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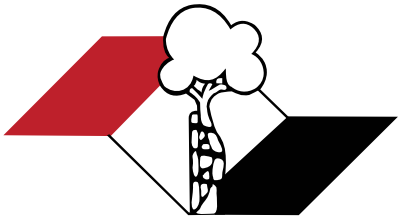

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ACTA ORTOPÉDICA BRASILEIRA

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(Reviewed January 2016)

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CONCLUSION: The conclusion should be clear and concise, establishing a link between the conclusion and the study objectives. Avoiding conclusions not based on data from the study in question is recommended, as well as avoiding suggest that studies with larger samples are needed to confirm the results of the work in question.

ACKNOWLEDGEMENTS
When applicable, briefly acknowledge the people who have contributed intellectually or technically to the study, but whose contribution does not justify co-authorship. The author must ensure that people agree to have their names and institutions disclosed. Financial support for the research and fellowships should be acknowledged in this section (funding agency and project number).

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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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EDITORIAL

Dear readers and collaborators,

Those who follow the history of Acta Ortopédica Brasileira know its laborious way to remain in the excellence of the scientific quality deserved by Brazilian researchers in the field of orthopedics. This path is marked by exceptional fruits, merit of the expeditious editorial board and dedicated authors.
For this year, which is about to end, it is extremely relevant to highlight the exponential increase in scientific editorial production. Although atypical, this year also had some favorable points, considering the arid context we live in, which surprisingly boosted the fields of science.

The time imposed by social isolation proved to be fertile in the field of scientific production. We got those pending projects "off the drawing board," making the productivity of medical researchers admirable in recent months. The sending of manuscripts for publication in Acta Ortopédica Brasileira doubled, we still had the largest number of accesses in the last 2 years with almost 110,000 readers in last April. We can only hope the good fruits will remain.

As this change in the scientific scenario is unprecedented, requiring constant evolutionary adaptation in the digital environment, we will bring beneficial changes to our researchers, to be disclosed in the editorials of 2021. Here is the new edition – 5 v.28, enjoy!

Professor Olavo Pires de Camargo
Editor-in-Chief
Acta Ortopédica Brasileira

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ORIGINAL ARTICLE

PEDIATRIC FLEXIBLE VALGUS FLATFOOT CORRECTION BY ARTHROEREISIS

CORREÇÃO DE PÉ PLANO VALGO FLEXÍVEL PEDIÁTRICO POR ARTRORRISE

Cíntia Kelly Bittar[1], Alberto Cliquet Júnior[2], Alexandra Mauriel dos Reis[1], Bruna Madeleine da Silva Simplício Flôr[1], Débora Penna Chaves Bertazzo[1], Maria Fernanda Rosa Dezan[1]

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2. Universidade Estadual de Campinas, Campinas, SP, Brazil.

ABSTRACT

Objective: This article aimed to evaluate the efficacy of arthroereisis using synthetic polyethylene implants to correct excessive valgus deformity in pediatric patients with flexible valgus flatfoot. Methods: Retrospective study of 20 pediatric patients with flexible valgus flatfoot, totaling 23 feet, between five and 14 years old, operated between January 2009 and July 2016. Clinical evaluations were performed by the Valenti podoscopic classification and the American Orthopaedic Foot & Ankle Society criteria, based on radiographic images and podoscopic analysis. These patients underwent surgical treatment with the introduction of a synthetic implant in the sinus tarsi. Multiple linear regression analysis with Backward selection of variables, angles of pre and postoperative of radiographic images of the patients submitted to arthroereisis were performed. Results: The arthroereisis with interposition of synthetic material was satisfactory, considering that 91% of the cases presented clinical and radiographic improvement, with correction of angles and improvement in deformity degrees. Two cases presented implant loosening. The variables of the Bordelon and Pitch angles significantly influenced ($p < 0,05$) the improvement of the correction of deformity degrees. Conclusion: The arthroereisis with the interposition of synthetic polyethylene material showed to be an effective technique for flexible flatfoot in symptomatic pediatric patients. ***Level of Evidence II, Prognostic studies – Investigating the Effect of a Patient Characteristic on the Outcome of Disease.***

Keywords: Prostheses and Implants. Flatfoot. Orthopedic Procedures.

