scientific evidence is available on the normal and pathological limit of spinopelvic mobility.[2,5,8] The literature has previously

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reported on the wide variation of values – as observed in our group of patients – and spinopelvic mobility has been classified as rigid, normal, and hypermobile.[6] The limits of normal values of spinopelvic mobility have ranged from 10 to 30°,[2,6,8] 20 to 40°,[5] and 20 to 35°,[12] showing that its physiological limits are still undefined.[2,10] Our studied group of patients had low values of spinopelvic mobility (< 20°), indicating stiffness. The possible implications of these values on arthroplasty results were commented. Spinopelvic hypermobility (> 40°) was also observed in our patients. The influence of this degree on the results of total hip prosthesis remains controversial.[2,10] Some reports indicate that THA reduces complications in patients with hypermobility,[13] whereas others associate hypermobility with lower results.[2,14] The physiological limits of spinopelvic mobility are still undefined, and the individual dynamic assessment of spinopelvic mobility should be considered.

Considering that hip flexion contracture can alter the interaction of the spinopelvic kinematic chain, we aimed to assess contracture influence on spinopelvic mobility. Our results showed statistical difference of spinopelvic mobility in patients with hip flexion contracture, who presented higher values than the control group. Compensatory mechanisms occur in this spinopelvic kinematic chain. Studies show that patients with lumbar spine stiffness increase the range of hip movements whereas patients with hip joint stiffness increase the range of lumbar spine movements.[6,10] Our study considered only sacral slope (SS), while other parameters related to spinopelvic movements, such as femoropelvic angle, femoral tilt, and others should be further analyzed together. The influence of joint contracture is still incipient in the literature despite being mentioned in the initial publication of Lazenec,[3] who first reported the influence of spinopelvic mobility and parameters on THA results. In the final phases of hip arthrosis, 80% of patients used lumbar spine mobility when changing from standing to sitting position, 10% mainly used the hip, and 10% mainly used the lumbar spine. Patients who mainly used the hip would have a higher risk of complications for not presenting compensatory mobility of the lumbar spine.[2,5]

Spinopelvic parameters were positively correlated with lumbar lordosis mobility and negatively correlated with pelvic tilt (PT). Considering that pelvic tilt increases during the transition from standing to sitting, reduced tilt indicates lower spinopelvic mobility, whereas increased tilt indicates hypermobility. Similarly to pelvic incidence (PI), lumbar lordosis alone was not correlated with pelvic mobility. However, lumbar lordosis mobility was correlated with pelvic mobility, corroborating the importance of lumbar spine mobility in spinopelvic mobility and its reduction in patients with arthrodesis or degenerative disease of the lumbar spine.[2,5,15]

This study presented limitations related to the small sample size due to difficulties in patient recruitment. Hip joint could also have been better analyzed. Patients with hip arthrosis had lower pelvic-femoral angle values and greater posterior femoral tilt.[12,15,16] Hip mobility can be assessed by comparing the values in the standing and sitting positions and measuring the position of the acetabular component (anterior inclination) and the femur (pelvic-femoral angle). The sum of these two parameters, called "combined sagittal index," has been used to determine the safe zone of acetabular component positioning.[11,12] In the kinematic chain of spinopelvic movements, changes are reciprocal. Lumbar spine stiffness increases hip movement, whereas hip joint stiffness increases the range of lumbar spine movements; both are relevant to positioning and adapting the acetabular component of the prosthesis.[2,3,5,11] These alterations are not homogeneous. Evidence shows that 80% of patients with advanced degree of hip arthrosis use the movements of both hips when changing from standing to sitting position, 10% mainly use the hip, and 10% mainly use the lumbar spine.[2,5] The detailed assessment of hip range of motion and its adaptations could clarify the behavior of spinopelvic mobility and adaptation. Future studies should therefore include it in their protocol.

Furthermore, this study did not consider the sagittal balance of the spine and other spinopelvic parameters since it aimed to analyze preoperative spinopelvic mobility in patients with hip arthrosis specifically. The study did not seek to assess the possible complications of THA but the changes in spinopelvic mobility in patients with hip arthrosis and subjected to total arthroplasty. Some patients showed significant variation and reduction of spinopelvic mobility, corroborating literature reports. Reduced spinopelvic mobility is a predictive factor of the late complications of total hip arthroplasty,[2,4,5,17] and a warning sign for the positioning of the acetabular component of THA. The results evidence the reduction of spinopelvic mobility in patients who did not undergo lumbar spine arthrodesis, reinforcing the current concept of assessing spinopelvic mobility and parameters before THA to avoid the complications observed in patients with lumbar spine stiffness.

CONCLUSION

The spinopelvic mobility of patients with primary hip arthrosis and indication of total arthroplasty varied significantly. Around 13.4% of patients presented spinopelvic mobility below 20°. Spinopelvic mobility > 20°, characterizing stiffness, may be associated with a higher risk of dislocation or impact of prosthesis components. Additional studies with bigger samples should seek to better understand the complex dynamic interaction between the lumbar spine, pelvis, and hip before and after THA.

AUTHORS' CONTRIBUTIONS: Each author contributed individually and significantly to the development of this article. FLG: study design, data collection, writing of the article, data analysis, project review, intellectual concept, and article review; GPP: study design, data collection, writing of the article, data analysis, project review, intellectual concept, and article review; HLAD: study design, data analysis, and project review.

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ANALYSIS OF THE MECHANICAL BEHAVIOR OF THE POSTERIOR CRUCIATE LIGAMENT IN A PORCINE MODEL

ANÁLISE DO COMPORTAMENTO MECÂNICO DO LIGAMENTO CRUZADO POSTERIOR EM MODELO SUÍNO

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ABSTRACT

Introduction: The knee has shown a significant increase in the frequency of injury due to sports practice. This increase and the improvement of surgical techniques of ligament reconstruction have led to a greater indication of this treatment to achieve a function close to normal. Objective: To conduct a preliminary analysis of the ligament behavior. Methods: The study consisted of the validation of an anatomical model of the pig, in which five models were subjected to mechanical tests. The data on the loads of the in situ model and the strains of the posterior cruciate ligament were collected. Results: The analysis of the tensile load showed, at first, a nonlinear increase in stresses. Subsequently, the pig's knee showed a relatively linear intermediate response until failure around 1,200 N. Strain × time showed a response of the posterior cruciate ligament, which also has a relatively linear response. Conclusion: We observed a linear behavior in the range of 1,000 to 5,000 microstrains in the strain of the posterior cruciate ligament. We suggest further studies to understand knee ligaments regarding their behavior in their function. ***Level of Evidence IV, Biomechanical Study.***

Keywords: Ligaments. Tensile Strength. Mechanical Stress.

RESUMO

Introdução: O joelho tem demonstrado um aumento significativo de frequência de lesão devido à prática esportiva. Esse aumento e a melhoria das técnicas cirúrgicas de reconstrução ligamentar têm levado a maior indicação desse tratamento com o objetivo de se atingir uma função próxima do normal. Objetivo: Realizar uma análise preliminar do comportamento ligamentar. Métodos: O estudo consistiu na validação de um modelo anatômico do porco, em que cinco modelos foram submetidos a ensaios mecânicos. Foram coletados os dados das cargas do modelo in situ e das deformações do ligamento cruzado posterior. Resultados: Na análise da carga trativa, foi observado que em um primeiro momento existe um aumento não linear das tensões. Em sequência, há uma resposta intermediária relativamente linear do joelho suíno até a falha em torno de 1.200 N. A deformação versus tempo mostrou uma resposta do ligamento cruzado posterior, que também possui uma resposta relativamente linear. Conclusão: Observou-se um comportamento linear na faixa de 1.000 até 5.000 microstrains na deformação do ligamento cruzado posterior. Sugerem-se novos estudos para a compreensão dos ligamentos do joelho quanto ao comportamento deles na sua função. ***Nível de Evidência IV, Estudo Mecânico.***

Descritores: *Ligamentos. Resistência à Tração. Estresse Mecânico.*

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INTRODUCTION

The knee is one of the body joints most vulnerable to trauma, which has been occurring more frequently in recent years due to sports practice.[1-3] This increase and improvement of surgical ligament reconstruction techniques have led to a greater indication of this treatment to achieve a function close to normal.[4]

The understanding of the behavior of knee structures regarding the tensile loads can allow to understand its physiological behavior to create new strategies to improve the result and choose the best graft for ligament reconstruction. The costs of ligament revision surgery and the scarcity of options as revisions are conducted may be factors that worry knee surgeons and managers.[5]

The concern with the quality of the reconstruction has made the researchers analyze the different points that can influence the result, such as new fixation devices, types of graft and other techniques that improve the result.[6]

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

The study was conducted at Centro Federal de Educação Tecnológica Celso Suckow da Fonseca and Instituto Nacional de Traumatologia e Ortopedia.
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The knee is a synovial diartrodial joint and some animals are used to simulate and reproduce surgical techniques, such as cattle and pigs, which can be widely used for training of surgeries and techniques.[7-10]

Mechanical tests to understand the behavior of materials can be performed as tensile and compression tests. We used tensile loads to evaluate the ligament structures to observe the stress in the specimens and the strain over time.[11]

The lack of information in the tested ligament structures and in the behaviors of the *in situ* ligament, the performance of destructive and *in vitro* tests, allow a distributed analysis of the load of ligament failure as well as the strain behavior over time.

For studies to develop new techniques, the National Health Council established in Resolution 1 of 07/15/1988, Decree 93,933 of 01/1987, Chapter II, Article 5, Item II, that: "Research in human beings must be based on previous experimental research conducted in animals".

Our study aimed to perform a preliminary analysis of the ligament behavior (posterior cruciate ligament) regarding the imposed tensile loads and their behavior by measuring their strains.

MATERIALS AND METHODS

The study consisted of the validation of an anatomical model of the pig's knee, in which five knee models of young pigs without reconstruction were subjected to mechanical tests on the Instron device, with the extended knee being subjected to increasing tensile stress forces until the final failure of these models *in vitro*.

The study was conducted in partnership with the Instituto Nacional de Traumatologia e Ortopedia, Universidade de Valença and Centro Federal de Educação Tecnológica Celso Suckow da Fonseca (CEFET/RJ) and the samples were provided by the animal room of the Universidade de Valença, respecting ethical standards to use the animals.

The anatomy of the pig's knee is essential because it is one of the joints significantly similar to the human being's, being a synovial diartrodial joint used as an anatomical model for experimental studies and surgical training.[7]

The models were dissected keeping the four main knee ligaments 13.5 cm away from the articular surface of the femoral and tibial knee. A 6-mm cross-sectional hole was performed in the proximal (femur) and distal (tibia) segment and were kept in a refrigerator of −80°C after removal. On the day of the experiment, they were removed from the refrigerator five hours before the test and wrapped in gauze with 0.9% physiological saline. They were subjected to destructive tests, until the failure of the specimens, at room temperature in an air-conditioned room (22°C).

The anatomical models were thawed according to what was planned, keeping the four main knee ligaments to subject them to mechanical testing.

Five young pigs were evaluated to observe the ligament behavior and regarding the tensile load of the knees. A displacement of 3 mm/minute was imposed.

Strain gages were placed, which are transducers capable of measuring mechanical strains in specimens, in posterior cruciate ligaments due to possible access to the extended knee. Then the data on the loads of the *in situ* model and the strains of the posterior cruciate ligament were collected from the information of the strain gages.

The strain of the posterior cruciate ligament was observed during the failure test of the specimens (Figure 1).

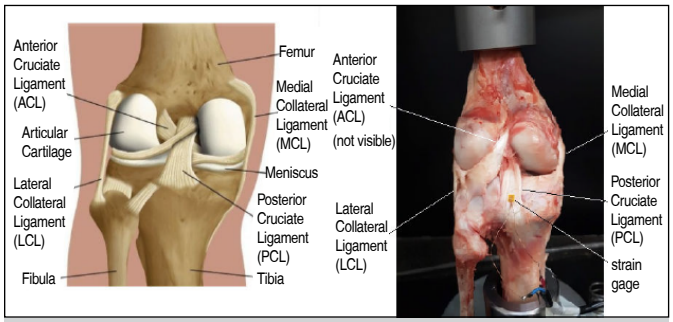

Figure 1. Image with posterior view of the knee structures (left) and of the anatomical model attached to the Instron with strain gage glued to the posterior cruciate ligament (right).

The results were obtained and tables were generated with descriptive numerical values and load × displacement and strain × time graphs.

RESULTS

We observed the posterior cruciate ligament by analyzing the knee behavior and the tensile loads, and we found a linear behavior when measuring the strain with the strain gage.

In the analysis of the tensile load, the load × extension graph showed, at first, an accommodation and a nonlinear increase in stresses. Subsequently, it showed a mean relatively linear intermediate response of the pig's knee until failure around 1,200 N (Figure 2).

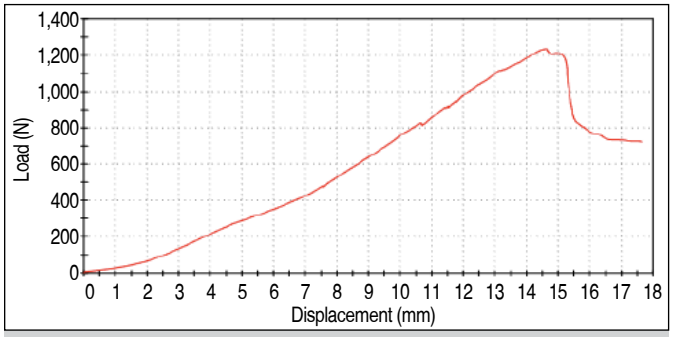

Figure 2. Load × displacement.

The load was apparently redistributed by other structures after failure, leaving some remaining residual strength. A relatively large displacement was imposed before the failure was noticed. The strain × time graph shows the response of the posterior cruciate ligament, which also has a relatively linear response between 1,000 and 5,000 microstrains (Figure 3).

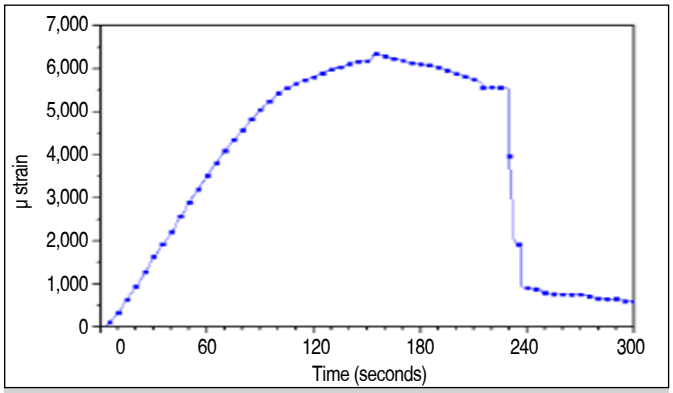

Figure 3. Strain × time Graph.

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DISCUSSION

The stability of the knee and its function depends on the perfect ligament action, and the reconstruction requires that the ligaments behave appropriately due to the loads imposed on it.

The knee is a joint that is subjected to compressive and tensile forces. The tensile forces request the ligament structures, which show complex behavior, different from the elastic, viscous or rigid behavior, and may show different behaviors depending on the applied load and time.

The reconstructions of ligament structures are frequently analyzed to understand the behavior of fixations and what would be the best fixation material. However, ligament behavior is essential to propose the best techniques, types of graft and fixation materials. The reconstruction seeks more rigid systems[12] to reduce eventual translations that may arise in the postoperative period, but accommodations may arise over time.

Some studies analyze in 3D models as if they had an elastic or rigid behavior[13] in studies of graft extraction analysis, disregarding a viscoelastic behavior either of the tendon used as a graft or of the remaining ligaments.[14] Galbusera et al.[15] affirms the importance of researchers who perform 3D simulations to consider the anisotropic and nonlinear behavior of ligament and tendon structures.

In our study, the posterior cruciate ligament showed a relatively linear behavior in the intermediate loads during the imposed load. The use of strain gages allowed to understand the strain behavior of the analyzed material, and in the case of musculoskeletal tissues they allow to understand this behavior and the choice of graft to better replace the injured structure.

The limitation of our study is that the analyzed structure is an *in situ* structure and the complexity of the redistribution of forces and stresses must be considered in the evaluation, thus, *in vitro* studies with isolated biomechanical tests of ligaments are necessary.

The strength of this study is the extraction of numerical values and data using strain gages to obtain new information, which might be the vanguard for use in musculoskeletal tissue tests.

CONCLUSION

Our study observed the linear behavior from 1,000 to 5,000 microstrains in the strain of the posterior cruciate ligament during the *in situ* displacement of the knee joint. We suggest further studies to understand knee ligaments regarding their behavior in knee function.

AUTHORS' CONTRIBUTION: Each author contributed individually and significantly to the development of this article. RRPR: writing, idealization and performance of sample dissections and mechanical tests; PPK: idealization, intellectual concept, testing and data analysis; BTD: testing and data collection; JAMG: article review and intellectual concept of the article; WRP: responsible for the samples and dissection of the samples.

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< < SUMÁRIO

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IMPACT OF MEASURES TO FIGHT THE PANDEMIC COVID-19 ON KNEE ARTHROPLASTIES IN BRAZIL

IMPACTO DAS MEDIDAS DE ENFRENTAMENTO À PANDEMIA COVID-19 NAS ARTROPLASTIAS DE JOELHO NO BRASIL

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ABSTRACT

Objective: To assess the impacts of measures to face COVID-19 on total knee arthroplasty procedures in the country, based on data provided by the SUS Information and Informatics Department (DATASUS). Methods: Cross-sectional study of secondary data in the public domain, available on the website of the Department of Information and Informatics of SUS (DATASUS), containing information about hospital admissions in the SUS. Results: Brazil suffered a 51.82% decrease, on average, in the performance of total knee arthroplasty by the Unified Health System (SUS) in 2020, due to measures to face COVID-19. The analysis by region offers more details on this reduction in the number of procedures. In the Northeast, the decrease was on average 48.02%, whereas in the Center-West it was 65.61%. Southeast, North, and South registered an average decrease of 49.38%, 51.81%, and 55.06%, respectively. Conclusion: COVID-19 impacted the realization of TKA in Brazil, with greater and lesser levels of decline observed in different Brazilian regions. In the Southeast region, for example, the states of São Paulo and Minas Gerais were the most affected, mainly due to the large population concentration, as well as Paraná, which has high numbers of procedures and a sharp decrease in 2020. ***Level of Evidence III, Retrospective Comparative Study.***

Keywords: COVID-19. SARS-CoV-2. Pandemics. Arthroplasty, Replacement, Knee. Orthopedic Procedures.

RESUMO

Objetivo: Avaliar os impactos das medidas de combate à COVID-19 nos procedimentos de artroplastia total do joelho (ATJ) no país, com base nos dados fornecidos pelo Departamento de Informações e Informática do Sistema Único de Saúde (SUS). Métodos: Estudo transversal realizado com dados secundários de domínio público, disponíveis no site do Departamento de Informações e Informática do SUS (DATASUS), contendo informações sobre as internações hospitalares realizadas no SUS. Resultados: O Brasil sofreu uma queda de 51,82%, em média, na realização da artroplastia total do joelho pelo SUS em 2020, decorrente das medidas de combate à COVID-19. A análise por região oferece mais detalhes dessa redução no número de procedimentos. Na região Nordeste, a queda foi, em média, de 48,02%, enquanto no Centro-Oeste foi de 65,61%. Sudeste, Norte e Sul registraram queda, em média, de 49,38%, 51,81% e 55,06%, respectivamente. Conclusão: A COVID-19 impactou a realização de ATJ no Brasil, com níveis de maior e menor declínio observados nas diferentes regiões brasileiras. Na região Sudeste, por exemplo, os estados de São Paulo e Minas Gerais foram os mais afetados, devido principalmente à grande concentração populacional, assim como o Paraná, que apresenta números altos de procedimentos realizados e forte queda em 2020. ***Nível de Evidência III, Estudo Retrospectivo Comparativo.***

Descritores: *COVID-19. SARS-CoV-2. Pandemias. Artroplastia do Joelho. Procedimentos Ortopédicos.*

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INTRODUCTION

In late 2019, a series of cases of pneumonia of unknown cause emerged in the city of Wuhan, China. The analysis of the sequencing of samples from the lower respiratory tract identified the existence of a new virus of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), and the disease was named, in February 2020, of COVID-19 by the World Health Organization (WHO). A month after the announcement, 114 countries were hit, recording more than 118,000 cases and 4,000 deaths resulting in a pandemic declaration.[1,2] COVID-19 is a disease caused by an RNA virus, with the typical appearance of a crown under an electron microscope due to the presence of spike glycoproteins in its envelope.[3] Of natural and zoonotic origin, SARS-CoV-2 presents various clinical characteristics and risk factors, causing its severity to vary from asymptomatic to

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

The study was conducted at Hospital Santa Casa de Misericórdia de Vitória, Departamento de Ortopedia e Traumatologia, Grupo de Cirurgia do Joelho.
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fatal, with lethality rates of about 1.4%.[4,5] Added to these aspects, its ability to propagate rapidly and cause symptoms more severe than those of seasonal influenza resulted in hospital overload of patients in need of respiratory support, thereby causing catastrophic effects on the health system and, consequently, on the world economy.[6,7]
On February 25, 2020, the first COVID-19 case was identified in Brazil, causing the spread of the disease throughout the country. Based on the WHO declaring a global pandemic, the government established control and prophylaxis measures supported by sanitary, epidemiological, and legal criteria. Among the measures adopted, postponing elective surgical procedures was recommended aiming to slow the spread of the virus, preserve patients and health professionals of asymptomatic or undiagnosed carriers, save personal protective equipment, ensuring hospital occupation for the most severe cases.[6,7]
Among elective orthopedic surgeries, total knee arthroplasty (TKA), which has been established in recent decades as a very successful treatment for advanced knee osteoarthritis mainly for relieving pain and improving the function and quality of life of those affected, stands out.[8,9] Whether its origin is primary, posttraumatic, or secondary to avascular necrosis, osteochondritis or septic arthritis, osteoarthritis – the main cause of musculoskeletal disability in the world – is the most common indication for TKA.[10] In severe and advanced cases, restoring the functional gait capacity and reducing pain are provided by TKA, whose number of procedures has been interrupted or decreased not only in Brazil, but worldwide, mainly due to the protocols established for COVID-19.[11]
Although scarce, the Ministry of Health makes official data on the number of TKA performed by the Unified Health System (SUS) available.[12] Based on this, this article aims to know the number of TKA carried out in the country in recent years, compared with the period in which the measures against COVID-19 were applied.

METHODS

Cross-sectional study of secondary data from the public domain, available on the website of the Department of Information and Informatics of the SUS (DATASUS), containing information on hospital admissions performed by SUS. Due to using collective data, without individual identification of patients in the databases, applying the informed consent form (TCLE) and submitting to the Human Subjects Research Ethics Committee was considered unnecessary.
The analyzed data were obtained from the DATASUS (http://www2.datasus.gov.br/DATASUS/index.php) platform, using the Hospital Admission Information System (SIHSUS). All Hospital Admission Authorizations (HAA) for procedures related to knee arthroplasty (codes: 0408050063 – primary total knee arthroplasty and 0408050055 – total knee arthroplasty – revision/reconstruction) from January 2010 to December 2020.[12]
Data from the Brazilian Institute of Geography and Statistics (IBGE) were also consulted to understand the relevance of this issue in relation to the population indices of the country.[13]
Descriptive statistics of the data are presented in absolute number, means, percentages, and in the form of graphs.
This study received no financial support from public, commercial, or non-profit sources.

RESULTS

In the period between 2010 and 2020, 81,825 HAAs were issued for TKA in Brazil. Between 2010-2018, the number of TKA performed in the country fluctuated, increasing progressively, with a more evident increase in 2019 compared with previous years, followed by a sharp decrease in 2020. Comparatively, the reduction in procedures performed between 2019-2020 was, on average, 51.82% (Table 1).

Table 1. Total knee arthroplasties performed per year in Brazil by the Unified Health System.

Year	North	Northeast	Southeast	South	Center-West	Total
2010	203	529	3,718	1,605	171	6,226
2011	156	573	3,799	1,935	175	6,638
2012	157	546	3,827	1,878	186	6,594
2013	199	690	4,240	2,338	271	7,738
2014	194	629	4,592	2,421	240	8,076
2015	237	510	4,604	2,330	265	7,946
2016	151	459	4,798	2,209	266	7,883
2017	163	605	4,915	2,198	412	8,293
2018	127	820	4,341	2,668	430	8,386
2019	107	756	5,317	2,821	477	9,478
2020	51	393	2,691	1,268	164	4,567
Total	1,745	6,510	46,842	23,671	3,057	81,825

Source: DATASUS, 2021.

Regarding the performance in different Brazilian regions, the North region saw an increase in procedures between 2013-2015 (peaked in 2015), compared with 2010-2012. A reduction occurs in 2016 compared with 2015, with annual fluctuations until 2019, the year before the pandemic. The decrease between 2019 and 2020 contributed to the total TKA decrease in the region being, on average, 51.81% (Figure 1).

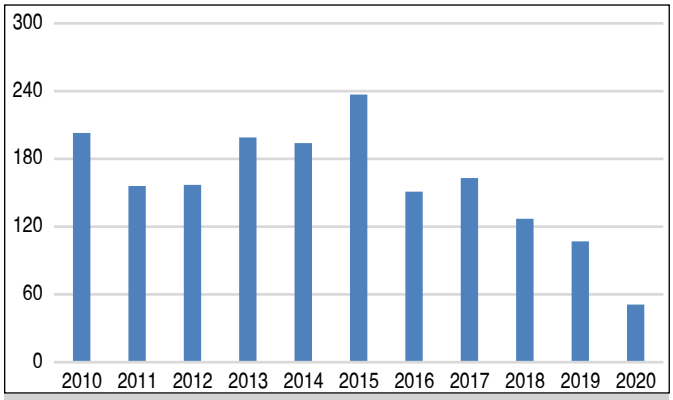

Figure 1. Total knee arthroplasties performed per year in the North region by the Unified Health System.
Source: DATASUS, 2021.

Between 2019-2020, the decrease was more pronounced in the Amazonas, which, from 2017, started showing a more expressive performance. The analysis of each state reveals fluctuation periods between 2010-2020, with increases and decreases in the number of TKA performed (Figure 2).

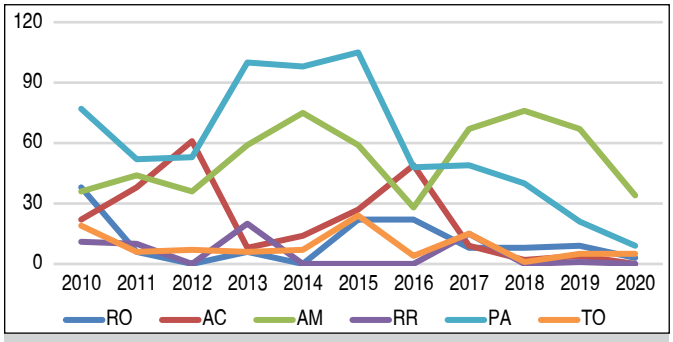

Figure 2. Total knee arthroplasties performed per year in the states of the North region by the Unified Health System.
Source: DATASUS, 2021.

In the Northeast region, TKA numbers were accentuated between 2018-2019, declining in 2020. The regional performance between 2010-2020 faced fluctuations, but the drop between 2019-2020 was responsible for the decrease of, on average, 48.02% in the number of procedures (Figure 3). Comparing the states shows the impact suffered by Bahia, which, after an increase in 2018, faced a great reduction in 2020, as well as Sergipe and Pernambuco (Figure 4).

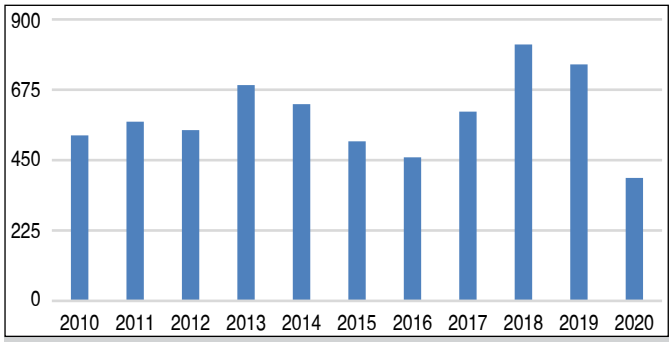

Figure 3. Total knee arthroplasties performed per year in the Northeast region by the Unified Health System.

Source: DATASUS, 2021.

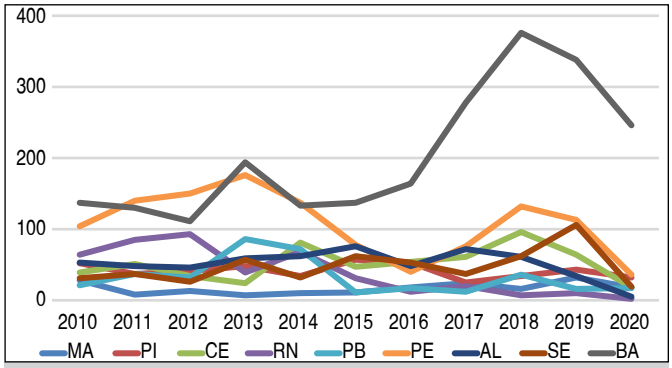

Figure 4. Total primary knee arthroplasties per year in the states of the Northeast region by the Unified Health System.

Source: DATASUS, 2021.

Recording the highest number of TKA in the country, the Southeast region had a progressive fluctuating performance between 2010-2019, before facing a mean decline of 49.38% in total procedures between 2019-2020 (Figure 5). São Paulo and Minas Gerais showed the steepest decreases in the period, unlike Rio de Janeiro, the only Brazilian state to slightly increase procedures during the pandemic (Figure 6).

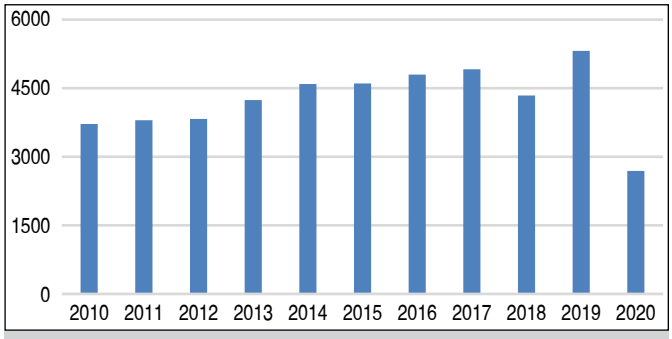

Figure 5. Total primary knee arthroplasties per year in the Southeast region by the Unified Health System.

Source: DATASUS, 2021.

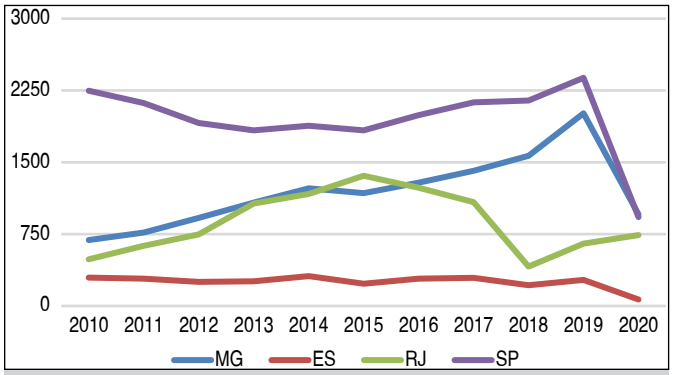

Figure 6. Total knee arthroplasties performed per year in the states of the Southeast region by the Unified Health System.

Source: DATASUS, 2021.

Like the Southeast, TKA performed in the South region decreased almost 50% in 2020 (Figure 7), mainly impacting the state of Paraná, compared with Santa Catarina and Rio Grande do Sul (Figure 8). The reduction between 2019-2020 across the Southern region corresponded, on average, to 55.06%.

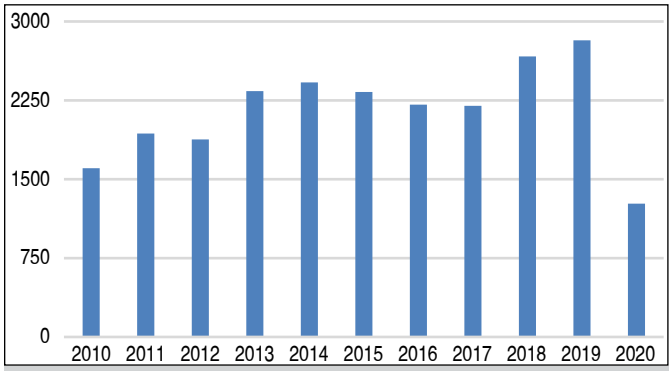

Figure 7. Total knee arthroplasties performed per year in the South region by the Unified Health System.

Source: DATASUS, 2021.

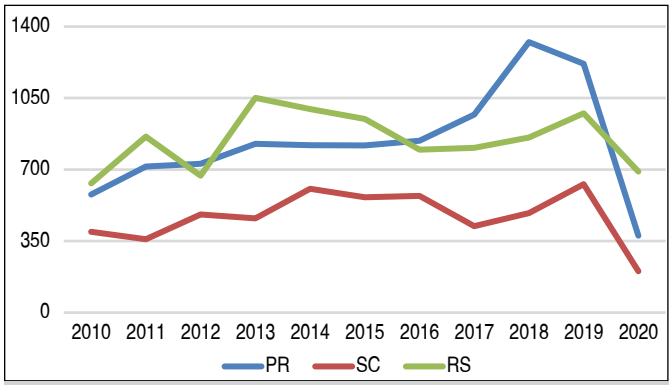

Figure 8. Total knee arthroplasties performed per year in the states of the South region by the Unified Health System.

Source: DATASUS, 2021.

A TKA numbers considerably increase between 2017-2019 in the Center-west region, which, in 2020, faced a reduction of 65.61%, on average, in these procedures compared with the previous year (Figure 9). Goiás and the Federal District were the most affected states during the period (Figure 10).

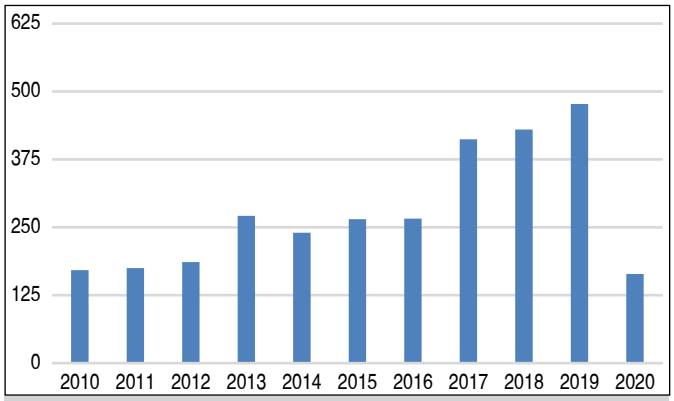

Figure 9. Total knee arthroplasties performed per year in the Center-west region by the Unified Health System.

Source: DATASUS, 2021.

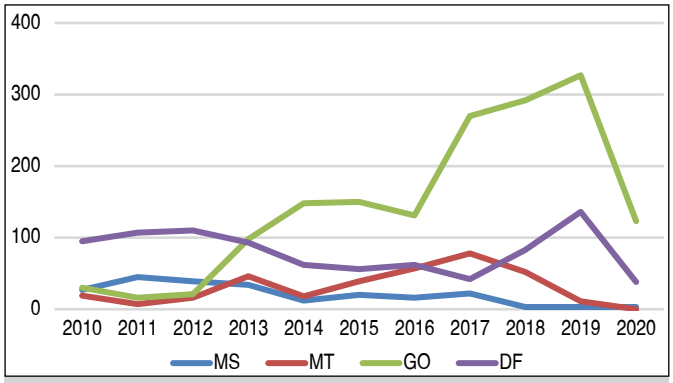

Figure 10. Total knee arthroplasties performed per year in the states of the Center-west region by the Unified Health System.

Source: DATASUS, 2021.

DISCUSSION

Brazil, as a whole, suffered the impacts caused by COVID-19 and the measures to cope with the pandemic, particularly in the performance of TKA by the SUS, recording a steep decrease (51.82%, on average) in 2020. Since 2010, the number of TKA performed by SUS has increased, with a more significant peak in 2019, the year before the notification of the first COVID-19 case.

The results of the study by Ferreira et al.[11] offer an overview of the discrepancy that Brazil faces and will still face regarding the performance of TKA. Their results demonstrate the analysis of the number of admission authorizations for TKA surgeries between 2008 and 2015 showing that the South and Southeast regions presented the best care ratio with 8.07 and 6.07 TKA/100,000 inhabitants and one TKA for 1,811 and 2,624 older adults, respectively. The worst rates were recorded in the North and Northeast, with 0.88 and 0.98 TKA/100,000 inhabitants and one TKA for 6,930 and 10,411 older adults, respectively.

In the United States, as demonstrated in the retrospective analysis by Barnes et al.,[14] who sought to determine the impact of COVID-19 on the number of arthroplasties performed by the American Medicare system, its variables, and the resulting financial implications. They identified a sharp decrease (94%) in the performance of the procedure in mid-March 2020, with reductions of 87% in the total daily revenue of the system for arthroplasty and 85% of the revenue for the surgeon.

The study by Wilson et al.[15] sought to quantify the number of cases of total hip and knee arthroplasties (THA and TKA) delayed in the United States, estimating the time needed to care for these patients after elective surgeries restart. Using population data, they projected a scenario with cases ranging from 77,646, at best, and 372,706, at worst of these delayed procedures, as well as a projected recovery time, on average, of 9 to 35 months.

A study developed by the Research Committee of the American Association of Hip and Knee Surgeons (AAHKS)[7] to assess the impacts on physical, mental, and economic health of patients with TKA and THA postponed due to the pandemic, with 360 patients with procedures canceled between March and July 2020, showed that the greatest concern of patients was related to uncertainty about when surgery would be rescheduled. Although 85% of the participants understood and agreed with the measures adopted to face the pandemic, approximately 90% intended to reschedule the procedure as soon as possible. Issues related to age and geographic region affected patients' anxiety levels, since younger people showed greater concern with financial aspects and safety at work.

In the study by Athey et al.,[16] 99 orthopedic surgeons affiliated with AAHKS answered a questionnaire to identify the global impact of COVID-19 on patient care. With the exception of Japan, in 31 of the 32 countries represented, the interviewees said that their practice was affected to some degree, with 70% needing to cancel elective procedures, more than a third needing to close their offices completely, and those who remained open were estimated to be sustainable, on average, for another seven weeks, causing, according to the authors, changes in most international arthroplasty practices. A retrospective study conducted in 2021 by Motta Filho et al.[17] found a 48.5% reduction in surgical productivity and 72.4% in outpatient care in 2020 compared with the same period in 2019, in a trauma unit of an institute specialized in high complexity elective orthopedic procedures.

In general, studies capable of directing professionals of the area and patients on the future of performing these procedures are lacking. Data on the impact on TKA in the supplementary and private health service, corresponding to a sizable portion of the procedures performed, is unknow.

The quantitative impact on TKA is important from the point of view of public health since the increase in life expectancy of the world population is directly related to a higher incidence of degenerative diseases. With this, the coming decades will evidently bring a significant growth in the number of procedures. In the United States alone, the projection indicates a 69% increase in the incidence of this surgery in 2050.[18] Understanding the phenomenon will help in planning strategies and managing services provided by the SUS, making it possible to dimension, from the comparison between regions, the demand of the coming months/years, and the generation of additional costs.

On the other hand, note that, regardless of the issues caused and the future challenges, postponing the procedures was relevant for reducing the risk of deaths from COVID-19. In a retrospective study, Holmes et al.[19] evaluated data from 320 individuals admitted to the orthopedics department of a UK hospital between March 23, 2020, and June 18, 2020. A total of 240 patients were SARS-CoV2 negative, 21 patients SARS-CoV2 positive, and 59 patients were not tested. During hospitalization, the in-hospital viral transmission rate was 12.5% of those initially tested on admission with negative results. During the evaluated period, 25 deaths were recorded, 56% occurred in positive SARS-CoV2 individuals, whereas 36% of deaths were SARS-CoV2 negative. Possibly, this relevant number of patients was infected by asymptomatic health professionals or hospitalized patients awaiting swab results.

CONCLUSIONS

In 2020, COVID-19 strongly impacted the performance of TKA In Brazil, which, in general, recorded an average decrease of 51.82%. The irregular distribution of the population in the different Brazilian regions resulted in greater and lesser decline, with the states of São Paulo and Minas Gerais, for example, among the most affected sites, due to the large population concentration, including that of older adults – commonly considered the largest risk group of cases of knee osteoarthritis – as well as Paraná, main representative of the Southern region, which has high numbers of procedures and a sharp decline in 2020. The data from this study may assist the competent authorities in identifying and correcting discrepancies in the service provided to SUS users in different Brazilian regions and states.

AUTHORS' CONTRIBUTIONS: Each author contributed individually and significantly to the development of this article. AMP: data collection, literature review, statistical analysis, and writing of the article; FFS: data collection, literature review, and writing of the article; SGO: data collection, bibliographic review, and preparation of the final project; GDBA: critical review of the article and preparation of the final project; CPMJ: data analysis and the entire intellectual concept of the article.

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STUDY BETWEEN SEMI-CONSTRAINED TOTAL KNEE ARTHROPLASTY WITH OR WITHOUT INTRAMEDULLARY STEM

ESTUDO ENTRE ARTROPLASTIA TOTAL DO JOELHO SEMI-CONSTRITA COM OU SEM HASTE INTRAMEDULAR

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ABSTRACT

Objective: This research sought to carry out a comparative study observing the clinical and radiographic analysis of primary prostheses of the type TC3 Depuy Johnson® with or without a stem during a short-term follow-up. Methods: The sample was divided into three groups: Group 1 (with stem), Group 2 (without stem) and Group 3 (mixed). Patients were evaluated to assess whether the implants were loosening and a clinical analysis was performed. Results: Preoperative deformities were predominantly considered severe. The total range of motion in the postoperative period was above 96.7° in the three groups. In the postoperative period, the femoral-tibial angle oscillated on average between 5 to 6° valgus. There was no record of implant loosening for cases treated with stem, and the incidence of loosening was 14.3% for the group without stem and 16.7% among cases in the mixed group. Conclusion: In general, preoperative deformities were considered severe. In the postoperative period, the total range of motion was above 96.7°. The postoperative femoral-tibial angle obtained an average of 5 to 6° valgus. There is no significant difference in implants loosening in the three groups. ***Level of Evidence III, Retrospective Comparative Study.***

Keywords: Arthroplasty, Replacement, Knee. Knee. Follow-up Studies.

RESUMO

Objetivo: Realizar um estudo comparativo observando a análise clínica e radiográfica das próteses primárias do tipo TC3 Johnson® com ou sem haste durante um seguimento de curto prazo. Métodos: A amostra foi dividida em três grupos: Grupo 1 com haste, Grupo 2 sem haste e Grupo 3 misto. Foi realizada a análise clínica dos pacientes e verificado se ocorreu soltura dos implantes. Resultados: As deformidades pré-operatórias foram predominantemente graves. O arco de movimento total no pós-operatório foi acima de 96,7° nos três grupos. No pós-operatório o ângulo tíbio-femoral oscilou na média entre 5 e 6° de valgo. Não houve registro de soltura do implante para os casos tratados com haste; a incidência de soltura foi de 14,3% entre os casos do grupo sem haste e de 16,7% entre os casos do grupo misto. Conclusão: Em geral, as deformidades pré-operatórias foram consideradas graves. No pós-operatório a amplitude total do arco de movimento foi acima de 96,7°. O ângulo tíbio-femoral pós-operatório obteve uma média entre 5 e 6° de valgo. Não há diferença significativa na soltura dos implantes nos três grupos. ***Nível de Evidência III, Estudo Retrospectivo Comparativo.***

Descritores: *Artroplastia do Joelho. Joelho. Seguimentos.*

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INTRODUCTION

Knee osteoarthritis associated with complex deformity is a challenge for orthopedists.[1] Sharp angular deviations, as well as severe flexion contractures, often require more constrained implants.[2] Extensive soft tissue releases or change of the articular interline in these deformities can generate instabilities, requiring more constrained implants to balance the flexion and extension spaces.[3]

More constrained implants with varus and valgus restriction increase stress transmission at the prosthesis-bone interface. Herewith, it is often necessary to use intramedullary stems in this type of prosthesis in order to achieve a better distribution of loads (Figure 1).[1]

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The study was conducted at the Knee Surgery Center at the National Institute of Orthopedics and Traumatology and at the Graduation Program in Medical Sciences at the Universidade Federal Fluminense.
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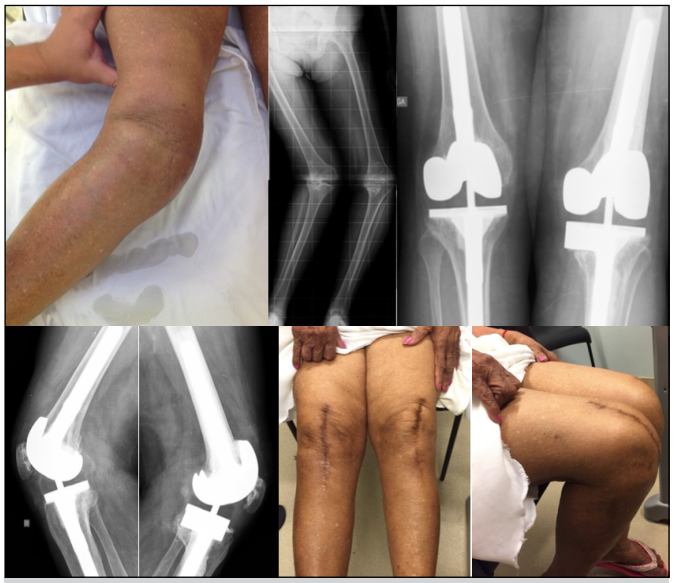

Figure 1. Clinical and radiographic analysis of total knee arthroplasty with stem.

Knee prosthesis associated with intramedullary stem allows for a better load distribution in the femoral-tibial region, reducing the risk of implant loosening.[4,5]

The literature is scarce on the absence of stems in more constrained knee implants (Figure 2).[6] The association of a prosthesis with intramedullary stem increases the risk of embolization, as well as the cost of the implant, morbidity, and the time of the surgery.[5] The pain at the tip of the stem should also be considered if there is a need for revision and removal of the implants, which can hinder the procedure.[5] This research aims to conduct a comparative study observing the clinical and radiographic analysis of TC3 Johnson® primary prostheses with or without stem during a short-term follow-up.

Figure 2. Total arthroplasty of the knee without stem.

MATERIAL AND METHODS

This is an observational, cross-sectional, and retrospective study. Participants were identified using data from the hospital implant sector. By identifying the patients linked to the specific implant, it was possible to have access to the medical records of those subjected to primary total knee arthroplasty (TKA). Thus, a comparative study was conducted, observing the radiographic analysis of the patients subjected to primary semi-constrained TKA from the TC3 Depuy Johnson® brand with or without stem during a minimum 2-year postoperative follow-up. The sample was divided into three groups: Group 1 with stem in both tibial and femoral components, Group 2 without stems and Group 3 with a mixed approach, i.e., with stem in the tibial component.

The sample consisted of patients of all genders and ages, who underwent primary TKA in the hospital with the TC3 Depuy Johnson® prosthesis who were admitted for treatment from 2012 to 2016. The inclusion criteria were: patients subjected to primary TKA with TC3 Depuy Johnson® prosthesis, regardless of the use or not of intramedullary stems. The exclusion criteria were: failure to collect data from the medical record and the use of another prosthesis model. No patients were excluded. The research was approved by the Institutional Ethics Council (protocol No. 98772718.0.0000.5273) according to established ethical standards. All participants signed the informed consent form. Medical records were analyzed by a single physician who was a member of the Brazilian Society of Knee Surgery, and demographic data of patients were collected, as well as the range of movement (ROM), comorbidities, body mass index (BMI), American Society of Anesthesiology (ASA) classification and the etiology of the surgical indication. The radiographic analyses of the implants were performed by a graduated (Doctor in Radiology) physician , without prior knowledge of the patients. The radiographs, according to the study hospital standards, were performed with bipodal support in the anteroposterior, lateral, and axial facets of the patella. The radiographic analysis evaluated implant loosening with the criteria used by the Knee Society Total Knee Arthroplasty Roentgenographic Evaluation and Scoring System.[7] The evaluation of osteolysis consisted in the observation of a radioluscent line in the region of the prosthesis-cement or cement-bone interface, which was quantified in millimeters of thickness and subsequently analyzed in each radiographic incidence for comparison. In addition, the type of deformity of the lower limb and the femoral-tibial angle were analyzed. This angle was calculated by drawing lines between the anatomical axes of the femur and tibia. The analysis of radiographic data was performed via the mDicomViewer 3.0 software (Microdata, RJ-Brazil, 2007).

The data collected from the study were arranged in an electronic spreadsheet analyzed by the SPSS (Statistical for the Social Science) Program, version 22.0, and by the Microsoft Excel 2007 program. The descriptive analysis was based on frequency distributions, and on the calculation of descriptive statistics (proportions of interest, minimum, maximum, mean, median, standard deviation, coefficient of variation – *CV*) seeking to synthesize and to characterize the behavior of the variables as well as to trace the participants' profile. The variability of the distribution of a quantitative variable was considered low if $CV < 0.20$; moderate if $0.20 \leq CV < 0.40$ and high if $CV \geq 0.40$. The Wilcoxon test was also used.

All discussions about significance tests were conducted considering a maximum significance level of 5% ($p < 0.05$).

RESULTS

Table 1 shows the frequency distribution of the variables that characterize the patients of the three groups. The main frequencies of each group (highest frequency and frequency that differs from the highest frequency by a maximum of 10%) are highlighted. The data show that the G1 and G2 present a higher frequency of patients aged from 67 to 77 years. On the other hand, G3 participants are aged from 47 to 57. Regarding BMI, all groups presented greater patterns for overweight or obesity. The predominant profession is "homeworker." White and Brown were the predominant skin color; the most frequent comorbidity

is systemic arterial hypertension. All groups were graduated as 2 via the ASA rating. Laterality can be considered well-distributed for the Group 1; however, for G2 or G3, we obtained a higher frequency of left-handedness. Most surgery indicated deformity; however, we observed a higher frequency of ligamentous cases in the Group 2 (35.7% of the cases, while in the other groups this percentage was below 10%). The frequencies of valgus/varus deformities can be considered well-distributed for both Group 2 and 3; however, Group 2 presented more cases of varus deformity. The time after surgery was two years at least; however, 25.0% of individuals in the G3 presented 5 years of surgery. There was no record of implant loosening for cases treated with stem. Furthermore, the occurrence of loosening was 14.3% among cases in the G2 (Figure 3) and 16.7% among cases in the Group 3 (Figure 4). In Group 2, we observed two patients with tibial component loosening. In these two cases, one presented ligamentous instability whereas the other presented joint deformity. In Group 3, we found a patient with bilateral implant loosening. The patient presented severe bilateral deformity and we observed bilateral loosening of all components. The three groups do not differ significantly with respect to any of the analyzed variables (all p-values are greater than 5%); that is, the patients of the three groups do not have significant differences in the analyzed characteristics.

Table 1. Frequency distribution of the variables that characterize the patients of the three groups.

Characteristic	With stem n = 20		Without stem n = 14		Mixed n = 12		p-value of the test comparing the distributions of the three groups
	F	%	F	%	F	%	
Age							0.296
27 |- 37	0	0.0%	1	7.1%	0	0.0%	
37 |- 47	1	5.0%	0	0.0%	0	0.0%	
47 |- 57	2	10.0%	0	0.0%	6	50.0%	
57 |- 67	3	15.0%	4	28.6%	0	0.0%	
67 |- 77	10	50.0%	8	57.1%	4	33.3%	
77 |- 87	4	20.0%	1	7.1%	2	16.7%	
BMI							0.926
Underweight	2	10.0%	0	0.0%	0	0.0%	
Normal weight	0	0.0%	2	14.3%	2	16.7%	
Overweight	8	40.0%	6	42.9%	4	33.3%	
Obesity Class 1	6	30.0%	3	21.4%	2	16.7%	
Obesity Class 2	2	10.0%	0	0.0%	4	33.3%	
Obesity class 3	2	10.0%	3	21.4%	0	0.0%	
Profession							-
Retiree	0	0.0%	1	7.1%	0	0.0%	
Trucker	1	5.0%	0	0.0%	0	0.0%	
Salesperson	0	0.0%	1	7.1%	0	0.0%	
Cook	1	5.0%	0	0.0%	0	0.0%	
Daytime cleaner	1	5.0%	0	0.0%	0	0.0%	
Homeworker	13	65.0%	7	50.0%	8	66.7%	
Housekeeper	1	5.0%	1	7.1%	1	8.3%	
Cleaner	1	5.0%	0	0.0%	1	8.3%	
Woodworker	0	0.0%	0	0.0%	1	8.3%	
Sailor	0	0.0%	1	7.1%	0	0.0%	
Auto mechanic	0	0.0%	1	7.1%	0	0.0%	
Metalworker	1	5.0%	0	0.0%	0	0.0%	
Baker	1	5.0%	0	0.0%	0	0.0%	
Bricklayer	0	0.0%	1	7.1%	0	0.0%	
Painter	0	0.0%	0	0.0%	1	8.3%	
Secretary	0	0.0%	1	7.1%	0	0.0%	
Skin color							
White	8	40.0%	9	64.3%	3	25.0%	0.091
Brown	7	35.0%	2	14.3%	8	66.7%	
Black	5	25.0%	3	21.4%	1	8.3%	
Comorbidity							
SAH	20	100.0%	13	92.9%	10	83.3%	0.099
DM	2	10.0%	3	21.4%	2	16.7%	0.680
RA	2	10.0%	1	7.1%	1	8.3%	1.000
Hypothyroidism	0	0.0%	0	0.0%	1	8.3%	0.261
Lupus	0	0.0%	1	7.1%	0	0.0%	0.565
Fibromyalgia	0	0.0%	1	7.1%	0	0.0%	0.565
AIDS	1	5.0%	0	0.0%	0	0.0%	0.435
Visually impaired	0	0.0%	1	7.1%	0	0.0%	0.565
Hyperthyroidism	0	0.0%	0	0.0%	1	8.3%	0.261
ASA							0.779
1	2	10.0%	1	7.1%	0	0.0%	
2	18	90.0%	13	92.9%	12	100.0%	
Laterality							0.566
Right-handed	11	55.0%	5	35.7%	5	41.7%	
Left-handed	9	45.0%	9	64.3%	7	58.3%	
Etiology							0.151
Deformity	18	90.0%	9	64.3%	11	91.7%	
Ligamentous	2	10.0%	5	35.7%	1	8.3%	
Prior deformity							
Valgus	11	55.0%	3	21.4%	6	50.0%	0.131
Varus	9	45.0%	11	78.6%	6	50.0%	
Surgery time							0.300
2 years	12	60.0%	7	50.0%	4	33.3%	
3 years	2	10.0%	2	14.3%	2	16.7%	
4 years	3	15.0%	2	14.3%	2	16.7%	
5 years	3	15.0%	3	21.4%	3	25.0%	
8 years	0	0.0%	0	0.0%	1	8.3%	
Loosening							0.148
No	20	100.0%	12	85.7%	10	83.3%	
Yes	0	0.0%	2	14.3%	2	16.7%	

BMI: body mass index; SAH: systemic arterial hypertension; DM: diabetes mellitus; RA: rheumatoid arthritis; AIDS: acquired immunodeficiency syndrome; ASA: American Society of Anesthesiology Classification.