RESUMO

Objetivo: Este artigo teve como objetivo avaliar a eficácia da artrorrise utilizando implantes sintéticos de polietileno para corrigir a deformidade em valgo excessivo em pacientes pediátricos com pé plano valgo flexível. Métodos: Estudo retrospectivo de 20 pacientes pediátricos com pé plano valgo flexível, sendo 23 pés, de cinco a 14 anos de idade, operados entre 2009 e 2016. Avaliações clínicas foram realizadas pela classificação podoscópica de Valenti e os critérios da American Orthopaedic Foot & Ankle Society. Esses pacientes foram submetidos a tratamento cirúrgico com a introdução de um implante sintético no seio do tarso. Foi realizada análise de regressão linear múltipla com seleção Backward das variáveis, os ângulos do pré e pós-operatórios das imagens radiográficas dos pacientes submetidos à artrorisse. Resultados: A artrorrise com interposição de material sintético foi satisfatória considerando que 91% dos casos apresentaram melhora clínica e radiográfica, com correção de ângulos e melhora nos graus de deformidade. Dois casos apresentaram afrouxamento do implante. As variáveis dos ângulos de Bordelon e Pitch influenciaram significativamente ($p < 0,05$) na melhora da correção dos graus de deformidade. Conclusão: A artrorrise com interposição de material sintético de polietileno mostrou-se uma técnica eficaz para pé plano flexível em pacientes pediátricos sintomáticos. ***Nível de Evidência II, Estudos prognósticos – Investigação do efeito de característica de um paciente no desenvolvimento da doença.***

Descritores: *Próteses e Implantes. Pé Chato. Procedimentos Ortopédicos.*

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INTRODUCTION

Flexible valgus flatfoot (FVFF) is one of the most common orthopedic pathologies in children.[1] Most patients do not present any symptomatology, referring only diffuse and poorly located pains when walking long distances and during physical activities. These pains can occur in the foot or extend to the ankle or leg.[2]

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

The study was conducted at the Pontifícia Universidade Católica de Campinas Hospital and has a contribution from the first author's archive.
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It is believed that children with FVFF who do not receive any treatment may develop some secondary deformity, such as postural deviations.[3] The evolution of the condition can generate hallux valgus, metatarsalgia, tarsal tunnel syndrome, posterior tibial tendon dysfunction and osteoarthritis, mainly on subtalar joint.[4,5]
The most evident changes for FVFF are the loss of medial longitudinal arch, plantar flexion of the talus in relation to the calcaneus, medial and plantar prominence of the talar head, forefoot abduction at the talonavicular joint and calcaneus valgus.[6] In addition to these modifications, FVFF is classified by degrees, depending on the deformities presented. The podoscopic analysis described by Valenti considers five grades (from Grade I to Grade V), depending on the severity of the deformity.[7]
The surgical indication in FVFF cases is a discussed subject.[5] Generally, when surgical treatment is indicated, it must be performed in patients between eight and 14 years old, with pain or other limitations.[8] In the literature, satisfactory clinical results can be observed for arthroereisis in pediatric patients.[1,4,9]
Arthroereisis represents one of the most commonly used procedures in pediatric patients with FVFF in Europe.[9,10] Above all, it becomes an interesting alternative for being minimally invasive[10] when compared to other surgical procedures, such as tendon lengthening and tendon transfer, bone excisions, osteotomies, arthrodesis, and interposition of bone or synthetic material in the sinus tarsi.
The arthroereisis of the subtalar joint reduces, without totally eliminating, joint movement. It promotes the neutralization of the foot abnormal pronation, corrects the calcaneus valgus and increases the medial longitudinal arch in the growing child, where the implant placement in the sinus tarsi limits the anterior and medial displacement of the talus.[11,12] It provides a quick recovery with little postoperative immobilization and preservation of the joint functional movement, with 85% of good results.[5,13]
Considering the cases of surgical indication in pediatric patients with FVFF refractory to conservative treatment, this study aims to evaluate the effectiveness of arthroereisis using a synthetic polyethylene implant as method to correct excessive valgus deformity in pediatric patients with flexible flatfoot, based on the improvement of degrees of deformity according to Valenti's classification.