Figure 3. Total knee arthroplasty without stem in valgus deformity with tibial component loosening.

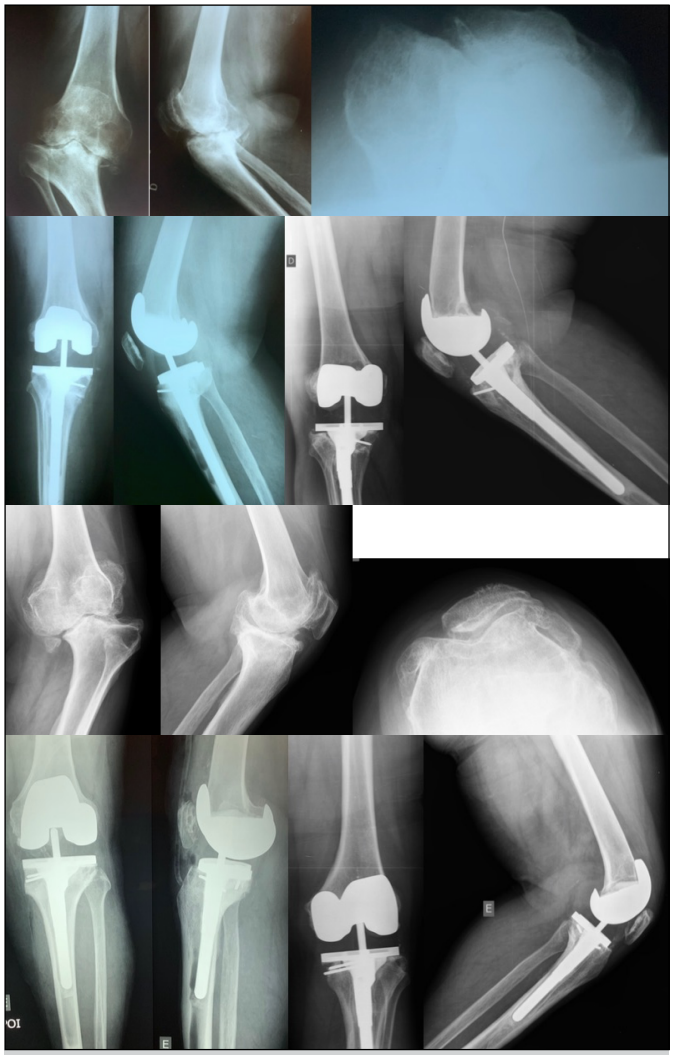

Figure 4. Total mixed knee arthroplasty with implants loosening.

Table 2 analyzes the total ROM before and after surgery. In Group 1, the ROM in the pre- and postoperative periods reached a mean of 103.5° and 105.5°, respectively. In Group 2, ROM in the pre- and postoperative periods reached a mean of 103.2° and 109.3°, respectively. As for Group 3, ROM in the pre- and postoperative periods reached a mean of 95.8° and 96.7°, respectively.

Table 2. Statistical analysis of the total angle of the range of motion in the pre- and postoperative periods of all groups.

Evaluation	Statistics	Procedure		
		stem (n = 20)	Without stem (n = 14)	Mixed (n = 12)
Preoperative	Minimum	65.0	50.0	30.0
	Maximum	135.0	130.0	120.0
	Median	105.0	107.5	100.0
	Mean	103.5	103.2	95.8
	SD	16.6	20.2	24.4
	CV	0.16	0.20	0.25
Postoperative	Minimum	80.0	90.0	60.0
	Maximum	135.0	120.0	120.0
	Median	110.0	110.0	100.0
	Mean	105.5	109.3	96.7
	SD	14.2	10.0	17.8
	CV	0.13	0.09	0.18
p-value of the Wilcoxon Test comparing pre-and post-operative measurements		0.671	0.319	0.686

Table 3 shows the angles of preoperative deformities subdivided by group and by type of deformity. In Group 1 , valgus deformities were all above 20°, mostly ranging from 38° to 47°. Also in G1, but for varus subgroup, deformities from 20° to 29° are highlighted. In Group 2 , valgus deformities ranged from 11° to 38° and varus deformities raged from 20° to 29°. In Group 3, the most frequent valgus deformities were found from 29° to 38°, and 47° to 58°; in the varus subgroup, the most frequent deformities ranged from 29° to 38°.

Table 3. Frequency distribution of angle measurements in prior deformities, by group and by type of deformity.

Axis angle (degrees)	With stem				Without stem				Mixed			
	Valgus (n = 11)		Varus (n = 9)		Valgus (n = 3)		Varus (n = 11)		Valgus (n = 6)		Varus (n = 6)	
	f	%	F	%	F	%	F	%	f	%	f	%
2 |- 5	0	0.0%	0	0.0%	0	0.0%	1	9.1%	0	0.0%	0	0.0%
5 |- 8	0	0.0%	1	11.1%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
8 |- 11	0	0.0%	1	11.1%	0	0.0%	1	9.1%	1	16.7%	0	0.0%
11 |- 20	0	0.0%	1	11.1%	1	33.3%	2	18.2%	1	16.7%	0	0.0%
20 |- 29	3	27.3%	3	33.3%	1	33.3%	5	45.5%	0	0.0%	1	16.7%
29 |- 38	2	18.2%	2	22.2%	1	33.3%	2	18.2%	2	33.3%	4	66.7%
38 |- 47	4	36.4%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
47 |- 58	2	18.2%	1	11.1%	0	0.0%	0	0.0%	2	33.3%	1	16.7%

Table 4 analyzes the femoral-tibial angles in the pre-and postoperative periods of the groups. The Wilcoxon test attests that the correction of deformity by the three groups is statistically significant with p-values of < 0.001, $= 0.035$ and $= 0.002$, respectively. The three groups underwent effective deformity correction.

Table 4. Statistical analysis of the angles of pre-and postoperative deformities in the three groups.

Evaluation	Statistics	With stem (n = 20)		Without stem (n = 14)		Mixed (n = 12)	
		Initial Deformity		Initial Deformity		Initial Deformity	
		Valgus	Varus	Valgus	Varus	Valgus	Varus
Preoperative	Minimum	20.0	□58.0	17.0	□31.0	10.0	□47.0
	Maximum	52.0	□5.0	36.0	□4.0	52.0	□28.0
	Median	40.0	□22.0	20.0	□20.0	30.5	□31.0
	Mean	36.2	□25.3	24.3	□19.3	31.8	□34.0
	SD	11.0	15.8	10.2	8.6	16.8	7.0
	CV	0.30	0.63	0.42	0.45	0.53	0.21
Postoperative	Minimum	3.0	5.0	5.0	□13.0	5.0	5.0
	Maximum	13.0	7.0	6.0	6.0	7.0	7.0
	Median	5.0	5.0	6.0	5.0	5.5	5.0
	Mean	5.8	5.4	5.7	3.6	5.7	5.3
	SD	2.5	0.7	0.6	5.5	0.8	0.8
	CV	0.43	0.13	0.11	0.83	0.14	0.15
p-value of the Wilcoxon Test comparing pre- and postoperative measurements		< 0.001		0.035		0.002	

DISCUSSION

As there are few studies on the topic,[1,4,5,8-15] we believe that our research is relevant and interesting to the orthopedic community. Anderson et al.[1] evaluated patients with primary TKA with a semi-constrained implant without intramedullary stem. The complication rate was low with a short- and medium-term follow-up. These authors question the use of intramedullary stems in constrained prostheses.[1] We have ratified this question and believe that there is room for the use of the semi-constrained implant without stem.

Anderson et al.[1] observed low incidence of radioluscent line and no progression on radiographs. Our study did not find significant difference in implant loosening.

Sculco[16] reports that the use of stems increases the cost between 350 and 500 dollars. Also, complications when using stems, such as pain at the tip of the stem and the risk of embolization should be highlighted.

TKA without stem and with varus and valgus restriction is safe in selected cases; furthermore, it is cheaper and can reduce operative time and preserve bone stock.[15] We believe that treatment should always be individualized, and we emphasize the importance of preoperative planning.

The tibial constrained polyethylene has a higher and central post; as such, there is a greater fit in the femoral component box reducing varus-valgus translation and rotational movement.[12] Our study evaluated an implant with varus and valgus restriction. There is a study that evaluates a constrained polyethylene in a primary implant,[17] however, this is not the scope of our work.

Nam et al.[5] indicated the semi-constrained implant for patients with severe bone deformity and ligament instability. Our research confirms these indications, and we further highlight that there is a predominance of severe cases in our study.

Ruel, Ortiz, and Westrich[9] observed the loosening of the femoral component in semi-constrained stemless implants. Therefore, these authors recommend the use of stems in patients with osteopenia. We believe the prosthesis model is responsible for the femoral component loosening. In our research, tibial component presented the highest rate of failure. We obtained two cases of tibial component loosening in the Group 2, as well as a patient with bilateral mixed prosthesis who presented loosening of all components.

Macdessi et al.[10] report four cases of aseptic loosening of the femoral component in semi-constrained stemless implants. In this study, three patients reported trauma prior to implant loosening. The authors conclude that a stemless semi-constricted prosthesis should be cautiously used. In addition, they mention that this prosthesis model has a larger femoral bone resection. We agree that this type of implant has a deeper femoral box to absorb polyethylene with a larger post. Thus, there is a greater risk femoral component loosening when a stem is not used; however, we did not observe any isolated cases in our sample.

Nam et al.[5] report excellent clinical results with a semi-constrained prosthesis without a stem. They concluded that it is an excellent option in patients with ligament instability. The femoral region obtained the highest rate of loosening. Our indications of this model of prosthesis with ligamentous instability also showed good results. Our patients obtained an overall postoperative range of motion above 96.7° in the three groups.

In severe valgus knees, the semi-constrained stemless implant is a good option.[4] Anderson et al.[4] observed a low rate of complications. Our rationale is that in severe valgus deformity, ligaments may fail , as well as bone loss. As such, the most constrained implant can be an excellent option in some cases. In our research, varus deformity was more frequent.

Moussa et al.[13] recommend the cautious use of the stemless semi-constricted implant. They report that this model of prosthesis is used in more complex cases; however, they also observed that the revision rate is twice as high when compared with less constrained implants. In our opinion, comparing a more constrained prosthesis versus an already stabilized model is inappropriate. We have no doubt that a less constrained implant has a longer survival; however, there are cases in which this type of prosthesis does not generate good stability.

Padgett et al.[11] analyzed 56 knees that were revised after the use of a stemless semi-constrained implant. These prostheses were revised with a mean follow-up of 21.2 months. The causes of revision were: infection 34%, instability 21%, aseptic loosening 18%, stiffness 11%, recurrent synovitis 9%, and unknown cause 7%. According to these authors, all polyethylenes presented some wear regardless of the failure etiology.[11] We believe that that some causes of failure Padgett et al. study may had masked the bad results of the implant.

Nazarian, Mehta, and Booth[8] analyzed patients undergoing TKA revision with and without intramedullary stem. The analysis of bone quality, component fixation, and ligament integrity based the decision to use the stems. They conclude that there was no significant difference in implant failure between the groups; however, they observed a higher rate of tibial component loosening with or without a stem.[8] In the TKA review we preferred the use of stems.

Jordan, Kligman, and Sculco[18] evaluated patients with poliomyelitis undergoing TKA. Implant with varus and valgus restriction with and without stems were used. They conclude that the topic is controversial; however, they did not observe any clinical or radiographic benefit with the use of the stem.[18] Even though we ratify their statements, in a patient with poliomyelitis, we would probably use a more constrained prosthesis.

Our study has a minimum follow-up of two years postoperatively based on the research of Moussa et al.[14]

Other semi-constrained prostheses from other models and manufacturers were used over several years in our hospital; however, none of them were used in scale and effectiveness as the TC3 Depuy Johnson®. Thus, the choice of implant for analysis is justified, not presenting any type of conflict of interest in the evaluation.

<< SUMÁRIO

In contrast Moussa et al.[14] evaluated four models of prostheses. We believe that multiple implant models could bias the research. The limitations of our research are because it is a retrospective and short-term study. Furthermore, some indications of a more constricted prosthesis were decided in the intra-operative act. We know that a simple radiographic analysis can mask an instability.

CONCLUSIONS

In general, preoperative deformities were considered severe. In the postoperative period, the total range of motion was above 96.7°. The postoperative femoral-tibial angle obtained a mean ranging from 5° to 6° of valgus. There is no significant difference in implant loosening in the three groups.

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EPIDEMIOLOGICAL PROFILE OF PROXIMAL FEMORAL FRACTURES IN OLDER ADULTS AT THE REGIONAL HOSPITAL IN COTIA – SP, BRAZIL

PERFIL EPIDEMIOLÓGICO EM FRATURA DE FÊMUR PROXIMAL DE IDOSOS NO HOSPITAL REGIONAL DE COTIA – SP

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ABSTRACT

Objective: To identify the epidemiological profile of older patients with proximal femoral fractures treated at the Hospital Regional de Cotia, SP – Brazil, and describe the nutritional status of these patients. Methods: Data were obtained from the electronic patient medical records from August 2020 to April 2021. The variables studied were age, gender, ethnicity, weight and height (for BMI calculation), and presence of comorbidities. Fracture circumstances were also assessed, including trauma mechanism, anatomical location, and treatment. Moreover, the nutritional profile of patients was assessed using the Mini Nutritional Assessment (MAN). Results: Most patients were white women, with a mean age of 80 years and an average BMI of 23.55 kg/m^2. Almost all patients suffered the fracture at home and the most common comorbidities were systemic arterial hypertension, *diabetes mellitus*, and Alzheimer's disease. Most patients were considered to be malnourished or at risk of malnutrition. Conclusion: The nutritional status of older adults seems to be directly related to the risk of proximal fractures of the femur. ***Level of Evidence II, Retrospective Study.***

Keywords: Orthopedics. Epidemiology. Femoral Fractures. Femur. Malnutrition.

RESUMO

Objetivo: Traçar o perfil epidemiológico dos pacientes idosos com fratura de fêmur proximal atendidos no Hospital Regional de Cotia – SP, além de descrever o estado nutricional desses pacientes. Método: As informações para confecção deste trabalho foram obtidas a partir dos prontuários eletrônicos dos pacientes atendidos no período agosto de 2020 a abril de 2021. As variáveis estudadas foram: idade, sexo, etnia, peso e altura (para cálculo do índice de massa corporal – IMC) e presença de comorbidades. Também foram avaliadas as circunstâncias da fratura, tais como mecanismo do trauma, localização anatômica e tratamento instituído. Ainda, avaliou-se o perfil nutricional dos pacientes por meio da Mini Avaliação Nutricional (Mini-MAN). Resultados: Predominaram pacientes do sexo feminino, brancas, com média de 80 anos de idade e IMC médio de 23,55 kg/m^2. Quase todos os pacientes se acidentaram em casa, e as comorbidades mais observadas foram hipertensão arterial sistêmica, diabetes mellitus e doença de Alzheimer. A grande maioria dos pacientes foi considerada desnutrida ou em risco de desnutrição. Conclusão: O estado nutricional dos idosos parece estar diretamente relacionado ao risco de fraturas proximais do fêmur. ***Nível de Evidência II, Estudo Retrospectivo.***

Descritores: *Ortopedia. Epidemiologia. Fraturas do Fêmur. Fêmur. Desnutrição.*

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INTRODUCTION

For the World Health Organization (WHO) and the Brazilian Ministry of Health, based on the legal framework of the National Health Policy for the Elderly and the Statute of the Elderly, all individuals aged 60 years or older are biologically considered as older adults.[1] Estimates show that more than 2 billion people will be older than 60 years by 2050, indicating how population ageing is a worldwide phenomenon. Brazil, for example, has a marked growth rate of approximately 260,000 new older adults per year. The probability of falling is higher at this stage of life, which has been showing aggravating incidence of hip fractures.[2]

Life expectancy has been increasing mainly because of better living conditions and the constant advancement of modern medicine. Aging, however, implies several problems, including fractures in the proximal region of the femur – a common and relevant cause of morbidity and mortality in older people.[3]

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

The study was conducted at Hospital Regional de Cotia.
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Estimates show that in 2050 about 6.5 million hip fractures will occur worldwide[1]. The incidence of these fractures among older adults is increasing especially due to osteoporosis but also to other risk factors, such as the presence of diseases and comorbidities, previous history of falls, smoking, and body mass index under 18.5 kg/m^2.[2-4]
Osteoporosis is a state of health characterized by increased risk of fracture from weakened bone tissue structure. When individuals suffer their first fracture caused by fragility, they are diagnosed with "established osteoporosis". From then on, they have a higher risk of fracture occurrence than patients with no previous fracture, requiring more intensive therapeutic intervention.[1]
Femoral fracture is among the most common traumatic injuries in older adults and may occur in the proximal, distal, or femoral diaphysis regions. Since the bone can transfer load during movement, a fracture results in loss of bone structural integrity. Older adults who remain immobilized for long periods of time thus become weaker, with lower functionality. Proximal fracture is the most common type of femoral fracture, being classified as intracapsular or extracapsular.[5]
Intracapsular fractures are identified as femoral neck fractures while extracapsular fractures are the transtrochanteric, out of which the most common are intertrochanteric fractures. These proximal femoral fractures are considered a serious problem in public health because of the high economic costs for their treatment and their high morbidity and mortality rates.[5]
The natural decline of physiological functions in aging leads to a lower absorption and metabolism of nutrients and several other natural transformations, including increased body fat and reduced bone mass and lean muscle mass. Social and economic issues also hinder achieving a healthy diet and maintaining an adequate nutritional status, thus increasing the risk of malnutrition.[6]
Besides malnutrition and its complications, other factors which affect the nutritional status of older people are the use of various medications (polypharmacy), routine changes (habits, schedules, and environments that impair adequate food intake), and lack of adequate nutritional assessment and monitoring. Nutritional assessment at admission decreases the risk of developing malnutrition during hospitalization and prevents worsening of the clinical picture in already malnourished patients.[6] Establishing early nutritional diagnosis with appropriate tools and resources available in the hospital is therefore essential.
The nutritional assessment of older people should be conducted judiciously, considering the changes caused by senescence in body composition. As an example, if an older adult has a slight decrease in weight and height, these data should not be interpreted as pathological. Their weight decreases because of the loss of bone and muscle mass and the physiological reduction of appetite, whereas height changes over the decades – mainly due to pes planus, decreased height of vertebrae and intervertebral discs, and postural changes. Several tools can be used for the nutritional assessment of older people.[7]
This study aimed to describe the epidemiological profile of proximal femoral fracture in older adults at the Hospital Regional de Cotia – SP and to describe the nutritional status of these individuals.

MATERIAL AND METHODS

A retrospective study was conducted to describe the profile of older patients with femoral fracture at the Hospital Regional de Cotia – SP using data collected from the Tasy® electronic medical record from August 2020 to April 2021. Inclusion criteria were patients aged 60 years or older with proximal femur fracture and who agreed to participate in the study by signing an informed consent form (ICF). The exclusion criteria were patients with subtrochanteric, diaphyseal, or distal femoral fractures, high-energy trauma mechanism (such as motorcycle accident, gunshot wound), older than 100 or younger than 60, and who did not sign the ICF.
The analyzed variables were age, gender, ethnicity, weight and height (to calculate BMI), and presence of comorbidities. Fracture circumstances were also analyzed, including trauma mechanism, anatomical location, and assigned treatment. The nutritional profile of older patients was assessed via Mini Nutritional Assessment (MNA),[8] which classifies the nutritional state of patients as "normal," "at risk of malnutrition," or "malnourished" by a score scale. Anthropometric data such as body mass index (PAHO) were also collected.

RESULTS

In total, 48 patients were assessed, out of which 34 (71%) were women and 14 (29%) were men (Figure 1). On ethnicity, 43 (90%) patients considered themselves white and five (10%) considered themselves black (Figure 2).

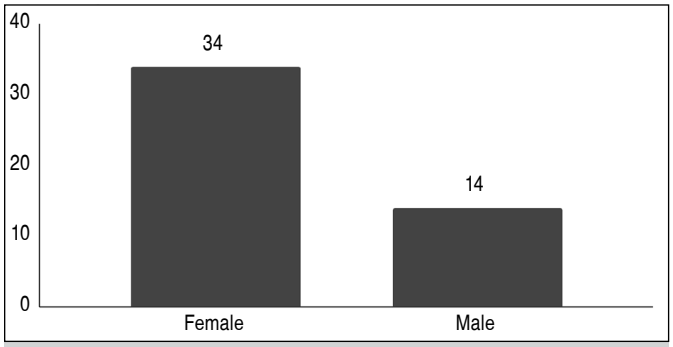

Figure 1. Patient distribution by gender.

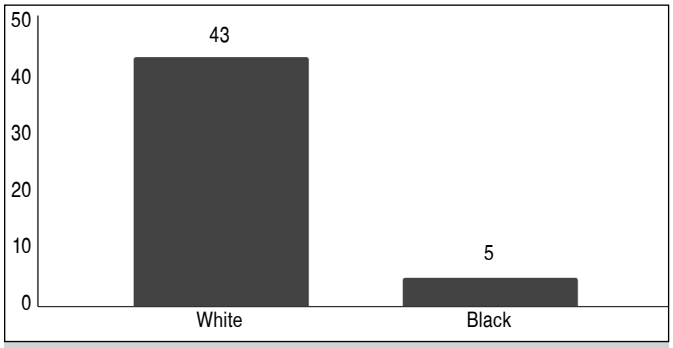

Figure 2. Patient distribution by ethnicity.

Of all patients, 47 (98%) suffered the fracture at home and one (2%) suffered it outside (Figure 3). The most common type of fracture was femoral neck fracture (26 cases – 56%) and the second most common were transtrochanteric fractures (22 cases – 46%) (Figure 4). All patients underwent surgical treatment.

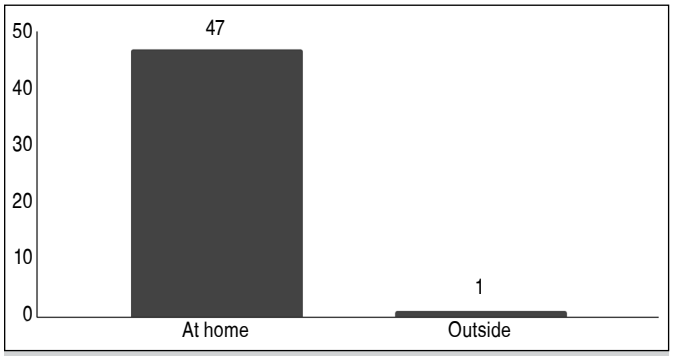

Figure 3. Distribution of fracture occurrence.

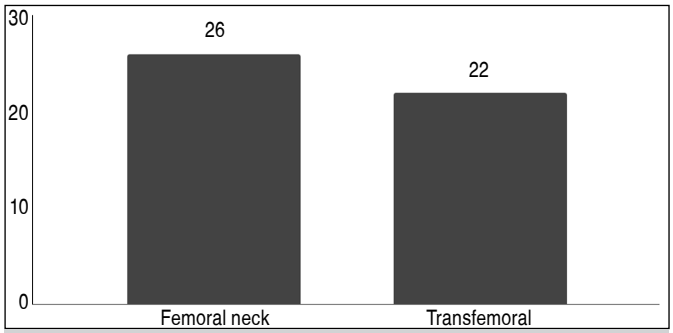

Figure 4. Patient distribution by fracture site.

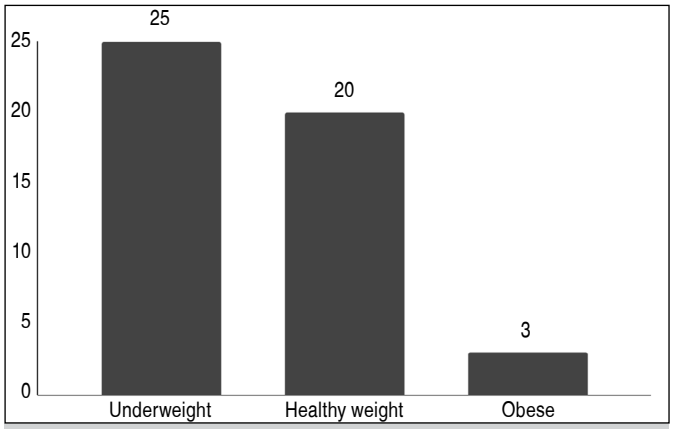

Figure 5. Patient distribution by BMI.

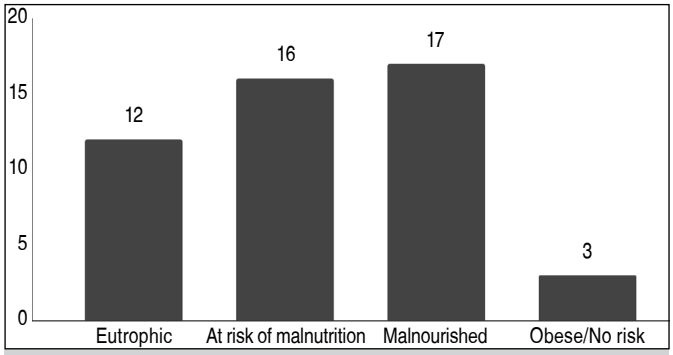

Figure 6. Patient distribution according to MAN scale.

Regarding body mass index (BMI), 25 patients (52%) were underweight, 20 had healthy weight (42%), and three were obese (6%) (Figure 5).
The MNA scale assessment found that 12 patients (25%) were eutrophic, 16 (33%) were at risk of malnutrition, 17 (35%) were malnourished, and three (6%) were obese (Figure 6).
Of all patients, one (2%) denied having any type of comorbidity, 24 (50%) had only one comorbidity, 19 (40%) had two, and four (8%) had three (Figure 7). For the comorbidities observed, 26 patients (54%) had Systemic Arterial Hypertension (SAH), 11 (23%) had *diabetes mellitus* (DM), three (6%) had hypothyroidism, one (2%) had a brain tumor, one (2%) suffered an Acute Myocardial Infarction (AMI), two (4%) had Congestive Heart Failure (CHF), three (6%) had chronic kidney disease (CKD), one (2%) suffered a cerebrovascular accident (CVA), three (6%) had arrhythmias, one (2%) was alcoholic, eight (17%) had Alzheimer's disease (AD), two (4%) had dementia, two (4%) had depression, one (2%) was obese, one (2%) had multiple osteochondromas, and one (2%) denied having any type of comorbidity. Three (6%) individuals died during the study (Figure 8).

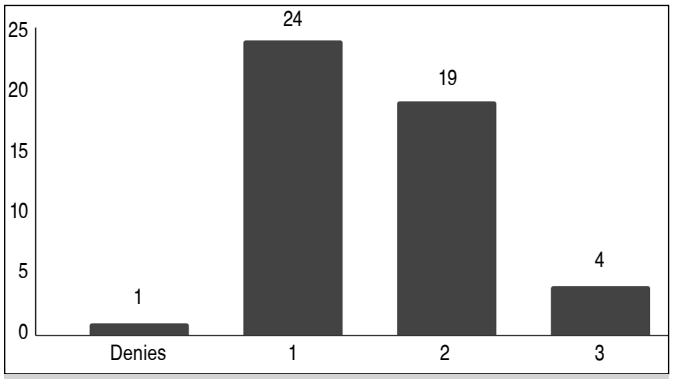

Figure 7. Patient distribution by number of comorbidities.

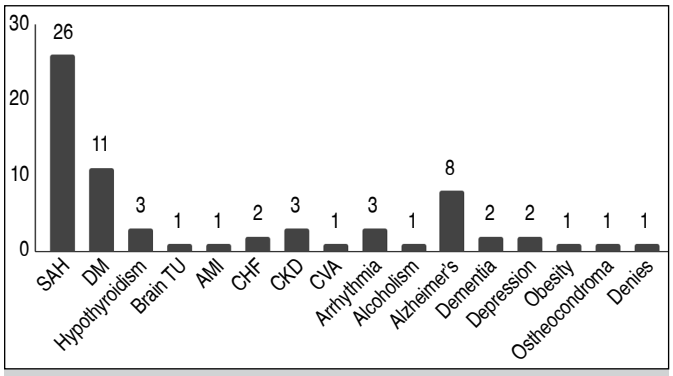

Figure 8. Patient distribution by comorbidities presented.

Regarding dispersion measures, the maximum age of patients was 99 years, the minimum was 62 years, and the mean age was 80.25 years. The mean BMI was 23.55 kg/m^2, with a minimum of 12.05 kg/m^2 and a maximum of 34.21 kg/m^2. The mean number of comorbidities was 1.54, with a minimum of 0 and a maximum of 3. Table 1 summarizes these results.

Table 1. Dispersion of data related to age, BMI, and number of comorbidities.

Variables	Minimum	Maximum	Mean
Age (years old)	62	99	80.25
BMI (kg/m^2)	12.05	34.21	23.55
Number of comorbidities	0	3	1.54

DISCUSSION

This study showed that most patients with proximal femoral fractures were Caucasian women. The proportion found in this study was similar to that found by Daniachi et al.,[9] who assessed the epidemiology of fractures in the proximal third of the femur. According to the authors, for each man, three women have proximal femoral fractures. Furthermore, the percentage obtained in this study for sex and ethnicity was similar to that of Machado et al.[10]
Corroborating the results of Daniachi et al.[9] on location of fracture occurrence, almost all injuries of patients occurred at home, where older people spend most of their time. This could be associated with the comorbidities found in the group of patients assessed.
In this study, most fractures were femoral neck fractures and the remaining cases were transtrochanteric fractures. In the study by Daniachi et al.,[9] femoral neck fracture was the second most observed type of injury, while transtrochanteric fractures were the most common. This could be related to the most frequent trauma mechanisms in each sample.

<< SUMÁRIO

Most of the older patients assessed in this study were underweight, others had healthy weight, and a few were obese. In their case-control study, Pagani et al.[11] showed that older patients with lower BMIs were precisely in the group of those who suffer the most fractures. Corroborating these results, Alfaro-Acha et al.[12] reported that body weight and risk of fracture of the proximal femoral extremity are inversely related. The authors also reported that a 10% weight loss significantly increased the risk of hip fracture in people aged 65 years or older. These suggest that our results are mainly determined by the deficient nutritional status of patients.

The MAN scale found similar percentages of malnourished older adults and older adults at risk of malnutrition, which represent, respectively, the first and second most observed findings. Dias et al.[13] found that most of their patients were also malnourished or at risk of malnutrition, showing that the nutritional status of older adults is related to the risk of femoral fractures.

Regarding the number of comorbidities per patient, most patients had only one comorbidity, followed by those with two comorbidities. In their study, Hungary Neto et al.[3] found a similar scenario, in which most individuals in the age group analyzed already had at least one comorbidity – mainly SAH, DM, and osteoporosis. In our study, the most observed comorbidities were, respectively, SAH, DM, and Alzheimer's disease. Our results differ from those of Dias et al.,[13] who indicated that SAH, DM, Alzheimer's, and osteoporosis are diseases typically related to older adults.

The death rate observed in our study can be considered low. According to Mesquita et al.,[14] mortality rates in this group of patients range from 7.4% to 34.8%.

Finally, the dispersion measurements obtained for age, BMI, and number of comorbidities were similar to those obtained by Hungary Neto et al.[3]. This shows that in groups of older adults from different localities and analyzed in different years, those who suffered fractures of the proximal third of the femur can have similar characteristics.

CONCLUSION

In this study, most patients were women (3:1) with a mean age of 80 years, Caucasian, underweight, and with at least one associated comorbidity – mainly SAH, DM, and Alzheimer's. Most fractures occurred when patients were at home, the most common being the proximal femoral fracture. Furthermore, considering that patients malnourished or at risk of malnutrition were most likely to suffer fractures, the nutritional status of the patients was directly related to fracture risk.

AUTHORS' CONTRIBUTIONS: Each author contributed individually and significantly to the development of this article. SAEF, WFN, MK, HVRQ, JKKF, REI: study conception and design, analysis and interpretation of the data, writing of manuscript and critical review of its intellectual content, and final approval of the final version of the manuscript.

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EPIDEMIOLOGY OF OPEN FRACTURES AND DEGREE OF SATISFACTION OF INITIAL CARE

EPIDEMIOLOGIA DAS FRATURAS EXPOSTAS E GRAU DE SATISFAÇÃO DO ATENDIMENTO INICIAL

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ABSTRACT

Introduction: Open fractures, although uncommon, with trauma have costs that exceed all other reasons for hospitalizations. Its epidemiology has fundamental importance to plan treatment and define priorities. Objective: To assess prospectively the epidemiological profile of open fractures and the degree of satisfaction with initial care. Methods: Epidemiological, prospective, descriptive, observational study was carried out in a convenience sample of open fractures. Quantitative, qualitative, and epidemiological aspects regarding open fractures were evaluated, as well as the degree of satisfaction with the initial care. Results: 124 patients treated with 155 open fractures. 88% were male; mean age 43 years (± 42.99); non-white (56.72%); married (52.41%); low level of education (51.60%); farmer, self-employed, bricklayer, industrialist (51.60%); with monthly earnings of up to 2 minimum wages (87%); healthy (76.13%); victims of labor accidents (39.51%) in bones of the hands (58.02%); 55% on the left side; attended between Thursday to Saturday (50%); work shift 6 a.m.–6 p.m. (77%). There was high level of satisfaction with the initial care provided (98%). Conclusion: Open fractures were related to healthy men, 43 years old, low education and low income, predominant in upper limbs, at 6 a.m. to 6 p.m., from Thursday to Saturday. Most were satisfied with the service provided. ***Level of Evidence II, Epidemiological, prospective, descriptive, observational study.***

Keywords: Accidents, Traffic. Epidemiology. Prospective Studies. Fractures. Open. Motorcycles.

RESUMO

Introdução: As fraturas expostas, apesar de pouco comuns, têm custos que superam todos os outros motivos das internações. Sua epidemiologia é de fundamental importância para planejar o tratamento e definir prioridades. Objetivos: Avaliar prospectivamente o perfil epidemiológico das fraturas expostas e o grau de satisfação do atendimento inicial. Métodos: Estudo epidemiológico, prospectivo, descritivo, observacional, em amostra de conveniência das fraturas expostas. Avaliaram-se aspectos epidemiológicos quantitativos e qualitativos das fraturas expostas e o grau de satisfação com o atendimento inicial. Resultados: Foram atendidos 124 pacientes com 155 fraturas expostas. Desses, 88% eram do sexo masculino com média de idade 43 anos (± 42,99); não branco (56,72%); casado (52,41%); com baixo nível de instrução (51,60%); agricultor, autônomo, pedreiro ou industriário (51,60%); com ganho mensal de até dois salários-mínimos (87%); hígidos (76,13%); vítimas de acidentes trabalhistas (39,51%) nos ossos das mãos (58,02%); especialmente do lado esquerdo (55%); atendidos entre quinta-feira e sábado (50%); no período diurno (77%). Esses pacientes mostraram elevado nível de satisfação com o atendimento inicial realizado (98%). Conclusões: As fraturas expostas se relacionaram com homens hígidos, em torno de 43 anos, baixo grau de instrução e baixa renda, nos membros superiores, no período diurno de quinta a sábado. A maioria ficou satisfeita com o atendimento prestado. ***Nível de Evidência II, Estudo Epidemiológico, Prospectivo, Descritivo e Observacional.***

Descritores: *Acidentes de Trânsito. Epidemiologia. Estudos Prospectivos. Fraturas Expostas. Motocicletas.*

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INTRODUCTION

Open fractures are uncommon and present variable occurrence, from 2.6%[1] to 23.5%[2] of fractures. In the United States, open fractures were estimated to represent an annual cost of US$ 230 million.[3] In Brazil, public spending on trauma, including open fractures, exceed all other reasons for hospitalizations.[4] Therefore, the main effect of open fractures and fractures in general is economic, because of social security costs with health and labor burdens,

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

The study was conducted at Hospital das Clínicas Samuel Libânio and Universidade do Vale do Sapucaí.
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as well as loss of productive capacity.[5] Open fractures are still more related to a worse prognosis than closed fractures.[6] Understanding the epidemiology of open fractures is crucially important for reference treatment centers for patients with this complex range of traumas, as this information can be used to plan treatments and define priorities.[2,6] The prognosis of patients treated in a trauma center is directly related to the quality of medical care provided, the speed such care is provided, and the established doctor-patient relationship, proven to be markers of good results in the medium- and long-term follow-up of these patients.[7] The Brazilian literature lacks of prospective studies on the incidence of open fractures and their consequent complications.[8] The socioeconomic and cultural profile of different populations influences the causes of open fractures in each region.[9] Thus, the epidemiological profile of injuries of a given region cannot be applied throughout Brazil, a large country with different realities and needs in each location. Due to the lack of epidemiological studies regarding trauma in our region, this study emerged to identify causal factors and favor targeted public policies of prevention.

METHODS

An epidemiological, prospective, descriptive, and observational study was performed on a convenience sample of open fractures treated at a regional reference university hospital (Hospital das Clínicas Samuel Libânio, Pouso Alegre, Minas Gerais). Data were collected from May 2019 to April 2020. This study was approved by the Research Ethics Committee, under protocol no. 3,345,548, on May 24, 2019. All patients agreed to participate in this study and spontaneously signed an information letter and the informed consent form.

All patients treated for open fracture were included and no restrictions were made regarding gender, fracture location, or associated injuries such as other closed fractures, vascular lesions of peripheral, abdominal, thoracic, cranial, maxillofacial, and cutaneous nerves. Excluded patients were those with initial care in other orthopedic services and later referral to our service for follow-up, death before undergoing an orthopedic surgery, evasion before hospital discharge, cognitive impairment (including caused by trauma) without legal representation, age under 18 years old, and refusal to sign the informed consent form. After receiving initial care from the trauma team and being cleared for traumatological and orthopedic treatment, all patients were subjected to an initial evaluation of the open fracture and classified, when anesthetized, according to the degree of exposure by the Gustilo-Anderson classification,[10] modified by Gustilo, Mendonza, and Williams.[11] Data were collected the day after the initial care, after the urgency. For patients who did not need to be hospitalized, the collection was made at the end of the care. Data were collected based on qualitative and quantitative demographic variables and epidemiological data related to open fractures: origin, profession, previous comorbidities, injuries associated with the trauma, trauma mechanism, distribution of open fractures regarding day, month, and time, aid providers, time until arrival at the hospital and time in the hospital until the beginning of the orthopedic treatment, established treatment, hospitalization time, and rating for the initial care. To evaluate the grade, a numerical satisfaction scale was used, classifying the care as 0–2 extremely poor, 3–4 bad, 5–6 average, 7–8 good, and 9–10 excellent. Data were tabulated in Microsoft Excel 2016 and subjected to statistical analysis. Minitab version 18.1 and Statistical Package for the Social Sciences (SPSS), Chicago, USA, version 22.0 were used.

RESULTS

A total of 124 patients and 155 open fractures were treated (20 patients with more than one open fracture), eight of which were polytraumatized. Of all patients, 109 (88%) were men and 15 (12%) were women, all aged from 18 to 101 years old. The mean age was 43 years old (± 42.99). No age group presented significant statistical difference from others, but, in absolute numbers, the group that suffered most open fractures was from 51 to 60 years old. Table 1 shows data from qualitative variables. The highest frequencies are non-whites (66 patients, 53.22%), patients with primary education (50.8%), and married people (65 patients, 52.41%).

Table 1. Frequency of qualitative demographic variables.

Demographic characteristics	N	%	p
Skin color (n = 124)			
White	58	45.77	0.00
Non-white	66	53.22	
Schooling level (n = 124)			
Illiterate	1	0.8	0.00
Primary education	63	50.8	
Secondary education	51	41.12	
Higher education	9	7.25	
Marital status (n = 124)			
Married	65	52.41	0.00
Single	46	37.09	
Separated	11	8.87	
Widower or widow	2	1.61	

Most patients treated were from the region where the hospital is a reference (63 patients, 50.80%) and not from the city where the Hospital is located (53 patients, 42.74%). Only eight patients (6.45%) were from other region or state. The main affected professions, which constituted 51.60% of all fractures, were farmers, self-employed workers, masons, and industrialists. A total of 108 patients (87%) had monthly income up to two minimum wages, 14 patients (11%) earned from two to five minimum wages a month and only two patients (1.6%), more than five minimum wages.

Only 37 patients (23.87%) had comorbidities, of which arterial hypertension was the most prevalent (42%) (Figure 1), and 17 patients (13.70%) had other associated injuries, of which closed fractures was the most frequent (Figure 2). The trauma mechanisms most related to open fractures were work-related accidents (Table 2), with equal distribution between crushing (blunt trauma) and blunt injuries. Half of the cases occurred from Thursday to Saturday (statistically significant), with higher frequency in November, January, and July (statistically non-significant) during daytime (77% of the cases) (Table 3). A percentage of 51.83% of the patients were taken to the hospital by family members and strangers, and most patients (62.90%) arrived at the hospital within 60 minutes. Upper limbs were the most affected by open fractures (64.51%) and fractures of the bones of the hands represented 58.02% of all fractures (Figure 3), most of them being a type III open fracture, according to Gustilo and Anderson[10] (Table 4). A total of 55% of the fractures were on the left side of the body. Once in the hospital, patients underwent early total care within 5 h, with predominance of resolution within the first 30 minutes (Figure 4). The main treatment was suture and dressing. The mean hospitalization time was 3.63 days, but most patients were hospitalized for only one day or not even got hospitalized (Figure 5). A total of 98% of the patients rated the initial care as good or excellent, 66% of them giving a 10 rating for the care. Only 1.6% of the patients considered the initial care from poor to average, but no one rated it lower than a 3 rating.

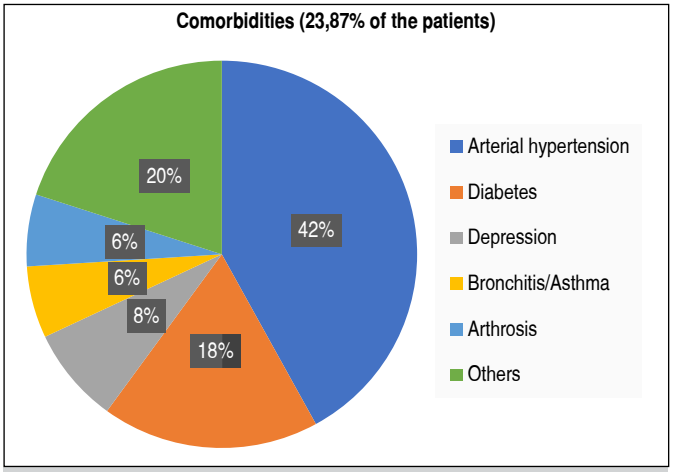

Figure 1. Comorbidities.

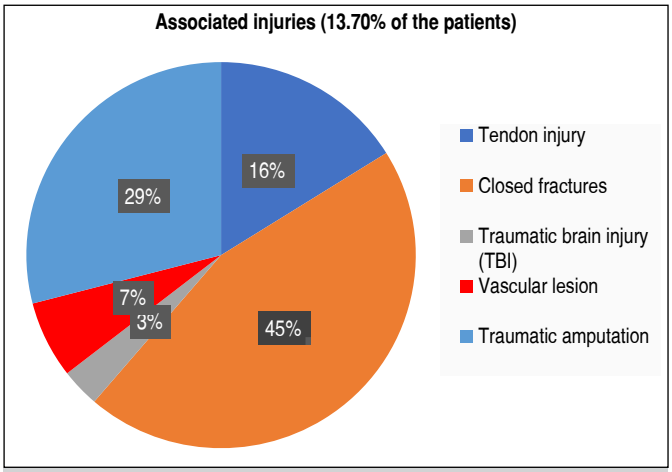

Figure 2. Associated injuries.

Table 2. Trauma mechanisms of open fractures.

CAUSE	n	%	p
Work-related trauma	49	39.51	0.00
Motorcycle	21	16.93	
Motor vehicle	15	12.09	
Fall	12	9.67	
Accident in rural areas	10	8	
Domestic trauma	9	7.25	
Aggression	2	1.61	
Dog bite	2	1.61	
Explosive material	2	1.61	
Gunshot wound	1	0.8	
Hit-and-run accident	1	0.8	
TOTAL	124	100%	

Table 3. Distribution of open fractures according to the day of the week, month, and time.

DAY	n	%	p
Monday	17	13.7	0.83
Tuesday	15	12.09	
Wednesday	17	13.7	
Thursday	22	17.74	
Friday	21	16.93	
Saturday	19	15.32	
Sunday	13	10.48	
MONTH	**n**	**%**	**P**
January	15	12.09	0.00
February	8	6.45	
March	2	1.61	
April	2	1.61	
May	9	7.25	
June	10	8.06	
July	17	13.7	
August	9	7.25	
September	6	4.83	
October	14	11.29	
November	22	17.74	
December	10	8.06	
TIME	**n**	**%**	**P**
06:01–12:00	50	40.32	0.00
12:01–18:00	46	37.09	
18:01–00:00	20	16.12	
00:01–06:00	8	6.45	

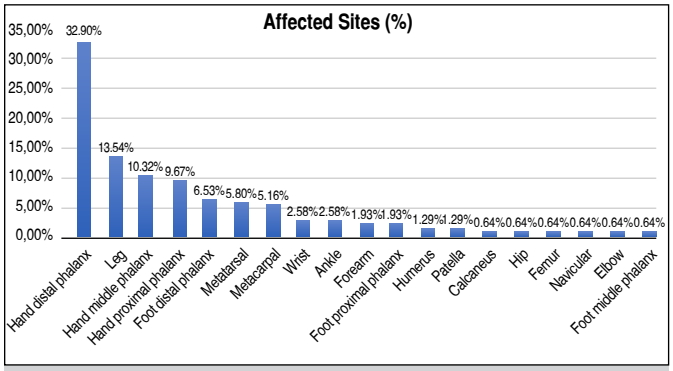

Figure 3. Bones affected.

Table 4. Distribution of open fractures regarding degree of exposure.

GUSTILO	Frequency	%	p
Type I	24	15.48	0.00
Type II	57	36.77	
Type IIIA	65	41.93	
Type IIIB	7	4.51	
Type IIIC	2	1.29	
TOTAL	155	100%	

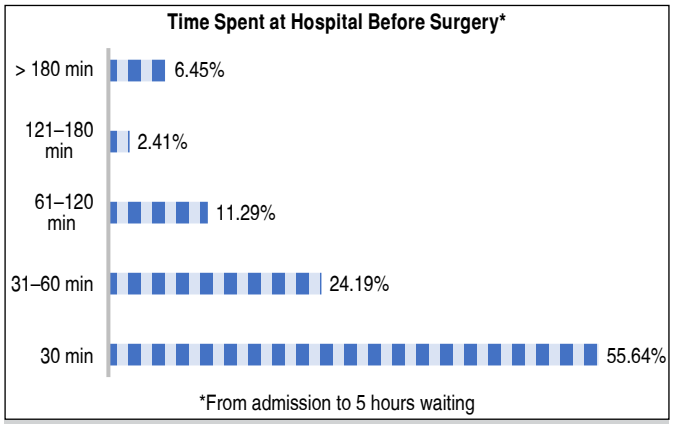

Figure 4. Time in the hospital until surgery.

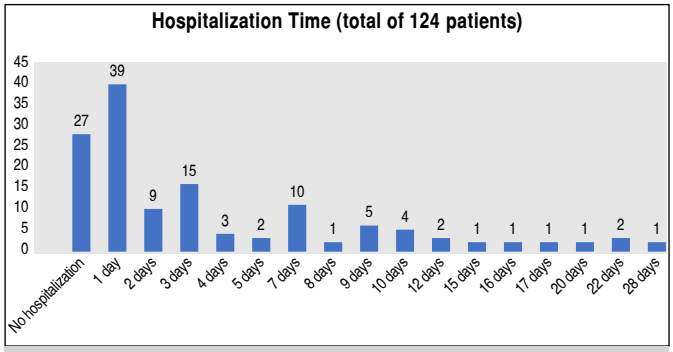

Figura 5. Hospitalization period.

DISCUSSION

Performing studies that consider variables related to the public treated daily in our public emergency health systems is extremely important.[9,12] However, studies similar to this tend to be rare and old, as the most recent ones prioritize other goals such as assessing the efficacy of therapeutic approaches and classifications.[13]

The main population with fractures is economically active and it may burden the public purse.[13] This is the reason why our study assess open fractures exclusively in the legally major population to assess the economically active patients, different from other studies that included children. No patient refused to participate in this study.

When the patient was anesthetized for treatment, we classified the open fracture. We used the Gustilo-Anderson classification of open fractures[10], modified by Gustilo, Mendonza, and Williams.[11] Although this classification is little reproduced[14] and its interobserver reliability is considered moderate to weak,[14,15] it is the most recognized and used classification worldwide, as it is easy to memorize and endorsed by the literature and clinical practice. We considered open fractures of the forearm, leg, and ankle as a single bone fracture since these region behave as a functional unit. Gustilo's type IIIA fractures were more frequent (41.93%) (statistically non-significant) (Table 4).

The skin color did not cause differences. Arruda et al.[8] observed higher incidence in non-whites, different from what was found by Muller et al.[16] (83.76% were white).

A feature in common national epidemiological studies of open fractures highlight is that the affected patients are, in general, those with low schooling, including a high illiteracy rate.[8,16,17] The schooling level of the patients assessed in our study was similar to these studies, since more than half of the patients (50.80%) completed all or part of primary education, but only 0.8% were illiterate. Patients with low schooling level tend to have low professional qualification, perform manual labor activities, and be exposed to risky activities. Another common feature of this and other studies that assessed the income of patients with open fractures is that most have low income.[7,17]

In our study, we observed no difference between married and single patients with open fracture. In places with a large number of vehicles, especially motorcycles, the most affected patients were single men.[18,19] On the other hand, in places where patients presented higher mean age, most of them were married.[16,20]

In this study, minors were excluded and the mean age of patients with open fractures was 43 years old. Most studies that assessed open fractures included children and, perhaps because of that, they presented lower mean age, around 30 years old, and the most affected age group was from 20 to 30 years old.[8,9,13,16,19]

A total of 108 patients (88%) were men. This male predominance is similar to what occurs in all literature,[11,16] in which men are predominant in trauma because they present a risk behavior potentially exposed to accidents. Arterial hypertension was the most frequent comorbidity (37 patients, 23.87%), just as in other epidemiological studies of open fractures,[7,19] but it was statistically equivalent to other comorbidities.

The most affected patients were farmers (23.38%), self-employed workers (11.29%), masons (8.87%), and industrialists (8.06%). These four professions represented more than half of the professions affected by open fractures (51.60%). The presence of masons and industrialists is due to the study being performed in a developing city with large industries and increasing civil construction activity. Self-employed workers, on the other hand, live in informality and currently represent an important portion of the Brazilian population. The presence of farmers is perhaps due to the care carried out for the small towns around, with mainly agricultural characteristics.

The main cause of open and closed fractures are traffic accidents, with a percentage ranging from 33% to 88%.[4,5,8,9,20] Car accidents are more frequent in non-industrial towns. Open fractures mostly affect lower limbs and the tibial diaphysis is the most fractured bone in patients under 65 years of age.[3-5] In this study, in absolute numbers, the most common fractures occurred due to work-related accidents (39.51%), with equal distribution between crushing (laceration trauma) and lacerations, especially regarding industrial and agricultural machines. In a study that considered work-related accidents as the main cause of fractures, they were related to the crushing of limbs.[1] The frequency of open fractures was higher in hand bones (phalanges and metacarpals) (58.02%), especially in the distal phalanx (32.9%). Open hand fractures affect more residents of industrial cities and manual labor professionals such as masons and farmers.[4]

The highest numbers of accidents occurred on Thursdays (17.74%), Fridays (16.93%), and Saturdays (15.32%), which together represent 50% of all open fractures. Most open fractures occurred on weekends, especially on Sundays, in relation to the consumption of alcoholic beverages.[13,17] A percentage of 77% of the open fractures occurred during daytime. This time slot also differs from national studies in which a higher number of open fractures occurred at night.[8,13]

A total of 51.83% of the aid was provided by family members (25.22%) and third parties (26.61%), unlike the study by Arruda et al.[8], in which most patients were aided by firefighters. The Mobile Emergency Care Service (SAMU) recently started its activities in the region, which may explain the lack of specialized service regarding initial emergency care and transportation to the hospital.

The quality of services is related to the customer's expectation and their satisfaction with the experience. User satisfaction surveys are indispensable for planning and evaluating health services and may provide to their managers the information required to define surgery strategies. After care or the next day, the patients answered a numerical satisfaction scale regarding the initial care

and we observed a high satisfaction rate. Since most patients were not polytraumatized, we lost little time in other medical evaluations and urgent surgeries, speeding up the initial care. Moreover, the service presents an emergency room available for traumas, speeding up, in most cases, the time between patients arriving to the hospital and being taken to the operating room. Moreover, the doctor-patient relationship may have favored high grades from patients in public services, a frequent subject of complaints. Braga Junior et al.[7] also evaluated grades of the care provided to musculoskeletal traumas in general. Less than half (48%) were patients with fractures, and, despite a high level of patient satisfaction, those who complained did so especially because of the delay in care. In this study, we did not ask the dissatisfied group (1.6%) the reasons for the low grade, so we could not identify the possible failures to improve the qualification process for improving hospital care.

CONCLUSIONS

The patients with open fractures treated in this study presented the following profile: Healthy man, mean age of 43 years old, low schooling level, low income, upper limb accident victim, especially in the bones of the hands, treated between Thursday and Saturday, during daytime. Most were satisfied with the initial care provided.

AUTHORS' CONTRIBUTIONS: Each author contributed individually and significantly to the development of this article. FCC: data analysis, statistical evaluation, and bibliographic research; JMR: data analysis, statistical evaluation, and bibliographic research; SPR: data analysis, statistical evaluation, and bibliographic research; LAB: data capture and tabulation; NFM: data capture and tabulation; CDMA: study design and final draft.

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ORIGINAL ARTICLE
ORTHOPEDICS AND TRAUMATOLOGY

INTERFERENCE OF EXTERNAL DAMAGE CONTROL FIXATION IN DEFINITIVE OSTEOSYNTHESIS

INTERFERÊNCIA DA FIXAÇÃO EXTERNA DO CONTROLE DE DANOS NA OSTEOSSINTESE DEFINTIVA

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ABSTRACT

Introduction: Indications for provisional external fixation prior to the definitive treatment of fractures are associated with the control of local and systemic damage and the impossibility of definitive osteosynthesis in the emergency. Objective: To identify complications associated with external fixation prior to definitive internal osteosynthesis. Methods: This is a comparative, prospective study (Level II). Inclusion criteria: patients treated as emergencies (November 2019 and March 2020) who underwent provisional external correction followed by definitive osteosynthesis. We look for signs of inadequacies in external correction and correlation with infections (erythema, hyperemia, fistulae in the path of the pins or surgical scars), systemic symptoms of infection, and radiographic parameters for treatment up to eight weeks after surgery. Results: The average time for conversion to definitive osteosynthesis was 15.9 days and 47 lower limbs and three upper limbs were fixed. Of the participants who had deep infections, three (6%) showed signs during initial treatment (external fixator) and nine (18%), after definitive internal osteosynthesis. We found no correlation between provisional external correction and complications in the definitive treatment with osteosynthesis. Conclusion: The use of temporary external fixation before definitive internal osteosynthesis in fractures of the appendicular skeleton failed to increase complication rates even if the path of the implants in both procedures overlapped. ***Level of Evidence II, Comparative Prospective Study.***

Keywords: Infections. External Fixators. Fracture Fixation, Internal.