MATERIALS AND METHODS

The study was approved by the Research Ethics Committee under CAAE number: 90459018.0.0000.5599
The study was performed with 20 pediatric patients with symptomatic FVFF between five and 14 years old at the time of surgery. Patients had symptoms that consisted of foot pain during daily activities, foot pain during or after sports, or early muscle fatigue during weight-bearing sports activities. Furthermore, these patients were considered to be refractory to conservative treatment, with no satisfactory response after the use of insoles, non-steroidal anti-inflammatory drugs and/or treatment with physiotherapy for stretching and strengthening of the extrinsic and intrinsic musculature of the feet.
Clinical evaluations were performed using the American Orthopaedic Foot & Ankle Society (AOFAS) criteria, based on radiographic images and podoscopic analysis according to Valenti's classification. In this case, according to Valenti's classification, those patients who presented grade III (midfoot width exceeding forefoot width) and grade IV (bulging of medial edge – semilunate image) were selected for the surgical procedure.
The following angles and lines were also considered in radiographs of the anterior-posterior (AP) and foot profile, with load, being: 20-40° of talocalcaneal axis (Kite > 40° in flatfoot) considered normal and 60-80° of talonavicular axis (Bordelon), considered normal for AP. The talo-first metatarsal axis (Meary), the normal being zero; 15-20° of inclination axis of the calcaneus (calcaneal pitch angle < 15° in the flat foot), being the normal; axis of plantar flexion of the talus (talus pitch angle, increased in the flatfoot), being the normal – 26° ± 5° and the talocalcaneal axis (Kite > 50° in the flatfoot), being normal 35-50° in the profile.
After a careful analysis of the factors, patients underwent surgical treatment by arthroereisis with the introduction of a synthetic implant (polyethylene conical screw) in the sinus tarsi between January 2009 and July 2016.
The technique consisted of inserting the guide wire through the sinus tarsi, about 15°-20° from the perpendicular to the sagittal plane, anterolateral to the postero-medial, leaving below the posterior tibial tendon (Figure 1).

Figure 1. Incision in the sinus tarsi.

A test sizer was inserted into the guide wire and initial evaluation was performed to verify the eversion of the calcaneus. Once the proper insertion distance was verified in the fluoroscopy, distance was confirmed using laser marks in the driver and comparison with the skin line. The lateral border of the implant was located in the middle or medial to the lateral side of the talus (Figure 2).

Figure 2. Insertion of the guide wire through the sinus tarsi.

After the surgical procedure, pre and postoperative radiographs were analyzed, comparing Bordelon, Kite, Gould, Meary and Pitch X-ray angles in anterior-posterior and foot profile, with load, with the

aid of the goniometer and podoscopic analysis. This information enabled the assessment of the FVFF degree and the exact correction of the deformity (Figure 3).

Figure 3. Preoperative (a) and postoperative (b) radiographic image of pediatric patient with flexible valgus flatfoot submitted to arthroereisis with implant of synthetic polyethylene material. We can observe an increase in the calcaneal pitch angle.

Therefore, we used the preoperative variables Valenti's classification, Bordelon, Kite, Gould, Meary and Pitch angles of pre and postoperative radiographic images of the patients to verify the predictive power over the response variable, in other words, the efficiency of arthroereisis in FVFF to improve the degree of deformity, by the classification of Valenti. Thus, multiple linear regression analysis with Backward selection of variables was used. The statistical analyses were performed with the aid of R Core Team software (2017).[14]

RESULTS

A total of 20 patients with FVFF were analyzed, of which three received bilateral procedure, totaling 23 feet, with a mean age of 8.13 years old. The average postoperative follow-up was 33 months (ranging between 24 and 43 months). In all patients the synthetic polyethylene implant was used.