RESUMO

Introdução: As indicações para a fixação externa provisória que antecedem o tratamento definitivo das fraturas está associado ao controle do dano local e sistêmico e à impossibilidade de osteossíntese definitiva na urgência. Objetivo: Identificar complicações associadas à fixação externa precedente à osteossíntese interna definitiva. Métodos: Estudo prospectivo comparativo realizado com pacientes atendidos em situação de urgência entre novembro de 2019 e março de 2020, que sofreram a fixação externa provisória seguida de osteossíntese definitiva. Buscamos indícios de inadequações na fixação externa e correlação com: infecção (eritema, hiperemia, fístula do trajeto dos pinos ou da cicatriz cirúrgica), sintomas sistêmicos de infecção e parâmetros radiográficos da evolução do tratamento até oito semanas do pós-operatório. Resultados: O tempo médio para conversão em osteossíntese definitiva foi de 15,9 dias, e foram fixados 47 membros inferiores e 3 membros superiores. Dos participantes que apresentaram quadros de infecções profundas, três (6%) apresentaram os sinais durante o tratamento inicial (fixador externo) e nove (18%) após a osteossíntese interna definitiva. Não foi encontrada correlação entre a fixação externa provisória e complicações no tratamento definitivo com osteossíntese. Conclusão: O emprego da fixação externa temporária antes da osteossíntese interna definitiva em fraturas do esqueleto apendicular não provocou aumento nas taxas de complicações, mesmo quando houve sobreposição no trajeto dos implantes usados nos dois procedimentos. ***Nível de Evidência II, Estudo Prospectivo Comparativo.***

Descritores: *Infecções. Fixadores Externos. Fixação Interna de Fraturas.*

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INTRODUCTION

Patients who arrive at the emergency room with extensive soft tissue injuries are indicated to use external fixators to control local damage, as surgical access for internal osteosynthesis is contraindicated. A second classical condition is patients with extensive lesions who require fracture stabilization but have an overall impairment so intense that the new aggression characterized by surgery puts the patient's life at risk. Definitive implants are available for at least 48 hours after hospitalization, wasting a surgical opportunity and increasing financial costs. This reality, imposed by the health care structure, makes us

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

The study was conducted at Departamento de Ortopedia e Traumatologia da Faculdade de Ciências Médicas da Santa Casa de São Paulo.
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use external fixation aiming at provisional osteosynthesis in practically all fractures of the skeleton's major bones. Even so, physicians most often stabilize exposed diaphyseal fractures , followed by polytraumas — the latter case to control systemic damage.[1]
Admittedly, the indication of provisional osteosynthesis with external fixators aims to provide stability to the bone fragments of the fractured limb and restore physiological conditions to adjacent tissues. With the understanding of the pathophysiology of the intense inflammatory process which occurs in polytraumatized patients who require fracture stabilization, the indication of osteosynthesis with external fixators, especially tube-to-tube monoliteral ones, becomes a highly indicated technique.[2]
After the time required to recover from the adversities of traumatic injuries and to restore systemic and local conditions, patients will again be surgically approached either for conversion to osteosynthesis with internal implants or for the installation of osteosynthesis with external fixators which enable definitive treatment to stabilize smaller and joint fragments.[2] Thus, this study aimed to identify the complication rates associated with the application of temporary external fixation.
This study received no financial support from public, commercial, individual or legal sources.

MATERIALS AND METHODS

A prospective study was conducted with patients treated at the Emergency Department of a quaternary School Hospital in the central region of the municipality of São Paulo between November 2019 and March 2020. Our sample consisted of patients who were treated in the emergency service and who received indication of fracture stabilization with external fixator for the following reasons: control of local muscle and skeletal conditions or control of systemic damage or appendicular bone fracture which required stabilization either by exposure or by lack of definitive internal osteosynthesis in the emergency sector. To contemplate our other inclusion criteria, these patients would need a second surgical procedure aiming at definitive osteosynthesis and undergo a new evaluation in the eighth week after the second osteosynthesis.
The informed consent form (ICF) was shown and explained to each patient. Patients who had not undergone conversion to definitive osteosynthesis for any reason and those whose skeletons were still growing were excluded from this study. Moreover, this study was submitted to and approved by the Research Ethics Committee under the opinion: CAAE 23759319.8.0000.5479.
The surgical procedures for temporary external fixation were performed by resident physicians under the supervision of an attending physician from the Orthopedics and Traumatology Department of the hospital. As stated in the introduction, the literature lacks standardization for the installation of external fixators to control damage. Thus, it was at the discretion of the head of each team to freely establish the configuration of external fixators. Although the teams knew of the research in progress, this study was observational throughout treatment, without interference from its authors.
According to the institutional protocol, these patients received postoperative antibiotic prophylaxis with the intravenous use of second-generation cephalosporin for 24 hours. Even in the interval between emergency care and the definitive surgical procedure, observations were silent, and notes were kept confidential.
As for the technique for installing the treatment pins, the conventional technique was followed with the use of a drill and manual passage of the pins. The criterion for releasing the soft tissue was the operative team's responsibility — observed by the authors in the immediate patient follow-up in the ward, at the first dressing in bed, or in a second procedure in the operating room. The documentation of this observation was made by photographs taken with cellphone cameras within 48 hours of treatment evolution. The photographs taken postoperatively were used to prove medical records and identify inflammatory or infectious processes installed in the path of the Schanz pins. In the radiographs after definitive fixation, signs of coincidence of bone borings during the emergency installation of the Schanz pins with definitive osteosynthesis implants were sought (Figures 1, 2 and 3).

Figure 1. We can identify the exposure of the tibial plateau fracture (A and B) with clinical images after transarticular external fixation (C) and the same fracture after a two-month follow-up (D).

Figure 2. Images of clinical signs of infection around the Schanz pins.

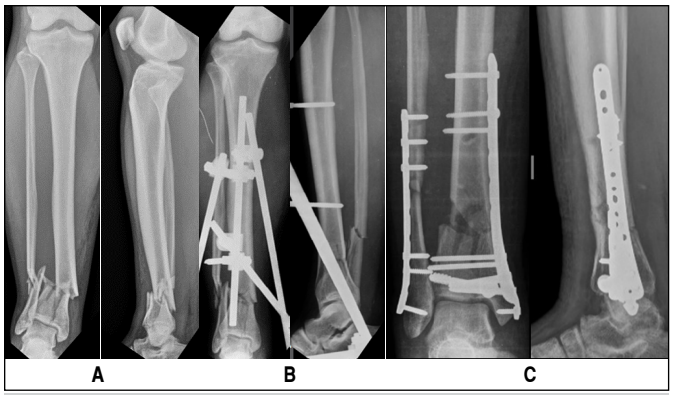

Figure 3. A tibial pylon (A) fracture was identified in the alignment after external fixation (B) and the immediate postoperative images, evincing the implant overlap with the prior port of the Schanz pin (C).

The classification of Gustilo and Anderson was performed by the team which performed the surgical procedure.[3] The indication of the need for soft tissue repair by flap rotation or other reconstructive surgery procedures was at the discretion of those responsible for conducting the treatment of patients, and no adversity was caused by the use of fixators with temporary osteosynthesis.
Post-procedure follow-up for clinical outcomes included the search for complications such as infections (erythema, hyperemia, fistula of the pin path or surgical scarring), systemic symptoms of infection, and postoperative radiographic parameters. Statistical analysis involved quantifying descriptive data via mean and standard deviations for the continuous variables and using percentages for the categorical variables via the SPSS Statistics 21 software.

RESULTS

Our sample initially consisted of 65 patients. In the established period of eight weeks for the postoperative follow-up, 16 abandoned follow-up in the institution, leaving a group of 49 participants who totaled 50 stabilized members with external fixators, 41 of which were males (83%) (Table 1).

Table 1. Descriptive data.

Characteristics	Total
Sample Size	**49 (100%)**
Age	**41.7 years (14.9)**
Days for conversion to DO	**15.9 days (10.7)**
Sex	
Male	41 (83.7%)
Female	8 (16.3%)
Energy at the time of trauma	
High energy	40 (81.6%)
Low energy	9 (18.3%)
Exposed Fractures	**28 (100%)**
Lower Limbs	25 (89.2%)
Upper limbs	3 (10.7%)

DO: definitive osteosynthesis; ±: standard deviation.

The mean time for conversion to definitive osteosynthesis was 15.9 days (± 10.7), with intervals varying between five and 69 days. Implant unavailability or the need to stabilize injured soft tissues caused the waits patients experienced for the definitive procedure. When waiting took longer than two weeks, patients had associated lesions in other devices which prevented definitive osteosynthesis (predominantly central nervous system injuries and respiratory failure). Table 2 shows that 47 lower limbs and three upper ones received fixators. Participants' mean age was 41.7 years (± 14.9) (Table 1).

Table 2. Fractured structure.

Anatomical part	Total
Leg	39 (78%)
Thigh	8 (16%)
Arm	2 (4%)
Forearm	1 (2%)

Of the total sample, 40 participants (81%) suffered high-energy trauma, whereas nine (18%) incurred in low-energy trauma. Considering the integrity of skin coverage, exposed fractures occurred 28 times, three in upper limbs and 25 in lower ones (78% of which in legs and 16%, in thighs). Regarding degree of exposure, following the classification of Gustilo and Anderson, nine were grade I, nine were grade II, and 10 were grade III (Table 3).

Table 3. Fractures with exposure.

Gustillo and Anderson Classification	Total
Grade I Classification	9 (32.1%)
Grade II Classification	9 (32.1%)
Grade III Classification	10 (35.7%)
Total	28 (100%)

Considering the 50 limbs stabilized in the emergency room, three (6%) suffered deep infection during initial treatment, i.e., between fixation in the emergency room and the wait for conversion to definitive osteosynthesis, probably as a result of bone exposure and soft tissue damage. Overall, nine segments stabilized in the emergency (18%) evolved with deep infection after definitive internal osteosynthesis (post-traumatic infection – Table 4). These patients required another hospitalization for systemic antibiotic therapy and 12% surgical debridement in this second hospitalization. In both groups, we did not find any treatment failures in the emergency room which could constitute the iatrogenic origin of the infection. Treatment of the infected followed the protocol of the institution with debridement, necessary reconstruction of the soft tissues, and specific antibiotic therapy.

Table 4. Postoperative infectious condition.

Presence of infection	Total
Infection post external fixator	
Yes	3 (6%)
No	46 (94%)
Infection post definitive osteosynthesis	
Yes	9 (18%)
No	39 (82%)

We also sought to characterize the presence of insufficient stabilization with the assembly of external fixators. In six patients, we found deviation of the fracture fragments in the radiographic controls between the intraoperative period on arrival and before the definitive surgery.
As for inadequacies in the installation of external fixators, 10 patients showed at least one inadequacy: four suffered from a coincidence of the surgical access to the fracture with the points of entry of the pins, one showed a coincidence of the entry of the pin with the incision to install the rod locking screw, two had phlogistic processes around the pin with tension of the soft tissues, and three incurred in multiple perforations for installation of the pins.
Regarding the implants used for definitive osteosynthesis, the most frequent ones were plates and screws of several models (56%), most often in the metaepiphyseal regions, intramedullary nails blocked in the diaphyseal lesions (22%), and Ilizarov circular external fixators (10%) (Table 5).

Table 5. Types of implants used.

Definitive fixation	Total
Plate and screw	28 (56%)
Intramedullary nail	11 (22%)
External fixator – Ilizarov	5 (10%)
Intramedullary nail	3 (6%)
Screw	2 (4%)
External fixator + Kirshner wires	1 (2%)

Regarding the overlap of the definitive osteosynthesis implants to the borings of the external fixation Schanz pins for provisional osteosynthesis, we found overlap in 34 fractured bones (68%), although we could observe no coincidence between the paths of the pins and the surgical accesses for definitive osteosynthesis. This coincidence occurred in 10 bones during subjection to internal osteosynthesis. we found that the Schanz pins caused tension on the soft injury tissue in 25 of the stabilized fractures (50%) (Table 6).

Table 6. Characteristics of the surgical procedure.

Characteristics	Total
Overlap of the definitive osteosynthesis pins	
Yes	34 (68%)
No	16 (34%)
Soft tissue tension	
Yes	25 (50%)
No	25 (50%)
Interference between pin and access route	
Yes	10 (20%)
No	40 (80%)
Consolidation after eight weeks	
Yes	45 (90%)
No	5 (10%)

We also observed patients eight weeks after definitive osteosynthesis, occasion in which we found delayed consolidation - in relation to what was expected - in five fractures (10%) (Table 6).

DISCUSSION

Applying monolateral external fixators in patients who arrive at the emergency room with multiple fractures or extensive local damage to soft tissues is a well-established conduct due to the low morbidity and minimal potential of the treatment to add tissue damage and consequent additional inflammatory processes. What the literature lacks is a standard assembly configuration for the external fixators used as provisional osteosynthesis, establishing the most appropriate arrangement of the Schanz pins to enable definitive osteosynthesis without coincidence of their entries and surgical access, for example. The fixation path of the Schanz pin, in particular steel ones, which is used in the emergency, determines the bacterial contamination and consequent colonization of its path. Research in the literature shows controversy regarding the higher prevalence of infections after provisional external fixation prior to definitive internal osteosynthesis.[1,2]

Our sample showed 18% of infected fractures after definitive osteosynthesis. We clinically and radiographically identified that the fracture foci were mechanically stable at the postoperative eight-week control, with neither clinical pain, functional disability nor bone lesion related to infections in the radiology exam. These patients required hospitalization for antibiotic therapy and 12% (two-thirds of the 18% group), a new surgical procedure for debridement. Studies mention postoperative infection rates of up to 30%.[4-6] In a previous study, the rate of infection after osteosynthesis was 12%.[6] We observed the overlap of definitive internal osteosynthesis with the boriongs of the Schanz pins in 43.8% of the patients. A current study has found such results in 68% of its patients.[6] The increased coincidence of surgical accesses to Schanz pin pathways was noteworthy, which seems undesirable to us, but it overlaps and the incidence of infection in definitive osteosynthesis showed no statistical significance. Some authors, when evaluating patients with fractures of the tibial plateau,[2] also reported the absence of correlation between the overlapping of the definitive implants with the infection of the definitive osteosynthesis. Another study found a rate of 16.5% of infection after internal osteosynthesis, followed by damage control with external fixation in the fractures of the tibial pylon, finding no correlation between infection and pin path overlapping to surgical accesses.[7] The overlapping correlation of the pins with surgical incisions, associated with infection, is also analyzed in a prospective study in which the external fixators installed for damage control are instruments for reducing fractures during definitive osteosynthesis.[1]

In our sample, we observed that between the accident and the definitive osteosynthesis procedure, nine patients (18%) underwent a clinically proven inflammatory and infectious process in the path of the installed Schanz pins, all with evidence of soft tissue tension against the pins. All patients underwent local debridement and antibiotics by a preoperative systemic approach to definitive surgery. Of these nine patients, two developed deep infections after osteosynthesis. We found no signs of correlation between infection of the pin path and deep infection, and we credited the association with definitive surgery. For our patients, the care with external fixators in the ward involved cleaning with a saline solution, removing crusts, and applying non-permeable dry dressings with sterile gauze around the Schanz pins. Studies suggest that specific care of pin injuries is unnecessary at follow-up, provided that the tension on the soft tissues against the Schanz pins is eliminated when installing the pins.[3]

When we seek information on the use of antibiotic therapy in the postoperative period after external fixator installation, we find that all patients received antibiotic prophylaxis with intravenous cephalosporin during the 24 hours immediately after surgery, according to hospital protocol. Studies state that this procedure shows no advantages for healthy patients, and that no significant correlation was found in relation to proven benefit or harm with the measure.[8]

Finally, we found no objective mention of the preparation for the pre-surgical planning to arrange the Schanz pins or the spatial structure of the external fixators in the damage control. In this series, we observed no association between pin arrangement, surgical access, and complications. From this observation, we should infer that it would be better to opt for a more stable conformation of the external fixators in damage control, not needing to seek atypical locations of the metal pins, avoiding the topography of the definitive implant. We were unable to find, in the literature, support which scientifically confirms this conclusion.

The clinical notes recorded by the surgical team were analyzed, seeking information on difficulties in the surgical procedure, criteria used to choose the points of insertion of the Schanz pins, existence of planning, prior to the surgical procedure, of the location of the pins, establishment of the probable surgical access for the definitive procedure, the occurrence of additional bone perforations to install the pins, and care in avoiding tension of the soft tissues against the Schanz pins. In this search for inadequacies in fixator installation, we found that ten patients showed at least one inadequacy: four had a coincidence of the surgical access to the fracture with the points of entry of the pins; one, a coincidence of the entry of the pin with the incision to install the rod locking screw; two, phlogistic processes around the pin with tension of the soft tissue; and three, multiple perforations for its installation. We sought to establish a relation between these data and the occurrence of complications but we found no significance.

In the definitive postoperative period, whenever we were unable to show the overlap of the definitive implants with the borings of the Schanz pins in postoperative radiographic images, we measured the distance from the pin boring to the extreme closest to the definitive implant in millimeters, compensating for the deformity in the digital

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imaging system. We found the range of 6 to 96 millimeters (mean 42 millimeters). By subjecting this finding to the occurrence of complications in the definitive treatment, we were unable to prove a statistically significant association.

CONCLUSION

The use of temporary external fixation before definitive internal osteosynthesis in fractures of the appendicular skeleton failed to cause an increase in complication rates even if the path of the implants used in both procedures overlapped.

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MORTALITY IN PATIENTS > 90 YEARS OLD WITH PROXIMAL FEMORAL FRACTURES SUBJECTED TO SURGERY

MORTALIDADE EM PACIENTES ACIMA DE 90 ANOS COM FRATURAS DO FÊMUR PROXIMAL SUBMETIDOS A CIRURGIA

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ABSTRACT

Introduction: Proximal femoral fractures have a high mortality rate among older adults, especially those aged > 80 years. Objective: To analyze predictive factors for hospital or late mortality of patients > 90 years old who showed proximal femoral fracture and subjected to surgery. Methods: The study included data from 230 patients aged > 90 years diagnosed with proximal femoral fracture and who underwent surgery between January and December 2017. The statistical evaluation was performed by multivariate analysis by a logistic regression. The associations were estimated by the odds ratio (OD) and confidence interval (95%). Statistical significance was determined with $p < 0.05$. Results: Late death occurred in 51.3% (118 patients) of the sample and hospital death in 3.5% (8 patients). Most patients were women (83.5%) and the most common fracture was transtrochanteric (57.0%). There was association between late death and the surgery duration ($p < 0.05$), and between hospital death and the presence of heart diseases ($p < 0.05$) or endocrinopathies ($p < 0.05$). Conclusion: Most patients aged > 90 years with proximal femoral fracture subjected to surgery died in less than one year. Late death was associated with the surgery duration and hospital death was associated with the presence of previous endocrinopathies or heart diseases, and the female gender was a protective factor from this outcome. ***Level of Evidence III, Retrospective Case-Control Study.***

Keywords: Hip fractures. Mortality. Older adults.

RESUMO

Introdução: As fraturas do fêmur proximal têm alta taxa de mortalidade entre os idosos, especialmente entre os considerados superidosos (> 80 anos). Objetivo: Analisar fatores preditivos para mortalidade hospitalar ou tardia de pacientes com idade superior a 90 anos que apresentaram fratura do fêmur proximal e foram submetidos ao tratamento cirúrgico. Métodos: O estudo incluiu dados de 230 pacientes com idade superior a 90 anos que apresentaram diagnóstico de fratura do fêmur proximal e foram submetidos ao tratamento cirúrgico entre janeiro e dezembro de 2017. A avaliação estatística foi realizada pela análise multivariada por meio da regressão logística. As associações foram estimadas pelo valor de odds ratio *(OD) e intervalo de confiança (95%). A significância estatística foi determinada com $p < 0,05$. Resultados: O óbito tardio ocorreu em 51,3% (118 pacientes) da amostra e o hospitalar em 3,5% (8 pacientes). A maioria dos pacientes foram do sexo feminino (83,5%) e a fratura mais comum foi a transtrocanteriana (57,0%). Houve associação do óbito tardio com a duração do procedimento cirúrgico ($p < 0,05$), e do óbito hospitalar com a presença de cardiopatias ($p < 0,05$) ou endocrinopatias ($p < 0,05$). Conclusão: A maioria dos pacientes com idade superior a 90 anos com fratura do fêmur proximal submetida ao tratamento cirúrgico evoluiu para óbito em menos de um ano. O óbito tardio foi associado à duração do procedimento cirúrgico e o óbito hospitalar à presença de endocrinopatias ou cardiopatias prévias, sendo o sexo feminino fator de proteção para tal desfecho.* ***Nível de Evidência III, Estudo Caso-Controle Retrospectivo.***

Descritores: *Fraturas do quadril. Mortalidade. Idoso.*

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INTRODUCTION

The annual number of hip fractures is expected to exceed six million by 2050 due to the worldwide progressive population aging, which makes this condition a serious public health problem.[1] Femoral fractures are associated with bone and systemic frailty, which cause high rate of functional loss and mortality. Death is estimated to occur in 12% to 37% of the older adults one year after the fracture and that one out of 15 older adults with hip fractures die while hospitalized.[1-4] Many studies focus on identifying patients with hip fractures who have a higher risk of morbidity and mortality because of the effect

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The study was conducted at Hospital Sancta Maggiore.
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on patients and their families, as well as on the health care system. Age > 85 years is considered an independent risk marker for death one year after proximal femoral fracture.[5]
Few studies analyze clinical outcomes, with representative sample, in the subgroup of patients with hip fractures and aged > 90 years.[6-8] Therefore, this study aimed to analyze predictive factors for hospital or late mortality in patients > 90 years old diagnosed with proximal femoral fracture and who underwent surgery.

MATERIALS AND METHODS

The study was initiated after approval by the institutional ethics committee and Plataforma Brasil (CAAE: 30995420.2.0000.8114). The guideline to good clinical practice and the Declaration of Helsinki were respected during its implementation. The Strengthening the Reporting of Observational Studies in Epidemiology - STROBE guide for observational studies was used to design the methodology of the study.[9]
This is a clinical, observational, retrospective, case-control study, in which the medical records of patients of both genders, > 90 years old, subjected to surgery, diagnosed with isolated proximal femoral fracture (transtrochanteric or neck) between January and December 2017 were included, without convocation, interview or intervention. The signing of the informed consent form was unnecessary. The fracture was anatomically classified by an orthopedic physician specialized in the area, in the orthopedic emergency room, and confirmed by the orthopedic surgeon in the backup hospital. Exclusion criteria were: fractures related to bone tumor or osteomyelitis, patients with osteosynthesis revision or hip arthroplasty and medical records with incomplete data regarding the diagnosis or surgery performed.
A total of 399 medical records of patients > 90 years old diagnosed with proximal femoral fracture who underwent surgery were initially selected. However, a sample of 230 patients was found after applying the inclusion and exclusion criteria.

Data collection

Data from the study participants were collected from the TechSallus® electronic medical record (TechSallus – Health Intelligence and Information. 2015©). The variables included were gender, age, type of fracture, type of surgery, previous comorbidities, surgical time, surgical risk, hospital death and late death (post-hospital period). All patients were operated in the same hospital and by the same team specialized in the surgical treatment of orthopedic trauma.

Patient's preparation and surgical techniques

All patients underwent surgical risk assessment by the anesthetic team when they arrived at the study hospital, being operated in the shortest possible time, depending on the clinical condition and fasting time. They were followed up by a specialized clinical team in the postoperative period. The immediate postoperative occurred in the ICU only in case of acute clinical decompensation. The antibiotic for infectious prophylaxis was cefazolin at a dose of two grams 30 minutes before skin incision in the transtrochanteric fractures, and sodic cefuroxime at a dose of 1.5 grams in femoral neck fractures treated with hip arthroplasty. The antibiotic used for anesthetic induction was maintained for 24 hours. The antibiotic was changed according to the Hospital Infection Control Commission in case of associated infection (pneumonia, urinary infection, erysipelas). Standard prophylaxis of deep vein thrombosis was performed with enoxaparin at a dose of 0.5 mg/kg in the hospital and with rivaroxaban after discharge, with dose adjusted according to the patient's renal function and associated with the use of elastic stockings of medium compression 7/8 for 30 days. The intended hospital discharge was approximately of 24 hours after surgery, depending on the patients' evolution and hemodynamic stability. The outpatient follow-up of these patients was performed by specialist orthopedists with > 10 years of experience in the area.

Transtrochanteric fracture

All patients included were operated on an orthopedic table using a cephalomedullary nail with conventional trochanteric entry (unstable fractures/insufficient lateral wall) or hip sliding screw system (DHS) – stable fractures and lateral wall competence – under image intensifier control. The nail used has a proximal locking system of the cephalic screw (locking pin) to avoid synthesis failure by rotational mechanical stress. The static locking screw was used in patients treated with short nail (190 mm) based on the guideline. A long nail with two distal blocks was manually used in patients with reverse oblique fractures or subtrochanteric extension. In the postoperative period, the load was protected with the aid of a walker for four to six weeks, according to clinical and functional evolution.

Femoral neck fracture

The decision of the method of treatment of these fractures was based on deviation, patient's age and previous functional status. Fractures without deviation (confirmed by front and profile radiographic examination and computed tomography) were treated with osteosynthesis using three 7.0 mm cannulated screws. The deviated fractures were treated with hip arthroplasty by direct lateral access (Hardinge). Total or partial arthroplasty was performed after analyzing the patient's functional level before the fracture and estimating the patient's survival within 10 years according to Charlson's comorbidity score.[10] Active patients without neurological impairment, with life expectancy ≥ 50% within 10 years and/or with previous symptomatic degenerative osteoarthritis in the hip were subjected to total hip arthroplasty. Patients who did not meet these criteria were subjected to partial hip arthroplasty. Only one patient was subjected to resection arthroplasty due to being previously bedridden and with contracture in the hip flexion-adduction. In the postoperative period, the load was protected with the aid of a walker for four to six weeks, according to clinical and functional evolution.

Statistical analysis

The analyses were performed by the R software. Categorical variables were described by their proportion and continuous variables by mean and standard deviation.
The univariate analysis of predictors for hospital or late mortality was initially used, and only the variables that showed $p < 0.20$ were included in the multivariate analysis. The multivariate analysis was performed based on a logistic regression by the iteratively reweighted least squares (IRLS) method. The associations were estimated by the odds ratio (OD) and confidence interval (95%). Statistical significance was determined with $p < 0.05$.

RESULTS

The sample consisted of data from 230 patients, 83.5% women and mean age of 92.6 years with standard deviation (SD) of 2.5, ranging from 90 to 104 years old. Hospital death occurred in eight patients (3.5%) and late post-hospital death, within one year postoperatively, in 118 older adults (51.3%), totaling 54.7% of death of the population. The most common proximal femoral fractures were transtrochanteric with 132 cases (57.4%), followed by neck fracture (33.0%), subtrochanteric (8.7%) and only two cases of periprosthetic fracture (0.9%).

Surgical procedure

The mean duration time in minutes was 104.0 minutes (SD 37.7), ranging from 25 to 230 minutes. The most common surgery was the cephalomedullary nail (65.7%), followed by cemented

partial hip arthroplasty (21.3%), non-cemented partial arthroplasty (7.4%), osteosynthesis with cannulated screws (2.6%), hip sliding screw (DHS) and total hip arthroplasty (1.3%), and one case of resection arthroplasty (0.4%).
Regarding comorbidities, most were diagnosed with systemic arterial hypertension (64.3%). However, some comorbidities did not represent the majority, such as dementia, which was found in 24.3% of the study population, heart disease (26.5%), lung disease (3.9%), previous stroke (6.1%) and endocrinopathies – diabetes and thyroid diseases (33.5%).

Early hospital death × control

We found as a risk factor the presence of heart disease, with odds ratio (OR) = 5.95 and p = 0.02, or endocrinopathy, OR = 7.5 and p = 0.01. Table 1 shows the analysis.

Table 1. Result of the univariate and multivariate analysis on hospital mortality outcome.

Outcome	Univariate	Multivariate	
	p-value	OR (95% CI)*	p-value
Women	> 0.05	-	-
Surgery duration	> 0.05	-	-
Age	> 0.05	-	-
Type of fracture	> 0.05	-	-
Type of surgery	> 0.05	-	-
Surgical risk	> 0.05	-	-
Systemic arterial hypertension	> 0.05	-	-
Dementia	> 0.05	-	-
Heart disease	0.03	5.95 (1.36; 30.92)	0.02
Lung disease	> 0.05	-	-
Stroke	> 0.05	-	-
Endocrinopathy	0.02	7.53 (1.63; 53.61)	0.01

OR: odds ratio; CI: confidence interval.

Late death × control

Table 2 shows the result of the univariate and multivariate analysis of the predictors for late post-hospital death within one year postoperatively, compared to the control group. Associating the surgical time with the highest mortality rate (p = 0.007) and the female gender as protection factor (p = 0.02).

Table 2. Result of the univariate and multivariate analysis on late mortality outcome.

Outcome	Univariate	Multivariate	
	p-value	OR (95% CI)	p-value
Women	0.02	0.40 (0.18; 0.86)	0.02
Surgery duration	0.007	1.009 (1.002; 1.017)	0.01
Age	0.13	1.10 (0.99; 1.24)	p > 0.05
Type of fracture	> 0.05	-	-
Type of surgery	> 0.05	-	-
Surgical risk	> 0.05	-	-
Systemic arterial hypertension	> 0.05	-	-
Dementia	0.19	1.74 (0.92; 3.33)	p > 0.05
Heart disease	0.03	-	-
Lung disease	0.05	6.89 (1.13; 133.25)	p > 0.05
Stroke	> 0.05	-	-
Endocrinopathy	> 0.05	-	-

OR: odds ratio; CI: confidence interval.

DISCUSSION

Our main findings are that the overall mortality of patients > 90 years old with proximal femoral fracture, within one year postoperatively, was 54.7%. The main risk factors for early hospital mortality were the presence of heart disease and/or endocrinopathy before the surgery; and the risk factor for late post-hospital mortality were the increase in surgical time (each minute increased in surgical time increased the probability of late death by 0.9%), and the female gender was a protective factor for this outcome.
The study by Smith et al.[5] from 2014 states that patients > 85 years old have a higher mortality rate within one year after fracture, which is similar to our study. Age can be considered an isolated predictor of the risk of death after fracture of the proximal extremity of the femur.[11]
We found a high mortality rate within one year (54.7%) compared to the study by Bolton, Bush and Wallace[12] (38.1%), which can be attributed to population risk factors intrinsic to the Brazilian population (poor control of chronic diseases, scarcity of access to the health care system during life, failure of clinical-geriatric follow-up in the postoperative period, inadequate rehabilitation). Previous studies on the national reality have found high mortality, even in younger patients.[13,14]
We found a higher prevalence of transtrochanteric fractures and mostly in women, similar to the literature,[12] since osteoporosis is a risk factor for the occurrence of these fractures and women are prone to this condition due to hormonal factors related to aging.[15] Although fractures are more prevalent in women, the female gender was protective regarding postoperative death, similar to the study by Xu et al.[16]
The presence of diabetes, thyroid dysfunctions and heart disease before the surgery were significant when comparing the mortality risk factors regarding the patients. The study by Xu et al.[16] shows similar findings, in which the authors found that the most relevant for mortality in patients with hip fracture were: multiple comorbidities, high level of ASA, cognitive impairment, low pre-fracture functional status, hospital discharge with low functional level, heart disease, frailty, cancer, renal failure, stroke, diabetes, delirium, malnutrition, low hemoglobin levels, delay in surgery > 48 hours, extra-capsular fractures, intraoperative fracture, advanced age, male gender and institutionalized patients were associated with higher mortality rates, risk criteria similar to other related studies.[17]
The literature shows that the patient's previous clinical conditions and non-modifiable epidemiological characteristics are the main responsible for mortality in case of proximal femoral fracture. However, we found, in an unprecedented way, that the surgery duration was a determining factor in the late death rate.
This fact emphasizes the need of a well-structured orthopedic service, a trained and specialized team to conduct orthogeriatric patients, and it questions the need to train surgeons focused on solving trauma in older adults.[18] A one minute delay beyond the mean time foreseen for the procedure increased the probability of late death, within one year postoperatively, by 0.9%.
The main limitation of our study is the information bias since it is based on information from medical records taken retrospectively. Besides, mortality was not stratified according to the surgeon's time of experience and specialization.
The health care service was completely restructured after the results found. The surgeries of older adults with hip fractures were aimed at a small group of surgeons with > 10 years of experience in general trauma and dedicated to the management of geriatric trauma. The patient is followed up in the pre and postoperative periods with a team of medical clinic and anesthesiology. Future data will be published on outcomes after the adopted intervention measures.

CONCLUSION

Most patients aged > 90 years with proximal femoral fracture subjected to surgery died within one year of postoperative. Late death was associated with the surgery duration and hospital death was associated with the presence of previous endocrinopathies and/or heart diseases, and the female gender was a protective factor from this outcome.

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REVERSE SURAL FLAP FOR LOWER LIMB RECONSTRUCTION

RETALHO SURAL REVERSO NA RECONSTRUÇÃO DE MEMBROS INFERIORES

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ABSTRACT

Introduction: Reconstruction of distal wounds in lower extremities can be challenging due to the lack of tissue to perform local flaps. Fasciocutaneous and muscular flaps are some options for coverage, such as the reverse-flow fasciocutaneous sural flap. Objective: To present an 18-month experience on ankle, calcaneus, and foot reconstruction using the reverse-flow sural flap, performed by the Complex Wounds Group of the Plastic Surgery Department of the University of São Paulo Medical School. Methods: An observational, retrospective and descriptive study was performed through data survey on medical records of all patients treated between November 2018 and June 2020. Results: Nine reverse-flow fasciocutaneous sural flaps were performed. All patients were men. The mean age was 38 years old. Five patients had acute wounds for traffic collision, one electrical trauma and three chronic post-traumatic injuries. The ankle was the most common injury site (6), followed by foot (2) and calcaneus (1). Four patients had complications, three of which were partial necrosis and one distal epitheliosis. No case of total necrosis was recorded. The average hospital stay was 30.1 days. Conclusion: The reverse-flow fasciocutaneous sural flap proved to be a viable, reproducible, and reliable option for distal lower limb reconstruction. ***Level of Evidence IV, Case Series.***

Keywords: Wounds and Injuries. Lower Extremity. Surgical Flaps. Leg Injuries. Plastic Surgery.

RESUMO

Introdução: Reconstrução de lesões distais de extremidades inferiores podem ser desafiadoras devido à limitação de tecido para retalhos locais. Retalhos fasciocutâneos e musculares são opções, como o retalho fasciocutâneo sural reverso. Objetivo: Apresentar a experiência de 18 meses do Grupo de Feridas Complexas do Serviço de Cirurgia Plástica da Faculdade de Medicina da Universidade de São Paulo no uso do retalho sural reverso para reconstruções de defeitos em tornozelo, calcâneo e pé. Métodos: Estudo observacional, retrospectivo e descritivo, com dados de prontuário de todos os casos operados no serviço entre novembro de 2018 e junho de 2020. Resultados: Foram realizados nove retalhos fasciocutâneos sural reverso. Todos os pacientes eram do sexo masculino, com idade média de 38 anos. Cinco foram vítimas de acidente automobilístico, um de trauma elétrico e três apresentavam sequelas pós-traumáticas. Seis lesões localizadas em tornozelo, dois em pé e um em calcâneo. Quatro pacientes apresentaram complicações, sendo três necroses parciais e uma epiteliólise distal. Não houve perda total de retalho. O tempo médio de hospitalização foi de 30,1 dias. Conclusão: O retalho fasciocutâneo sural reverso mostrou-se uma opção viável, reprodutível e segura para reconstrução de lesões complexas em terço distal de perna e pé. ***Nível de Evidência IV, Série de Casos.***

Descritores: *Ferimentos e Lesões. Extremidade Inferior. Retalhos Cirúrgicos. Traumatismos da Perna. Cirurgia Plástica.*

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INTRODUCTION

The reconstruction of distal lower limb injuries may be challenging due to the lack of tissue for local flaps, and deficient vascularization in trauma or arteriopathy situations.[1] Muscle flaps for this region are restricted in use, as they are more used for the reconstruction of defects in the proximal and middle thirds of the leg.[2] Microsurgical flaps are excellent alternatives, but their surgery is difficult and requires a qualified team, sophisticated equipment, and tertiary hospital centers. Cutaneous and fasciocutaneous flaps with distal pedicle are another alternative to be considered.[3]

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

The study was conducted at Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo.
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Potén, in 1981, was the first to address the use of fasciocutaneous flaps from the sural angiosome in repairing soft tissue defects, with proximal base.[4] Two years later, Donski and Fogdestam[5] introduced the distally based fasciocutaneous flap and, after a long period unmentioned in the literature, Masquelet et al. reintroduced the reverse sural fasciocutaneous flap in 1992.[6] Since then, it has become a pillar of leg, calcaneus, and foot reconstruction with local flaps.[7]

The reverse sural flap is a well-studied method for covering defects of the lower third of the leg, ankle, and foot.[6] It is based on communicating and perforating branches of the fibular artery, which originate from 5 to 6 cm cranially to the lateral malleolus. Its indication to diabetic people, smokers, or patients with peripheral vascular disease must be cautious.[8] Its main limitation is covering more distal defects, especially plantar, due to the limited range of its perforating.[6]

This study aims to present an 18-month experience of the *Grupo de Feridas Complexas do Serviço de Cirurgia Plástica da Faculdade de Medicina da Universidade de São Paulo* (FMUSP) with the use of reverse sural fasciocutaneous flaps for the reconstruction of ankle, calcaneus, and foot defects.

MATERIAL AND METHODS

A retrospective, observational, and descriptive study was performed. All patients who underwent lower limb reconstructive surgery with reverse sural fasciocutaneous flaps from December 2018 to June 2020 were included by the *Grupo de Feridas Complexas do Serviço de Cirurgia Plástica da Faculdade de Medicina da* FMUSP.

The following variables were considered: age, gender, personal medical history, etiology, injury site and size, number of surgeries, associated traumas, surgery time and its technical details, length of hospital stay, postoperative evolution, complications, and outcome. Data were analyzed by descriptive statistical analysis.

The Research Ethics Committee of the *Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo* approved this study, according to the Declaration of Helsinki and the Document of the Americas, under registration no. 4,255,946, with exemption from informed consent form.

Surgical technique (figures 1 and 2):

Figure 1. Male patient, 35 years old, healthy, with post-traumatic chronic wound in the posterior side of the ankle. (a) Initial injury with devitalized tissue area, including a part of the calcaneus tendon; (b) Injury after surgical debridement; (c) Marking of the reverse sural fasciocutaneous flap; (d) Flap dissection; (e) Primary inset and closure of the donor area; (f) Postoperative evolution without complications; (g) Release of the pedicle.

Figure 2. Male patient, 35 years old, smoker, victim of high-voltage electrical trauma (13,000 V). (a) Complex wound on the back of the right foot, with bone exposure; (b) Marking of the reverse sural fasciocutaneous flap; (c, d) Flap dissection; (e) Inset; (f) Primary closure of the donor area; (g) Release of the pedicle.

The patient is placed in ventral or lateral decubitus position, under spinal anesthesia or general anesthesia. The usual procedures are performed and the entire lower limb is kept exposed in the operative field. First, the surgical debridement of the injury is performed, followed by the measurement of the defect and the flap marking. The cutaneous perforators that will irrigate the flap are most commonly found in the posterolateral margin of the distal region of the leg. To be preserved in greater number, the rotation point is marked at least 5 to 6 cm above the lateral malleolus. The skin island is drawn in the proximal and middle thirds of the leg, so that it covers the entire defect without excessive traction of the pedicle.

The dissection begins by incising the skin in the proximal edge of the flap until piercing the deep fascia. The small saphenous vein and the neurovascular bundle are identified in the center of the flap and proximally connected. The flap is lifted so that the pedicle is always well visualized and intact, and dissected to the rotation point. Then, the flap is rotated to reach the defect area and sutured on the bed to cover the exposed deep structures, which are usually tendon, bone, or joint. An interpolated flap can be performed, keeping the pedicle with bloody area on the skin or inserting the pedicle under the skin or defect. Finally, the primary closure of the donor area is performed with suture, or, if the tension is excessive or the closure impossible, the area is covered by an autologous skin graft. The pedicle is released from 2 to 3 weeks after surgery. A tourniquet is applied in the pedicle before its resection to verify the integration of the flap to the bed.

RESULTS

We performed nine reverse sural fasciocutaneous flaps from December 2018 to June 2020. All nine patients were men with a mean age of 38 years old (the youngest was 29 years old and the oldest, 46 years old). Regarding personal medical history, eight patients (88.89%) presented no comorbidities, one (11.11%) presented hypertension, two were smokers, two were alcoholics, one used illicit drugs, and five had no addictions. Table 1 presents epidemiological data and other results.

Table 1. Epidemiological data of the patients included.

	Number	Percentage
Gender		
Man	9	100%
Woman	0	-
Age (years old)		
< 20	0	-
20–30	1	11.1%
30–40	3	33.3%
40–50	5	55.5%
> 50	0	-
Medical: 38.4		
Comorbidities per patient		
Healthy	5	55.5%
Hypertension	1	11.1%
Smoking	2	22.2%
Alcoholism	2	22.2%
Illicit drug use	1	11.1%
Etiology		
Traffic accident	5	55.5%
Motorcycle vs. fixed object	2	22.2%
Motorcycle vs. car	1	11.1%
Motorcycle vs. truck	1	11.1%
Hit-and-run accident	1	11.1%
Electrical trauma	1	11.1%
Post-traumatic chronic wound	3	33.3%
Site		
Calcaneus	6	66.6%
Ankle	2	22.2%
Foot	1	11.1%

Regarding the etiology of injuries, five patients (55.56%) were victims of car accidents, three (33.33%) presented post-traumatic chronic wound, and one (11.11%) was a victim of electrical trauma. Regarding the injury time, five patients (55.56%) presented acute wounds (less than 30 days between trauma and reconstructive surgery), and four (44.44%) presented chronic wounds (more than 30 days). Among the victims of recent trauma, only one patient (16.7%) presented injury exclusively in the lower limb. The other patients (83.33%) presented injuries in other body segments. Regarding the injury site, six patients (66.67%) injured the ankle, two (22.22%) injured the foot, and one (11.11%) injured the calcaneus.

We analyzed technical details of the surgery: all reverse sural fasciocutaneous flaps were pedicled; the mean surgery time was 160 minutes (the quickest surgery lasting 80 minutes and the longest, 220 minutes); five donor areas were treated with skin graft (55.56%) and four of them, with primary closure (44.44%). During the postoperative follow-up, four patients presented complications (44.44%): three of them presented distal necrosis and one presented distal epitheliosis. We observed no total loss of the flap. The mean length of hospital stay was 30.1 days (minimum stay of five days and maximum stay of 57 days).

DISCUSSION

Lower limb reconstruction is traditionally considered a challenge among plastic surgeons, with a progressively higher degree of difficulty, as injuries are more severe.[9] The lack of donor tissue and potentially deficient vascularization in the region (especially in high-energy traumas) explain this difficulty.[10] Therefore, free flaps gained great popularity and became the main indication for reconstruction of extensive injuries in the lower third of the leg and foot. However, due to the long surgery time, morbidity in the donor area, and need for a specialized team and center, not all patients would be candidates for this type of reconstruction.[11] Pedicled flaps reappear as a reconstruction option, with the benefits of faster dissection and transfer, besides providing local tissue similar to the original.[12] The reverse sural flap is an axial flap commonly used in the treatment of distal wounds in lower limbs.[1] Its arterial blood supply depends on the retrograde flow coming from septocutaneous perforators from the fibular artery. The branches of the posterior tibial artery also contributes to it.[9] Its venous drainage is performed by venocutaneous branches that heads to the small saphenous vein, maintaining sensitivity by the sural nerve.[7]

The reverse sural flap can be used to cover different injuries; traumatic injuries are the etiology most mentioned in the literature,[1] as all cases included in this study. It is indicated for reconstructions of the distal third of the leg, anterior and lateral sides of the ankle, posterior side of the heel, instep, and lateral side of the hindfoot.[13] Belém et al. advise caution in its use for total coverage of the calcaneus, at risk of excessive traction of the pedicle.[14] In the experience we presented, this flap was used for this purpose in one case, without postoperative complications.

The complication rate for this flap varies widely in the literature, with several authors reporting even no complications.[15] We must consider, however, that most of these studies included only young and healthy victims of trauma. In a systematic review performed by Daar et al. in 2019, the overall complication rate was 33.7%, reaching 50% when considering only the group of older patients.[1] The most common complication is partial necrosis of the flap, especially in its distal part.[16] Technical changes in the surgery, such as the application of adipofascial extension and previous placement of tissue expander, seem to reduce the chance of complications.[1]

In this study, we used no technical change. Three cases presented partial necrosis (33.3%), a frequency similar to the literature. We treated the complication of two patients with debridement, flap readvance, and closure. One case needed debridement of the ischemic part and coverage with skin graft. We also observed one case of epitheliosis of the distal edge and treated it in a conservative way. Thus, despite the complication rate similar to those described in the literature, all complications underwent local treatment and minor surgeries, and no additional reconstruction was required.

What would be the factors associated with higher risks of flap loss is still a subject in discussion. Patients with peripheral vascular disease present high incidence of necrosis and venous congestion.[8] Advanced age, diabetes mellitus, and obesity are also involved.[17] However, smoking alone seems to be the main risk factor.[1] The effects of smoking on wound healing are already well studied *in vitro* and include reduced blood flow at the expense of vasospasm, tissue hypoxia, and predisposition to infection.[18] *In vivo*, the risk of loss of free or pedicled flaps is higher.[19] Two of the three patients with partial necrosis in the postoperative period presented smoking history, which may explain this outcome.

CONCLUSION

The reverse sural fasciocutaneous flap proved to be a viable, reproducible, and safe option for reconstruction of complex injuries in the distal third of the leg and foot. It can also be used for the treatment of acute wounds (less than 30 days) and chronic wounds (with more than 30 days).

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RESULTS OF THE SURGICAL TREATMENT OF ARTICULAR SCAPULAR FRACTURES

RESULTADOS DO TRATAMENTO CIRÚRGICO DAS FRATURAS ARTICULARES DE ESCÁPULA

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ABSTRACT

Introduction: Scapular fractures are rare injuries and are often associated with high-energy trauma, with joint fractures accounting for only 15% of all scapular fractures. Surgical treatment is indicated for fractures with large deviations and with joint instability. Objective: This study evaluates the clinical and functional results after surgical treatment of scapular fractures. Methods: Eight patients with scapular fractures were surgically treated between 2013 and 2019. For indication for surgical treatment, mediolateral deviations, glenopolar angle, angular deviations and joint deviations greater than 4 mm were taken into account. Radiographic results of consolidation, range of motion, functional score and visual analogue pain scale were obtained. Results: In the mean follow-up of twenty-nine months (13–40 months), all patients presented fracture consolidation. The mean UCLA score was 29 points (with 75% good results and 25% moderate results). Regarding the range of motion, the mean elevation was 146° (ranging from 110° to 60°), lateral rotation of 62° (36–80°) and medial rotation at the level of T7 (T6–T10). The final VAS mean was 2.3. All patients returned to the pre-injury level at work. Conclusion: In this series of cases, surgical treatment of scapular articular fractures provided satisfactory results with low rates of complications, showing to be an option in selected cases of deviated fractures. ***Level of Evidence IV, Case Series.***

Keywords: Scapula. Glenoid Cavity. Shoulder Joint.

RESUMO

Introdução: As fraturas de escápula são lesões raras e muitas vezes associadas a traumas de alta energia, sendo que as fraturas articulares correspondem a apenas 15% de todas fraturas escapulares. O tratamento cirúrgico é indicado para fraturas com grandes desvios e com instabilidade articular. Objetivo: Avaliar os resultados clínicos e funcionais após o tratamento cirúrgico das fraturas de escápula. Métodos: Oito pacientes com fraturas da escápula foram tratados cirurgicamente entre o período de 2013 e 2019. Para indicação do tratamento cirúrgico, levou-se em consideração os desvios mediolaterais, ângulo glenopolar, desvios angulares e desvio articular maior que 4 mm. Resultados radiográficos de consolidação, arco de movimento, escore funcional e escala visual analógica de dor foram obtidos. Resultados: No seguimento médio de 29 meses (13–40 meses), todos os pacientes apresentaram consolidação da fratura. A média do escore UCLA foi de 29 pontos (sendo 75% de resultados bons e 25% de resultados moderados). Com relação ao arco de movimento, a elevação média foi de 146° (variando de 110° a 160°), rotação lateral de 62° (36–80°) e rotação medial no nível de T7 (T6–T10). A média final do EVA foi de 2,3. Todos os pacientes retornaram ao nível pré-lesão de trabalho. Conclusão: Nesta série de casos, o tratamento cirúrgico das fraturas da escápula com envolvimento articular proporcionou resultados satisfatórios com baixa taxas de complicações, mostrando ser uma opção em casos selecionados de fraturas desviadas. ***Nível de Evidência IV, Série de Casos.***

Descritores: *Escápula. Cavidade Glenoide. Articulação do Ombro.*

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INTRODUCTION

Scapula fractures are rare injuries, representing about 3% of all fractures of the shoulder girdle and 1% of all fractures of the human body. Most affect the body and spine (70%) and 15% of cases affect the glenoid cavity.[1] Generally, it affects the young and middle-aged male population, victims of high-energy trauma. Associated injuries are common, especially costal cartilage fractures, clavicle fractures, and lung lesions. A total of 90% of scapula fractures undergo conservative treatment, however, in some cases, they can lead to poor results, causing osteoarthritis and eventually glenohumeral joint instability.[2–4]

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<< SUMÁRIO

As they are rare injuries, the literature on the subject is relatively scarce, especially in relation to the surgical treatment of fractures affecting this joint.[1,5–7]

This study aims to present functional and radiographic results of the surgeries performed in patients with articular scapular (neck and glenoid) fractures, according to Ideberg-Goss and AO classifications.[8,9]

METHODS

This study was approved by the Research Ethics Committee of the institution and all participants signed an informed consent form. From January 2013 to May 2019, 16 patients from a trauma center or the authors' private clinic presented scapular fractures, eight of which were included in the study, as they presented joint fractures with indication for surgery (Figures 1, 2, and 3).

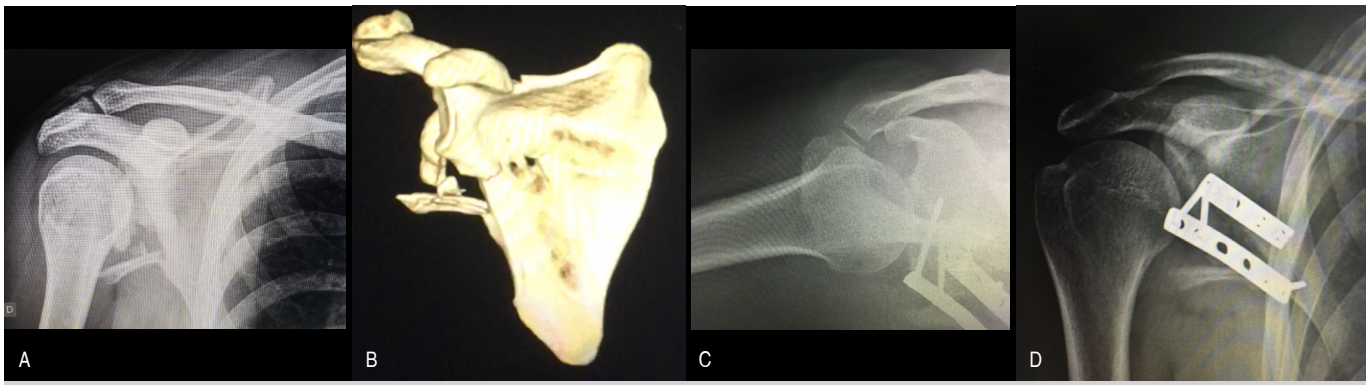

Figure 1. A: Anteroposterior (AP) radiograph of a 33-year-old patient with AO type 14F1.2 fracture; B: Computed tomography scan with 3D reconstruction; C and D: Postoperative AP and axillary radiographs, respectively, of a patient subjected to fixation of small fragments with two dynamic compression plates (DCP).

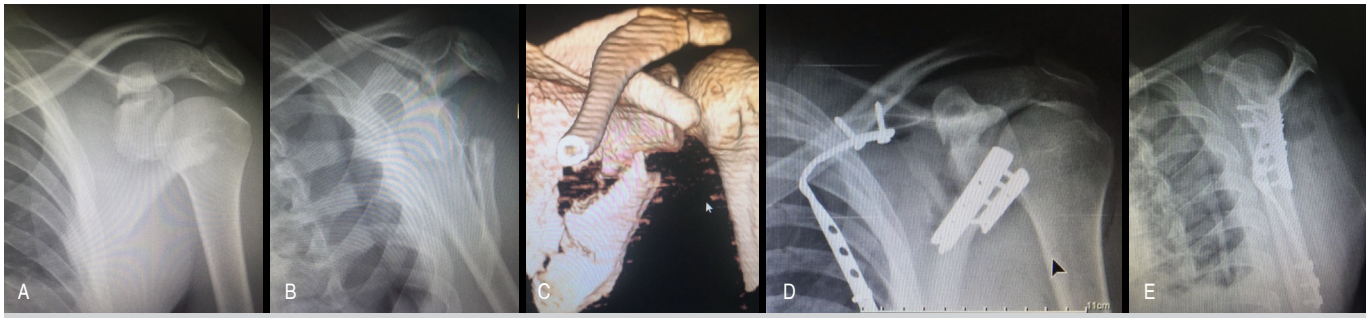

Figure 2. A: Anteroposterior radiograph of the shoulder of a 28-year-old patient with AO type 14F1.2 fracture; B: Perfil radiograph shoulder showing a translation greater than 100%; C: Computed tomography scan with 3D reconstruction; D and E: Postoperative AP and profile radiographs highlighting the fixation of small fragments with plates on the lateral and medial borders of the scapula.

Figure 3. A: Anteroposterior radiograph of the shoulder of a 55-year-old patient with AO type 14F1.3 fracture. B and C: Computed tomography scan with 3D reconstruction highlighting the affected medial border of the scapula; D, E, and F: Postoperative AP and perfil radiographs of the shoulder, highlighting the fixation of the lateral and medial borders of the scapula, with fixation of the clavicle.

All patients were subjected to fixation via posterior approach: three patients via classic or modified Judet approach (without elevation of the infraspinatus muscle), four patients via mini-open lateral approach (according to Peter Cole), and one patient via combined posterior and anterior (deltopectoral) approach (Figure 4).[10–12]

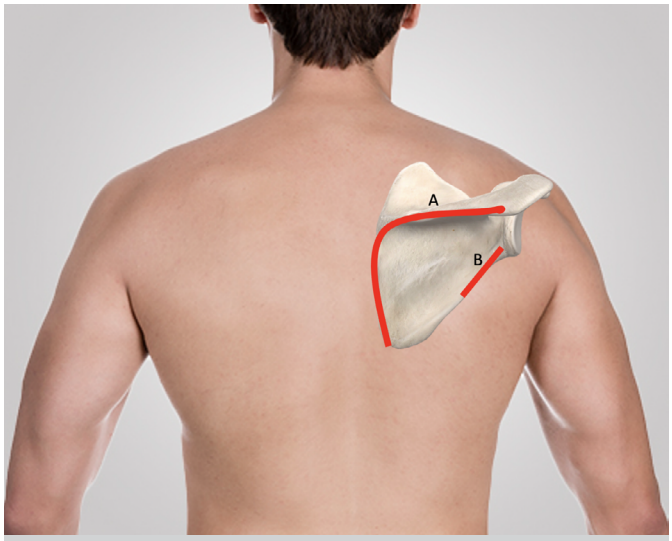

Figure 4. Photograph of the scapular region showing the Judet (A) and mini-open lateral (B) approaches.

The criteria used for indication for surgery were:

- Deviation greater than 4 mm.
- 100% translation on profile radiograph of the shoulder.
- Medialization or lateralization greater than 1 cm on AP radiograph of the shoulder.
- Glenopolar angle (GPA) < 2°.
- Scapular neck angle > 40°.
- Involvement of the superior shoulder suspensory complex at two or more sites, according to Goss.

The fixation was made with reconstructions plates of small (3.5 mm) and mini (2.7 mm) fragments (DCP - dInamical compression plates). All patients were evaluated regarding the neurovascular aspect. The preoperative imaging evaluation was made by true AP, perfil scapular, and axillary radiographs. Patients were subjected to computed tomography scan with 3D reconstruction. Fractures were classified according to Ideberg-Goss and AO classifications (Figure 5).[8,9,13]

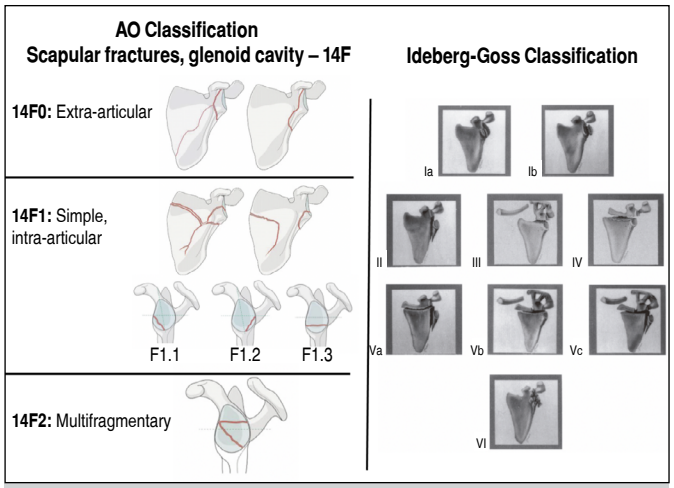

Figure 5. Classifications used: AO and Ideberg-Goss.

Surgical technique

The choice of approach was based on the fracture pattern and degree of fragmentation of the joint. For coracoid process fractures with intra-articular fragments, the anterior (deltopectoral) approach was performed. For posterior approaches, both the classic or modified Judet approach (without elevation of the infraspinatus muscle) or Peter Cole's mini-open scapular lateral approach were used. In the classical Judet approach, the infraspinatus and teres minor muscles were elevated in its medial regions. The space between the teres minor and infraspinatus muscles allowed a direct visualization of the joint after arthrotomy and fixation of posterior glenoid fragments, as well as of the lateral border of the scapula.

The patient's position was lateral decubitus when the posterior or anterior and posterior approaches were performed. Reconstruction plates or DCPs of small or mini fragments were used.

Rehabilitation

In the postoperative period, patients were immobilized with a simple sling for analgesia and encouraged to begin assisted passive and active movement the day after surgery. Antibiotic prophylaxis was performed for 24 hours with first-generation cephalosporin. Patients who underwent the anterior (deltopectoral) approach, in which the minor tuberosity was removed from the subscapularis muscle and it was subjected to tenorrhaphy, used the sling for four weeks. For those patients, external rotation was limited to 30° in the first four weeks after surgery.

The goal was to recover the entire range of motion by the second month after surgery. Strengthening exercises started in the second month after surgery and patients were allowed to return to work activities three months after surgery.

Postoperative evaluation

Perfil, axillary, and AP radiographs of the shoulder (Grashey view) were performed during postoperative appointments. For all patients, in order to assess the success of the reduction and restoration of the articular surface, pre- and postoperative images were compared between themselves and with the contralateral side. Fracture healing was defined as bone filling of the fracture line and clinically based on the patient's function and pain. The range of motion was assessed by a goniometer. The medial rotation was measured based on the highest point that the thumb of the operated limb could reach, considering some anatomical landmarks (T3: scapular spine; T8: inferior angle of the scapula; L1 iliac crest).

RESULTS

The mean age was 39 years old (28–62 years old). Eight patients were men. The mean time between trauma and surgery was 16 days (11–33 days).

All cases presented fracture healing. The mean follow-up period was 26 months (6–40 months). The mean UCLA score was 29 points (75% were good results and 25% were moderate results). The mean visual analog scale (VAS) for pain was 2.4 (0–4). The mean elevation was 146° (110–160°). The mean lateral rotation was 62° (36–80°). The mean medial rotation was T7 (T6–T11) (Table 1).

Regarding associated lesions, the most common were costal cartilage fractures (four patients) and clavicle fractures (three patients).

All patients returned to their pre-injury work activities.

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Table 1. Data from eight patients, with a mean age of 39 years old, mean UCLA score of 29, and mean VAS of 2.4.

							Range of motion		
Case	Age	Follow-up period (months)	AO Classification	Ideberg Classification	UCLA	VAS	Elevation	Lateral rotation	Medial rotation
1	33	40	14F1.2	Ib	32	0	160	80	T6
2	28	38	14F1.3 / 14FB1	II	31	1	150	60	T7
3	55	32	14F1.3	II	28	4	130	45	T10
4	38	36	14F1.2 / 14B1	IV	27	4	140	70	T7
5	31	28	14F1.2 / 14B1	IV	29	2	160	80	T6
6	33	18	14F0	II	32	2	160	80	T6
7	33	13	14F1.3 / 14B2 / 14A2	III	28	3	160	45	T9
8	62	6	14F2 / 14A3	Vc	26	3	110	36	T11
MEAN	39	26			29	2.4	146	62	70

Patients presented no complications such as pseudarthrosis or loss of reduction, however, we observed a case of superficial infection (infected hematoma), which was resolved with first-generation cephalosporin for seven days. Two patients evolved with infraspinatus muscle atrophy, but without clinical repercussion regarding the range of motion. For these two patients, the suprascapular nerve might have suffered injury due to the fragment pattern of the glenoid neck fracture.

DISCUSSION

Currently, no consensus exists regarding the treatment of scapula fractures.[9,14] The conservative treatment is usually used in most cases, however, fractures with significant deviation may cause adverse functional results, causing osteoarthritis. For these fractures, surgical treatment is recommended.[15,16]

Restoring joint congruence and stability is critical for long-term satisfactory functional results. The fixation of the lateral border is the first step in surgeries, followed by the fixation of the medial border of the body of the scapula to neutralize shear and rotational forces. In 1991, Ada and Miller observed excellent results in the surgical treatment of eight patients with scapula fractures.[17] For Schandelmaier et al., evaluating 22 patients subjected to internal fixation, 82% of the results were satisfactory.[14] Giordano et al. evaluated 15 patients who underwent fixation of scapular fractures and 86% of the results were excellent.[18] In our study, 75% of the results were good and 25% were moderate, with a mean UCLA score of 29 points. Patients with the worst scores were those with multifragmentary articular fractures and fractures of the inferior border of the glenoid.

For Anavian et al., 27 of 30 patients with surgically treated joint fractures presented satisfactory results when returning to activities at the same pre-injury level—only four patients reported occasional moderate pain.[15] Mayo et al. observed good and excellent results in 22 of 27 patients with surgically treated glenoid deviated fractures.[19] In our study, the mean visual analog scale for pain was 2.4 and all patients returned to pre-injury work activities—only two reported occasional use of anti-inflammatory medication.

All patients were subjected to fixation via posterior approach: three via classic or modified Judet approach, four via mini-open lateral approach (according to Peter Cole), and one via combined posterior and anterior approach.[11,12] The patient who underwent the anterior approach presented an AO type 14F1.3 fracture with a horizontal line at the glenoid equator, thus we inserted two screws in cephalocaudal direction through the base of the coracoid process. Hardegger, Simpson, and Weber performed a vertical incision from the acromion to the inferior angle of the coracoid process, however, it is contraindicated when facing Ideberg types IV, V, and VI fractures.[20–22] During surgery, we initially tried to fix the lateral border of the scapula with direct visualization of the articular fragment through the opening of the posterior shoulder capsule. Then, in cases with extension of the fracture to the body of the scapula, we fixed the medial border. The limitations of our study were the limited number of patients and the fact of being a retrospective study without control group. However, it addresses an unusual type of fracture, especially joint fractures, which corresponds to 15% of all scapular fractures. Indications for surgery were based on criteria established in the literature and the poor results of joint fractures treated conservatively.[2,3]

CONCLUSION

In our series of cases the surgical treatment of articular scapular fractures presented good functional results with a small rate of complications, proving to be an option in selected cases of articular glenoid fractures. Multifragmentary articular fractures and fractures with inferior fragment presented worse functional results.

AUTHORS' CONTRIBUTIONS: Each author contributed individually and significantly to the development of this article. BBT: study concept and design, data collection, analysis, and interpretation, and surgery performance; TJS: data collection, analysis, and interpretation, surgery performance, and review of the article; JVRSP: study concept and design, data collection, analysis, and interpretation, and surgery performance; MANL: data analysis and writing of the article; DBS: data analysis and writing of the article; VSA: data analysis and writing of article.

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EFFECTS OF HIP FLEXION CONTRACTURE ON SAGITTAL SPINOPELVIC PARAMETERS

INFLUÊNCIA DA CONTRATURA EM FLEXÃO DO QUADRIL SOBRE OS PARÂMETROS ESPINOPÉLVICOS

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ABSTRACT

Objective: To assess the influence of hip flexion contracture on lumbar lordosis and spinopelvic parameters and the changes in these parameters after total hip arthroplasty (THA). Methods: Twenty adult patients with hip osteoarthritis were divided into two groups (ten patients with hip flexion contracture and ten without contracture). Patients were assessed preoperatively and six months after THA using the radiographic parameters sagittal vertical axis (SVA), lumbar lordosis (LL), pelvic incidence (PI), sacral slope (SS), and pelvic tilt (PT). Results: No statistical difference was found between pre- and postoperative LL values in the groups. After THA, both groups had increased PT and the group without hip flexion contracture had reduced SS. Conclusion: Patients with hip osteoarthritis and hip flexion contracture tend to have an increased LL in the orthostatic position compared to patients without contracture, but with no statistical significance. After THA, PT increased in both groups and SS decreased in patients without hip contracture. Studies should further investigate the role of hip flexion contracture on pelvic mobility and spinopelvic parameters to better understand these relations. ***Level of Evidence III, Case-Control Study.***

Keywords: Postural Balance. Spine. Hip. Pelvis.

RESUMO

Objetivo: Avaliar a influência da contratura em flexão da articulação do quadril sobre a lordose lombar, parâmetros espinopélvicos e as alterações desses parâmetros após a artroplastia total do quadril (ATQ). Métodos: Vinte pacientes adultos com artrose do quadril e indicação de ATQ foram divididos em dois grupos, sendo 10 pacientes com contratura em flexão da articulação do quadril e 10 sem contratura. Os pacientes foram avaliados no pré-operatório e seis meses após a realização da ATQ, através dos seguintes parâmetros radiográficos: eixo vertical sagital (SVA), lordose lombar (LL), incidência pélvica (PI), inclinação do sacro (SS) e versão da pelve (PT). Resultados: Não foi observado diferença estatística entre os valores da LL pré e pós-operatória nos grupos avaliados. Após a realização da ATQ, houve um aumento da PT nos dois grupos, e redução da SS somente no grupo de pacientes sem contratura em flexão do quadril. Conclusão: Os pacientes com artrose do quadril e contratura em flexão da articulação do quadril apresentam tendência para uma LL aumentada na posição ortostática comparado aos pacientes sem contratura, porém sem significância estatística. Após a realização da ATQ foi observado aumento da PT em ambos os grupos e redução da SS nos pacientes sem contratura em flexão da articulação do quadril. O papel da contratura em flexão do quadril na mobilidade da pelve e nos parâmetros espinopélvicos deve ser estudado com maior profundidade para melhor compreensão destas relações. ***Nível de Evidência III, Estudo de Caso-Controle.***

Descritores: *Equilíbrio Postural. Coluna Vertebral. Quadril. Pelve.*

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INTRODUCTION

The static and dynamic interaction of the spine, pelvis, and lower limbs is responsible for the sagittal balance of the body and an upright posture. These segments suffer mutual alterations and the concept that hip muscle contractures affect the lumbar spine and the sagittal balance of the spine has been universally accepted despite lacking scientific evidence.[1-3]

The interaction between the spine, pelvis, and lower limbs was widely disseminated after Legaye et al.[4] objectively described the angles representing the spinal parameters, the mathematical relationship between the spinal parameters (pelvic incidence = pelvic tilt + sacral slope), and the association of lumbar lordosis with these parameters.[4] The sagittal balance of the spine and its correlation with spinopelvic parameters guide modern spinal

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

The study was conducted at the Outpatient Clinic of Orthopedics-Spine of the Hospital das Clínicas de Ribeirão Preto of the Universidade de São Paulo.
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and hip surgery – particularly total hip arthroplasty (THA) – and several studies have reported its influence on the results of surgical treatment.[5,6]

Patients with previous lumbar spinal fusion have presented greater late dislocation of the prosthesis (6%) than other patients (1.6%), motivating the study of spinopelvic mobility and its relationship with spinopelvic parameters.[6-8] This is likely because those subjected to lumbar spinal fusion cannot retrovert the pelvis in the sitting position, thus reducing acetabular anteversion and leading to dislocation.[7,8] Several studies have shown how spinopelvic mobility is essential for the transition from orthostatic to sitting position since it promotes pelvic retroversion and acetabular anteversion to accommodate the head of the femur, influencing the dislocation of THA components.[6,8-10]

Hip arthrosis causes pain and limits joint movements, possibly resulting in hip flexion contracture, which is classically assessed by the Thomas test.[7,9] Hip contracture can then increase lumbar lordosis and affect spinopelvic parameters by reducing sacral slope, increasing pelvic tilt, and reducing thoracic phosis.[6,9]

This study's object of interest was hip flexion contracture in patients with arthrosis and subjected to THA. The literature has reported on the interaction between hip joint and spine and the changes in spinopelvic parameters,[7,9,11] but the behavior of lumbar lordosis in patients subjected to THA is still unclear.

This study aimed to assess and compare lumbar lordosis and spinopelvic parameters in patients with unilateral hip osteoarthritis (with and without flexion contracture of the affected joint) and before and after THA.

MATERIALS AND METHODS

This study was approved by the Research Ethics Committee of the Hospital das Clínicas of Faculdade de Medicina de Ribeirão Preto under no. 4.531.372. The study was retrospective and observational. Twenty patients who met the inclusion criteria were randomly allocated, being ten patients with hip flexion contracture (positive Thomas test) before surgery and ten patients without hip flexion contracture (negative Thomas test) also before surgery. The study's inclusion criteria were adult patients (over 18 years old) of both sexes with hip arthrosis subjected to primary total arthroplasty and with no spinal deformities, no previous spinal or hip surgery, and no hip flexion contracture (negative Thomas test) after surgery. All patients included in the study signed an informed consent form.

Hip joint contracture was assessed by the Thomas test preoperatively and six months after THA surgery. Patients with and without hip flexion contracture before surgery were divided into two groups to compare the parameters selected.

Radiographic assessment was performed using panoramic radiographs of the spine obtained in anteroposterior and lateral projections preoperatively and six months after THA surgery. Radiographs were conducted with the patient in the standardized position: standing position with hips and knees extended, upper limbs flexed at 30°, and elbows slightly flexed to place the upper limb on the support.

The radiographic parameters selected for the study were sagittal vertical axis (SVA), lumbar lordosis (LL), pelvic incidence (PI), pelvic tilt (PT), and sacral slope (SS) (Figures 1 and 2). Clinical and radiographic parameters were assessed independently by two study participants. The images were analyzed individually and the radiographic parameters selected were measured using the SURGIMAP software (Nemaris Inc., NY)

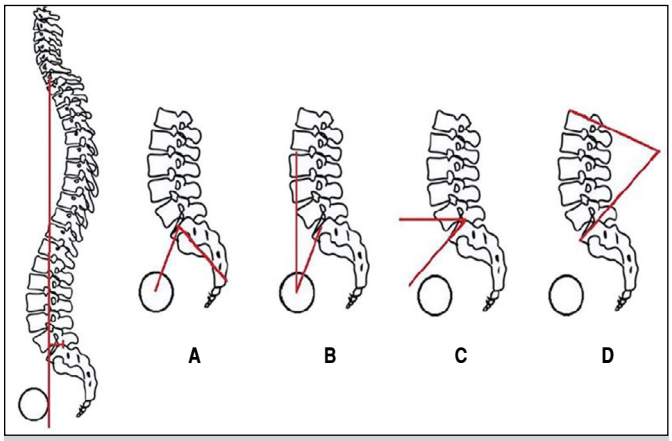

Figure 1. Drawing illustrating the radiological parameters assessed: the image on the left represents the sagittal vertical axis; image A represents pelvic incidence (PI); image B represents pelvic tilt (PT); image C represents the sacral slope (SS); and image D represents lumbar lordosis (LL).

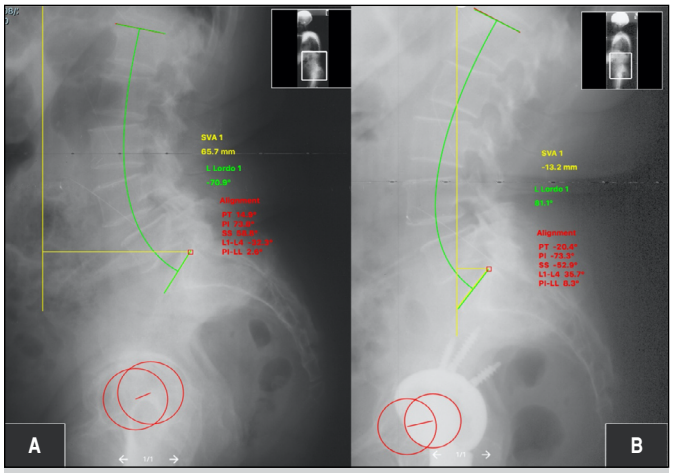

Figure 2. Pre- (a) and postoperative (b) lateral radiographs illustrating the radiological parameters assessed.

Descriptive statistical analysis was performed for quantitative variables (mean, standard deviation). Pearson's correlation coefficient was used to assess the reliability degree of the measurements of the two evaluators. The radiographic parameters were compared using Student's *t*-test and the significance level of 5% ($p < 0.05$) was established.

RESULTS

Table 1 shows the demographic data of patients and results of the assessed parameters. Thirteen patients (65%) were male and seven (35%) were female. The age of the patients ranged from 42 to 71 years (59.35 ± 8.56 years). In the group of patients without hip contracture, age ranged from 42 to 69 years (mean 57.7 ± 9.11 years); in the group with hip flexion contracture, age ranged from 49 to 71 years (mean 61 ± 8.11 years).

Hip flexion contracture assessed using the Thomas test ranged from 10 to 30° (mean 18 ± 7.88°) in the preoperative assessment and the Thomas test was negative in all patients in the 6-month postoperative assessment (Table 1).

A high degree of correlation (> 0.9) (Pearson's Coefficient) was found between the radiographic parameter measurements of the two evaluators using the SURGIMAP software (Surgimap – New York, USA).

<< SUMÁRIO

Table 1. Demographic data of patients and assessed parameters.

Patient	Contracture	Preoperative					Postoperative				
	Degrees	SVA	PI	PT	SS	LL	SVA	PI	PT	SS	LL
1	0	12	58	3.4	54.7	69.9	12.3	56.4	8.4	48	68.1
2	0	118.8	79.6	31.9	47.8	52.4	42.1	83.9	37.1	46.8	55.7
3	0	-29.4	40.9	1.1	39.8	60.1	-13.6	44.2	4.6	39.6	61
4	0	-22.4	48.6	4.2	44.4	64	8.9	52.8	6.3	46.6	60.3
5	0	92.3	58	13.9	44.1	50.2	43.1	61.3	18	43.3	49
6	0	26.1	34.3	-8.4	42.7	47.2	-2.3	35.9	3.7	32.2	41.6
7	0	62	42.6	4	38.6	51	1.6	45.7	14.1	31.6	52
8	0	7.7	40.1	-4.9	45	63.8	-30.6	40.4	-2.3	42.7	70.9
9	0	22.3	41.3	16.9	24.4	43.4	19.1	48.6	26.9	21.7	41.5
10	0	28.1	54.9	11.3	43.6	63.2	26.9	56.4	14.9	41.5	62.8
11	20	4.7	46.9	-7.2	54.2	69.9	39.5	48.2	13	35.2	62.9
12	30	23.1	50.1	8.5	41.6	68.9	73.1	62.3	15.1	47.2	65.7
13	10	8.1	50.2	17.4	32.9	49.3	6.6	54.8	27.9	26.8	47.7
14	10	-3.8	63.4	7.1	56.3	72.3	-16	65.1	16.8	48.4	72
15	20	-29.3	24.2	-12.7	37	52.5	-48	21.9	-14.1	36	58.3
16	30	39.6	40	-1.1	41.1	52.1	17.6	45.7	1.8	43.9	53.5
17	20	20.7	52.5	1.3	51.1	77.3	44.9	54.5	7.4	47.1	70.7
18	20	48.4	33.5	14.5	19	18.5	51.9	33.3	16.2	17.1	19.7
19	10	-18.3	68.1	14.5	53.7	81.1	17.2	63.2	13.2	50	76.6
20	10	65.7	73.8	14.9	58.8	70.9	13.2	73.3	20.4	52.9	81.1

SVA: sagittal vertical axis; PI: pelvic incidence; PT: pelvic tilt; SS: sacral slope; LL: lumbar lordosis

The sagittal vertical axis corresponds to the distance from the vertical plumb line that passes through the center of C7 to the rear edge of S1. This parameter is age-dependent and values under or equal to 5 mm are considered normal.[12] In the preoperative period, the SVA ranged from −29.4 to 118.8 mm (mean 31.75 ± 47.06 mm) in the group without hip flexion contracture and from −29.3 to 65.7 mm (mean 15.89 ± 29.73 mm) in the group with hip flexion contracture. Postoperatively, the SVA ranged from −30.6 to 43.1 mm (mean 10.75 ± 23.38) in the group without hip flexion contracture and from −48 to 73.1 mm (mean 20 ± 34.95 mm) in the group with hip flexion contracture. No statistical difference was found between the pre- and postoperative SVA values in the groups assessed (Table 1 and Figure 3).

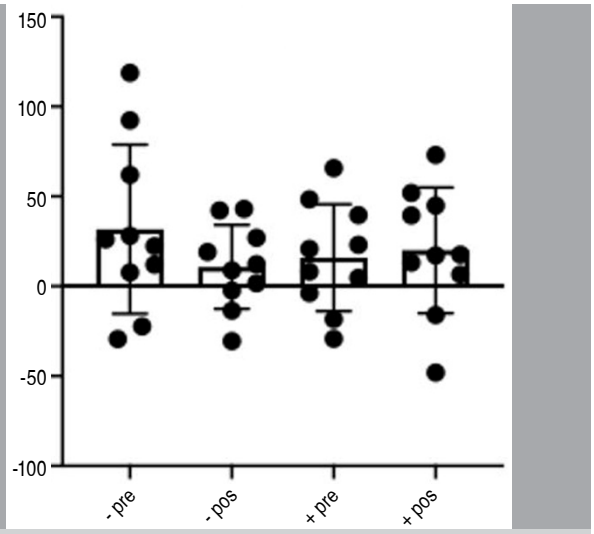

Figure 3. Values of the sagittal vertical axis (in millimeters) in the group of patients with (+) and without (-) hip flexion contracture pre- and postoperatively. No statistical difference was observed between the groups (p > 0.05 – Student's *t*-test).

Preoperatively, lumbar lordosis ranged from 43.4 to 69.9° (mean 56.52 ± 8.76°) in the group of patients without hip flexion contracture and from 18.50 to 81.1° (mean 61.28 ± 18.65°) in the group with hip flexion contracture. Postoperatively, LL ranged from 41.5 to 70.9° (mean 56.29 ± 10.22°) in the group without hip flexion contracture and from 19.70 to 81.10° (mean 61.43 ± 17.93°) in the group with hip flexion contracture. No statistical difference was found between the pre- and postoperative LL values in the groups assessed (Table 1 and Figure 4).

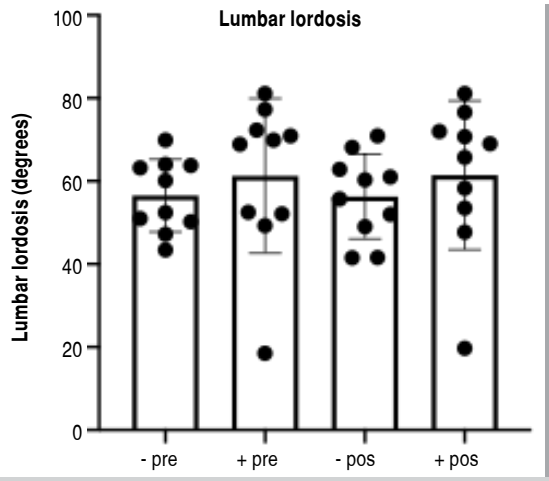

Figure 4. Lumbar lordosis values (in degrees) pre- and postoperatively in the group of patients with (+) and without (-) hip flexion contracture. No statistical difference was observed between the groups (p > 0.05 – Student's *t*-test).

The sacral slope is represented by the angle formed between the horizontal plane and the line of the upper surface of the first sacral vertebra (Figure 1). Preoperatively, LL ranged from 24.40 to 54.70° (mean 42.51 ± 7.75°) in the group of patients without hip flexion contracture and from 19 to 58.80° (mean 39.40 ± 8.41°) in the group with hip flexion contracture. Postoperatively, LL ranged from 21.70 to 48° (mean 39.40 ± 8.41°) in the group without hip flexion contracture and from 17.10 to 52.90° (mean 40.46 ± 11.50°) in the group with hip flexion contracture. Statistical difference was observed between pre- and postoperative SS in the group of patients without hip flexion contracture (p < 0.05 – Student's *t*-test). No statistical difference was observed between the other comparisons of SS among the groups studied (Table 1 and Figure 5).

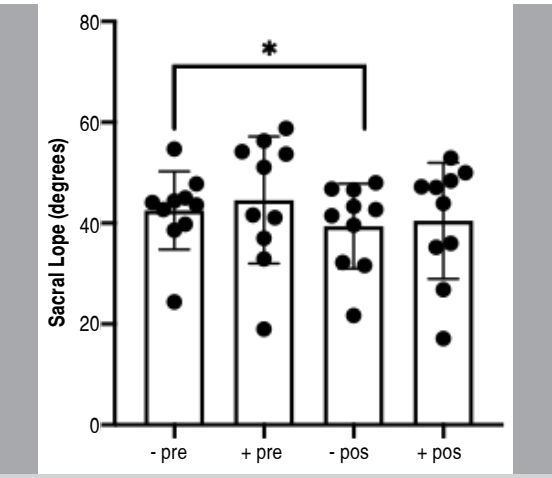

Figure 5. Sacral slope values (in degrees) pre- and postoperatively in the group of patients with (+) and without (-) hip flexion contracture. The asterisk (*) indicates statistical difference (p < 0.05 – Student's *t*-test).

The pelvic tilt is represented by the angle between the vertical line and a line that unites the center of the femoral heads with the center of the sacral vertebrae. Preoperatively, LL ranged from −8.40 to 31.90° (mean 7.34 ± 11.67°) in the group without hip flexion contracture and from −12.70 to 17.40° (mean 3.10 ± 10.31°) in the group with hip flexion contracture. Postoperatively, PT ranged from −2.30 to 37.10° (13.70 ± 11.84°) in the group without hip flexion contracture and from −14.10 to 27.90° (mean 11.77 ± 11.46°) in the group with hip flexion contracture. Statistical difference was observed (Table 1 and Figure 6) between the pre- and postoperative values of PT in the group of patients without hip flexion contracture ($p = 0.0006$ – Student's *t*-test) and in the group with contracture ($p = 0.0156$ – Student's *t*-test).

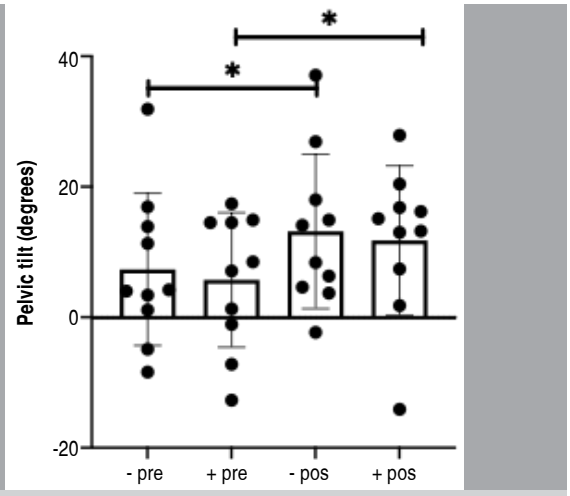

Figure 6. Pelvic tilt values (in degrees) pre- and postoperatively in the group of patients with (+) and without (-) hip flexion contracture. The asterisk (*) indicates statistical difference ($p < 0.05$ – Student's *t*-test).

Pelvic incidence is a morphological parameter defined as the angle between the line perpendicular to the upper edge of the first sacral vertebra at its midpoint and a line that connects this point to the center of the femoral heads. No statistical difference was found between the pre- and postoperative PI values in the groups assessed (Table 1 and Figure 7).

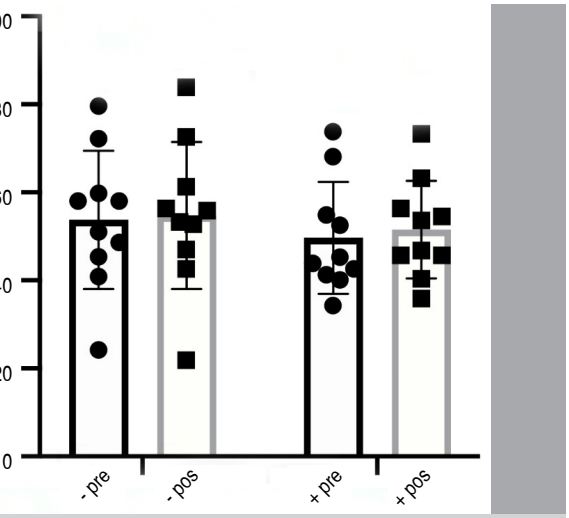

Figure 7. Pelvic incidence values (in degrees) pre- and postoperatively in the group of patients with (+) and without (-) hip flexion contracture. No statistical difference was observed between the groups ($p > 0.05$ – Student's *t*-test).

DISCUSSION

Patients with positive Thomas test (indicating hip flexion contracture) had higher mean lumbar lordosis values pre- and postoperatively than patients with negative Thomas test. However, no statistical difference was observed between the groups, requiring a cautious interpretation of the results. Hip flexion contracture has been considered responsible for increasing lumbar lordosis in ambulatory patients with neurological disease despite the lack of reliable evidence.[1] Patients with arthrosis and hip flexion contracture cannot tilt and physiologically move the pelvis while standing, which could increase lumbar lordosis.[9] Patients with hip arthrosis had increased lumbar lordosis in the orthostatic position[13], but other authors did not observe this relationship.[9,14,15] Arthrosis patients can adapt the lumbar spine by increasing lumbar lordosis to compensate for the loss of hip extension.[7,9,16] The amplitude of the hip joint extension allows assessing the movements of the hip and understanding the adaptation mechanism of the spinal complex, considering that the lumbar lordosis does not increase in all individuals with hip flexion contracture but depends on one's ability to adapt the lumbar spine.[7,9,16]

Lumbar lordosis was equal in both groups after THA, corroborating another national study.[11] This result was unexpected after hip mobility restoration, being likely caused by degenerative changes in the lumbar spine from increasing age, which reduce mobility[17]. Lumbar spine stiffness has been described for individuals over 65 years old, with increased prevalence after 75 years old.[5,14,18]

Lumbar lordosis values showed no statistical difference after THA; however, PT showed statistical difference in both groups and SS had statistical difference in the group without hip flexion contracture. Total hip arthroplasty restores the movements of the hip joint and the anterior pelvic rotation in the orthostatic position, corresponding to the increased PT and reduced SS observed. The literature has widely reported on the readaptation of the pelvic parameters after THA[11,19,20], usually showing how limited hip movement hinders posterior pelvic rotation, reducing PT.[5,7,9] However, few studies have assessed the effects of hip flexion contracture on these parameters. Reduced thoracic kyphosis is the additional mechanism of patients with limited lumbar spine and hip arthrosis to compensate for hindered posterior pelvic rotation, and sagittal imbalance of the spine occurs when all compensation mechanisms are insufficient.[9,14,15]

Sagittal vertical axis assessment also expresses the interaction between the hip, pelvis, and lumbar spine. Patients with more severe hip arthrosis have shown higher SVA values than patients with lighter degrees of the disease.[9] Sousa et al.[11] also observed that patients with hip arthrosis had higher SVA values than patients without hip joint disease. No statistical difference was observed in our group of patients, but the group studied was small. Patients without hip flexion contracture tended to have higher mean and greater variation of SVA values and greater reduction of these values after THA.

This study has limitations, including sample size, assessment in the orthostatic position only, and the non-inclusion of radiographic parameters related to hip flexion contracture (pelvic-femoral angle, femoral version angle), which have been used for complementary assessment of hip range of motion.[7,10] Despite these limitations, the study addresses an unexplored topic in the study of spinal and hip arthrosis mobility, presenting preliminary results that could motivate further studies on spinopelvic mobility.

The complexity of the interaction between the lumbar spine, the pelvis, and the hip increases with the divergent results in the literature. The available scientific evidence on the influence of spinopelvic mobility on the results of THA, especially regarding stability, reinforces the need to better understand all parameters involved. To date, studies on spinopelvic mobility and its influence

<< SUMÁRIO

on THA have not focused enough on hip flexion contracture, which should be considered as an additional parameter in this scenario.

CONCLUSION

Patients with hip arthrosis and hip flexion contracture are more likely to have increased LL in the orthostatic position than patients without contracture; however, our results showed no statistical significance. After THA, both groups had increased PT and patients without hip flexion contracture had reduced SS. Further studies should focus on the effects of hip flexion contracture on pelvis mobility and spinopelvic parameters to better understand these relationships.

AUTHORS' CONTRIBUTIONS: Each author contributed individually and significantly to the development of this article. RPP: data collection and analysis, writing of the article, project review, intellectual concept, and article review; MPD: data collection and analysis, writing of the article, project review, intellectual concept, and article review; FLG: study design, data analysis, and project review.

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UPDATE ARTICLE
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RELATIONSHIP BETWEEN TBS SCORE, BONE DENSITY AND FRACTURES IN OLDER MEN: INTEGRATIVE REVIEW

RELAÇÃO ENTRE O ESCORE TBS, DENSIDADE ÓSSEA E FRATURAS EM HOMENS IDOSOS: REVISÃO INTEGRATIVA

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ABSTRACT

Population ageing is an inexorable truth. This is the reason for an increase in the number of studies analyzing common pathologies, such as osteoporosis, in older people. Osteoporosis is a disease resulting from bone fragility, thus increasing the risk of fracture. Although the occurrence is predominant in women, studies analyzing the male population have raised interest among the scientific community. Nevertheless, there is no consensus regarding the best way to estimate the risk of fracture. Bone density testing and TBS (trabecular bone score) assessments are alternatives available for diagnosing. To assess the relationship between bone mineral density, the changes in TBS and fractures in older men. We conducted an integrative review of the literature in the LILACS, Scopus and PubMed databases, searching for studies in the last five years. We found 97 studies, and five of these matched our guiding question. We found five articles that matched our selecting criteria. All five presented the importance of using TBS for a better accuracy in improving the estimate of risk of fracture in older men. The association of TBS with bone density is important to best estimate the risk of fracture in elder men. ***Level of Evidence II, Diagnostic Studies.***

Keywords: Bone Density. Osteoporotic Fractures. Men's Health. Aged.

RESUMO

O envelhecimento populacional é uma realidade inexorável. Portanto o número de estudos relacionados às patologias comuns em idosos, como a osteoporose, tende a crescer. A osteoporose é uma doença caracterizada pelo aumento da fragilidade óssea, elevando o risco de fratura. Embora seja uma patologia predominante em mulheres, os estudos analisando a população masculina tem despertado interesse na comunidade científica. Entretanto, ainda não há consenso sobre a melhor forma estimar o risco de fratura. A densitometria óssea e a avalição do trabecular bone score (TBS) são alternativas disponíveis para o diagnóstico. Avaliar a relação entre a densidade mineral óssea, a alteração do TBS e a presença de fratura em idosos masculinos. Realizou-se uma revisão integrativa da literatura nas bases de dados LILACS, Scopus e PubMed, procurando estudos realizados nos últimos cinco anos. Foram encontrados 97 estudos, sendo que cinco se adequavam aos nossos critérios de seleção. Todos os estudos mostraram a importância do uso do TBS para uma melhor acurácia no intuito de aprimorar a estimativa do risco de fratura em homens idosos. A associação do TBS com a densidade óssea é útil para estimar de forma mais adequada o risco de fratura. ***Nível de Evidência II, Estudos Diagnósticos.***

Descritores: *Densidade Óssea. Fraturas por Osteoporose. Saúde do Homem. Idoso.*

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INTRODUCTION

The growth of the older population is a reality. The population over 60 is the fastest growing proportionally, according to the World Health Organization (WHO). In Brazil, from 2000 to 2010, there was an increase in the number of older adults from 14.4 million to 20.6 million.[1] Rio Grande do Sul, according to the Brazilian Institute of Geography and Statistics (IBGE), is the first Brazilian state with a proportional number of older adults. Due to this phenomenon, the pathologies associated with the aging process have aroused the curiosity of researchers.

Aging is a biological, dynamic, progressive, irreversible and inevitable phenomenon that affects all living beings. During this process, morphological, physiological, biochemical and psychological changes occur, as well as a progressive loss of the individual's ability to adapt to the environment, which ultimately lead to death.[2] Therefore, the musculoskeletal system is also affected by this process, culminating in the progressive loss of bone mass due to

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

The study was conducted at Pontifícia Universidade Católica do Rio Grande do Sul, Instituto de Geriatria e Gerontologia.
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the imbalance between the reabsorption mechanism and the bone formation. Osteocytes, which are responsible for the metabolism of the extracellular matrix, decrease with aging, unbalancing calcium metabolism and reducing the formation of this matrix. In turn, the osteoclasts, which are responsible for resorption of bone tissue, have their activity increased, inducing the process of osteoporosis.[3,4]

Osteoporosis is a disease that is characterized by low bone mass and loss of bone tissue microarchitecture, significantly increasing the risk of fracture. It is a chronic and progressive disease, with a decrease in bone mineral density.[5,6] In practice, according to the definition of the World Health Organization, it is a disease that predisposes a fragility fracture, that is, one that occurs in a situation that would be insufficient to fracture a normal bone.[7] This disease does not present characteristic signs and symptoms; this is a factor that delays early diagnosis and consequent prevention of fractures. Although osteoporosis is prevalent in women, the number of studies focused on the male population has increased, due to the data already described on population aging.

In the last 20 years male osteoporosis has been recognized as a public health problem. It is estimated that about 30% of hip fractures occur in men. The probability of a fragility fracture in men after the age of 50 is 13%.[8] Some risk factors are determinants for this pathology in men. In a recent study, the prevalence and associated risk factors for osteoporosis were analyzed in 325 men aged 50 or over. During the evaluation of this group, it was found that 44.6% of the participants had osteopenia and 15.4% of the study participants had osteoporosis. The most prevalent risk factors were low body mass index (BMI), sedentary lifestyle in the last 12 months, advanced age, smoking, white ethnicity, and history of maternal fracture over the age of 50.[9]

The diagnosis of osteoporosis is made through the clinical history of fractures that is characteristic of bone fragility and/or by bone densitometry (DXA). Densitometry is an accurate, non-invasive, low-dose radiation test that is accessible to most people. The densitometry apparatus uses X-rays of two distinct energies to provide quantitative and qualitative information related to bone mineral density. Currently, a complement to traditional bone densitometry is available which is the *Trabecular Bone Score* (TBS). TBS is a calculation algorithm based on DXA images that improves fracture prediction.[10] It is a simple and fast method performed by installing software on the usual densitometry devices that evaluates the quality of bone microarchitecture.[11] The use of this tool has been authorized in Europe since 2009, in the United States since 2011. In Brazil, it was released by the National Health Surveillance agency (Anvisa) in 2015. However, we noticed in medical practice that not all clinics that work with bone densitometry have adopted the application of TBS in their routine.

Therefore, the current challenge for those who treat osteoporosis is to optimize the identification of patients at risk of bone fracture, although there is no consensus on how to best achieve this goal. Therefore, this integrative literature review aims to present the relationship between TBS score, bone density and fracture in the male older population.

METHODS

This study is an integrative literature review with data collection performed from secondary sources, through a bibliographic survey and based on the following guiding question: What is the relationship between bone mineral density, TBS score and the presence of fractures in the male older population. To survey the articles in the literature, a search was carried out in the following databases: Latin American and Caribbean Literature in Health Sciences (LILACS) and *Medical Literature Analysis and Retrieval System online* (MEDLINE) and Scopus. The research was carried out on September 25 and 26, 2019 and the following descriptors and their combinations in Portuguese and English were used with the help of Boolean operators (*AND* and *OR*); parentheses for ordering operators and quotation marks for identifying compound words, as follows: ("densidade mineral óssea" *OR* osteoporose) *AND* ("*bone mineral density*" *OR osteoporosis*), *AND* ("escore do osso trabecular"/"*trabecular bone score*"), *AND* ("fratura em idosos homens"/"*fractures in older male*"). In addition, we searched for data from the CAPES database of theses and dissertations, as well as original articles linked to the literature found in the aforementioned search.

The inclusion criteria defined for the selection of articles were: original articles published in Portuguese and English; articles available in full that portrayed the theme related to the review carried out, and articles published and indexed in these databases in the last five years. Articles that did not meet the established inclusion criteria were excluded from this review. To avoid excessive inclusion of articles, keywords were restricted to search fields *Title*, *Abstract* and *Keywords*; they must be present in at least one of the specified search fields. Additional filters were applied, such as Article language (Portuguese/English/Spanish), species (humans), sex (male), age group (older adults).

The analyses and selection of the articles were carried out by two researchers (independently), who selected the potentially relevant studies based on the titles and abstracts. When they did not provide sufficient information for inclusion or exclusion from the study, the full text was analyzed. In situations, in which there was a conflict of opinion about the inclusion or not of the study, a third researcher was called to make the tie-breaker.

The results and data collected will be presented in a synoptic table evaluating database, authors, objective, methods and results.[12]

RESULTS

The search performed in the aforementioned databases found a total of 97 articles related to the theme of the review. Among these, nine were found in the LILACS database, 32 in MEDLINE and 56 in Scopus. There were articles found in more than one base: five were found in the three bases, 11 were found in Scopus and MEDLINE, three were found in MEDLINE and LILACS and one was found in Scopus and LILACS.

After the analysis of the abstracts found, 56 were excluded, leaving only 21 original articles that partially met the inclusion criteria and were selected for detailed analysis in full by two evaluators. Among these 21 articles, one was immediately excluded as the original article was in French. Another article was excluded because it was in a population with basic pathology; in this case, it was a group of chronic kidney disease. Among the other 19 articles, there was consensus for inclusion among the researchers on three articles. On the other hand, there was a consensus of exclusion on 12 articles. Therefore, there were four other articles that generated disagreement among the researchers. As such, these four articles were taken to a third opinion that selected two of them, totaling five selected articles. Figure 1 summarizes the search.

The selected articles were organized in a synoptic table to facilitate comprehension (Table 1). In this framework, the general characteristics, Qualis, and the main results of each of the articles selected for this integrative literature review were exposed.

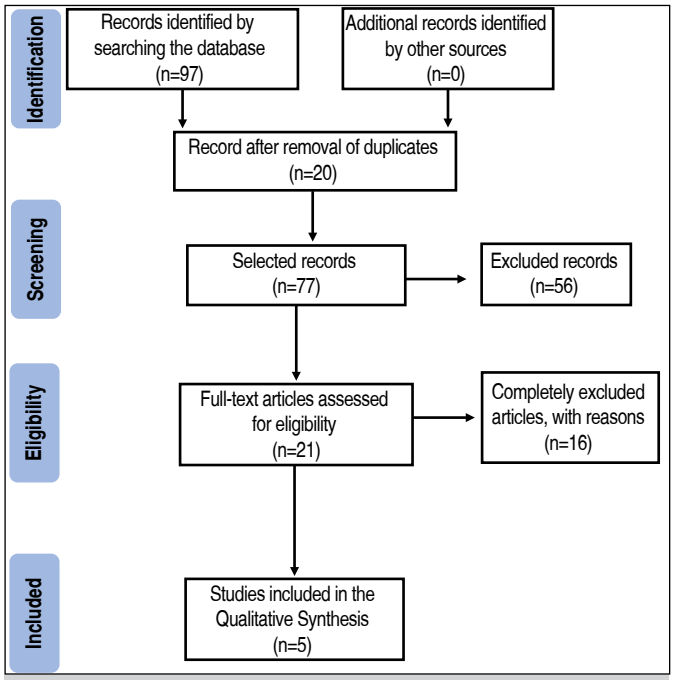

Figure 1. Process carried out in the integrative review.

Table 1. Selected articles in the LILACS, Medline and Scopus databases on integrative review.

Reference/ Qualis	Sample characterization	Objective	Main results
Iki et al.[13]/A2	N: 2012 men over the age of 65 Country: Japan	To assess the risk of fracture with the combination of FRAX and TBS in relation to FRAX alone.	In total, 22 men with MOF were identified. TBS can improve FRAX MOF prediction accuracy for Japanese older men
Schousboe et al.[14]/A1	N: 5979 men over the age of 65 -Country: USA	To assess the association between TBS and incident fractures in men independent of the prevalence of radiographic vertebral fracture.	TBS and the prevalent radiographic vertebral fracture are associated with large osteoporosis fractures incident in older men, independent of each other.
Su et al.[15]/ A2	N: 2000 men over the age of 65 Country: China	To validate and recommend practical TBS thresholds for predicting fractures in the older population	TBS in combination with BMD can predict MOF more reliably in older men than BMD alone.
Schousboe et al.[16]/B1	N: 5831 men over the age of 65 -Country: USA	To evaluate the association of TBS with clinical and radiographic vertebral fractures in older men	TBS is not associated with incidental vertebral fracture in older men when adjusted for the age and BMD of the lumbar spine; the study leaves open this association with clinical vertebral fractures. The study reinforces the influence of BMI on the calculation of TBS.
Anderson et al.[17]/B1	N: 728 Country: Australia	To investigate whether the presence of degenerative changes in the spine in older men affects TBS in the same way that they affect BMD.	This study suggests that TBS is less affected by degenerative changes in the spine than BMD. Thus, TBS may be useful in assessing the risk of fractures in men with degenerative changes in the spine.

TBS: Trabecular Bone Score; BMD: bone mineral density; DXA: bone densitometry; FRAX: fracture risk assessment tool; MOF: major osteoporosis fracture (hip, spine, wrist, shoulder).

The results of the studies included in this integrative literature review have mostly shown that there is a relationship between the decreased TBS score and the increased risk of fracture in older men. Therefore, the addition of the routine use of the TBS score assessment seems to have clinical importance in the creation of preventive measures for fractures.

DISCUSSION

Most of the selected studies reported the importance of assessing TBS *score* in clinical practice. The authors concluded that, although they still need complementary studies, the data available at the moment attest to the usefulness of this tool. Osteoporosis is characterized by the loss of bone mass as well as by the alteration of the microarchitecture which leads to bone fragility. Therefore, evaluation only by bone densitometry has been shown to be insufficient.[18] The studies found show us that isolated densitometry is not able to estimate the risk of fracture accurately.[19] This data is proven by the fact that most fractures occur in patients with bone mineral density considered normal or osteopenic.[20] Therefore, TBS appears as a useful predictor of fractures, for men, which are the focus of the current study, as well as for women.[21]

Evaluating the articles selected in this review, we note that there is a desire of the scientific community to find the best way to predict the risk of fracture and, therefore, indicate the ideal time to start treatment. We realized that each author used a way to try to improve this prediction.

Iki et al.[13] chose to analyze the use of FRAX associated with TBS to improve the accuracy of the diagnosis of osteoporosis and/or increased risk of fractures, since the isolated use of FRAX proved insufficient. The author reinforces that bone densitometry remains the gold standard for diagnosing osteoporosis, but not for assessing the exact risk of fracture, since half of hip fractures occur in patients without osteoporosis.[13] In the study, the author highlights the limitations of FRAX alone and reinforces the use of TBS, which evaluates the texture of the gray level in densitometry images, thus more accurately evaluating the bone microarchitecture. The elevated TBS score, i.e. darker shades of gray, indicates a stronger bone.[13] According to some authors, elevated TBS would have a predictive value for fractures.[22,23] The author also highlights a study conducted by Leslie et al.[24] in Canada that also showed the usefulness of the association of FRAX with TBS to estimate the risk of hip fractures. Iki et al.[13] demonstrated in his pioneering study, in the Asian continent, that patients with low TBS are at high risk for MOF; he further stressed the importance of using FRAX as an associated tool to optimize this evaluation.[13,24] This study presents some possible confounding factors, such as the low number of fractures, perhaps because it evaluates a healthier population without major underlying pathologies.

The study by Schousboe et al.[14]gave rise to several other studies, within the same line. The results reinforced the fact that most fractures occur before the diagnosis of densitometric osteoporosis and, therefore, there is a need for new alternatives.[21] The author states that low TBS score is associated with the diagnosis of MOF in women, regardless of FRAX or DXA.[25] The objective of the research was to study the relationship of TBS with vertebral fracture without clinical repercussion, since both measures reflect changes in the microarchitecture. The patients subjected to the study were questioned every four months by the post office about the presence or not of any fracture, and performed face-to-face revisions every two years, whenever X-ray examinations of the dorsal and lumbar spine were performed in the profile. The average age of the evaluated population was approximately 73 years.[14] The author found data that associate the use of TBS modestly with MOF, considering it a useful tool, but not mandatory in the management of this pathology. In addition, he demonstrated that the associated use of the TBS score and bone

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density assessment with the investigation of incidental vertebral fracture optimizes risk assessment for fractures. The author cites the reference from the Canadian study from Manitoba that associated TBS with hip fracture, but not with MOF.[14]

Su et al.[15] warn about population aging, which is a global trend. It is estimated that 45% of hip fractures will occur in Asia by 2050.[26] Thus, the author sought to study if the association of TBS evaluation with bone mineral density can optimize the follow-up of these patients. The study showed that patients with osteopenia and low TBS have a higher predictive value for fracture than isolated osteoporosis.[15]

In a study conducted in Australia, Anderson et al.[17] decided to investigate if the TBS score is affected by degenerative changes in the spine, in the same way that bone density is affected. There is consensus in the literature that older men have a tendency to increase bone mass secondary towards degenerative changes and, therefore, there is a need to seek new techniques for a better diagnostic accuracy of fracture risk.[27] In fact, there are reports that show that this fact is observed more in men than in women.[28,29] The mean age of the study population was 63 years, approximately, and the alteration that most affected the result of DXA was the presence of osteophytes. Padlina et al.[28] demonstrated similar results in a study conducted with women stating that TBS is less affected by degenerative changes than bone density to estimate fracture risk.

Although our study was based on a very narrow question, we noticed in our research an increasing number of evaluations on the topic. Therefore, there are many studies that have evaluated the importance of using the TBS score in the routine evaluation and research of patients at higher risk of osteoporosis fracture. However, some studies have evaluated populations with a specific profile, which may impair the final conclusion on the subject.

We also reviewed a study done with patients undergoing hemodialysis. Although the author recognizes the importance of other markers such as FRAX and low vitamin D level, he defined that only low bone mineral density can be considered as a predictive factor for low impact fractures.[30] Another study conducted in a population of diabetics showed that, although the bone mineral density in prediabetic and diabetic patients is higher than that found in normoglycemics, the bone quality of bone microarchitecture (TBS) showed no difference.[31] In a cohort also performed in diabetics, the importance of TBS evaluation in this population was reinforced, especially in the evaluation of the proximal femur.[32] The importance of the TBS score was reinforced in another article that evaluated patients with ankylosing spondylitis, in which the author concluded that patients with vertebral fractures had a low TBS score, even with normal mineral density.[33] In a case control study done in a population with *Crohn's* disease, the importance of the TBS score as a better predictor for fracture risk than the assessment of bone mineral density alone was also confirmed.[34]

Following another path, but also evaluating the TBS score, some authors have researched genetic alterations related to osteoporosis and, consequently, the most effective ways to evaluate, diagnose and treat the pathology, to prevent fractures. In a 2016 article, the authors showed that approximately 45% of cases there is variation of TBS under genetic influence, in the same way that occurs with bone mineral density, alerting to the need for more studies directed to this area.[35]

CONCLUSIONS

The use of the routine TBS score, associated with the assessment of bone mineral density, seems to be a useful tool to improve the assessment of fracture risk in the older population. Our review showed that there are still few reports of the use of this tool to evaluate the fracture outcome in men during the aging process. Therefore, we decided to expand our studies at the discussion level, since our research was directed to analyze a very specific situation, as we did not consider studies in patients who had established pathology. At the time that we expanded the research on the importance of TBS, we realized that there are other reports, in populations with previously documented disease, that strengthen the use of this additional analysis to densitometry in our medical routine *screening* for osteoporosis. Despite this, studies have not yet found an ideal way to improve this assessment, so more studies must be carried out to achieve this goal.

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