Among the operated feet, two presented loosening of the implant, which had to be removed by a second surgery. In these cases, there was no correction of the Bordelon, Kite and Meary angles and the angles of Gould, Pitch and deformity degree by the Valenti's classification (Grade IV) remained unchanged (Table 1).

The arthroereisis with interposition of synthetic material was satisfactory, considering that 21 feet (91% of the cases) presented clinical and radiographic improvement, with correction of the angles and improvement in the deformity degrees by Valenti's classification. It was observed that the Bordelon, Kite and Meary angles decreased by a mean of 6,75°, 10,5° and 7,5°, respectively. The calcaneal pitch increased by an average of 6,7° (Figure 3) and the talonavicular coverage angle (Gould) increased by 1,9 mm. The mean correction was 7° for the calcaneal pitch, one and two mm for the Gould, 9° for the Bordelon and Kite angles, 9° and 6° for the Meary (Table 1).

We also observed the improvement in deformity degrees based on Valenti's classification. From five feet evaluated as grade III, four improved to grade II and one improved to grade I. From the 18 feet evaluated as grade IV, five improved to grade III and 11 improved to grade II (Table 1).

By the Backward regression model, the variables of the Bordelon and Pitch angles significantly influenced ($p < 0,05$) the improvement of the correction in deformity degrees based on the Valenti's classification. The obtained model presented correlation of 64%, demonstrating the relation between the variables.

The score obtained in AOFAS criteria was 73 points in preoperative period and 92 points in postoperative period. Two patients were unsatisfied due to the screw looseness.

Table 1. Evolution of the radiological parameters, Valenti podological classification, American Orthopaedic Foot & Ankle Society criteria, and pre and postsurgical procedure for flexible flatfoot correction by arthroereisis in pediatric patients between 5 and 12 years of age.

	Age	Sex	Bordelon angle	Kite angle	Gould angle	Meary angle	Pitch angle	Valenti classification	AOFAS criteria
			Pre/post surg.	Pre/post surg.	Pre/post surg.	Pre/post surg.	Pre/post surg.	Pre/post surg.	Pre/post surg.
Foot 1	7	M	17-18°	48-51°	8-8mm	21-24°	12-12°	Grade IV-IV	69-80
Foot 2	12	M	20-12°	43-35°	8-5mm	18-11°	10-16°	Grade IV-II	70-97
Foot 3	8	F	19-15°	50-41°	7-6 mm	22-17°	8-12°	Grade III-II	70-94
Foot 4	8	F	22-18°	54-49°	9-7 mm	25-19°	8-13°	Grade IV-II	73-97
Foot 5	6	M	28-18°	58-46°	9-5 mm	26-17°	9-16°	Grade IV-III	70-95
Foot 6	5	F	20-15°	55-40°	7-4 mm	17-10°	10-18°	Grade III-II	78-92
Foot 7	7	M	22-13°	61-41°	7-5 mm	20-14°	9-17°	Grade IV-II	75-96
Foot 8	10	M	28-20°	62-40°	7-4 mm	27-17°	7-13°	Grade IV-II	71-97
Foot 9	8	F	17-12°	42-38°	6-5 mm	18-15°	10-14°	Grade III-I	76-97
Foot 10	9	M	23-16°	56-41°	8-5 mm	19-14°	12-19°	Grade IV-III	74-89
Foot 11	6	M	23-14°	50-41°	7-5 mm	26-14°	8-14°	Grade IV-II	73-95
Foot 12	8	F	28-20°	55-42°	8-5 mm	28-16°	7-18°	Grade IV-III	75-88
Foot 13	7	F	30-16°	47-39°	7-5 mm	31-16°	10-19°	Grade IV-III	70-87
Foot 14	8	F	32-18°	50-41°	7-6 mm	28-18°	9-16°	Grade IV-II	72-98
Foot 15	9	M	27-15°	49-38°	8-6 mm	31-18°	11-18°	Grade IV-II	74-97
Foot 16	9	M	26-16°	53-41°	8-7 mm	29-20°	10-18°	Grade IV-II	75-97
Foot 17	7	M	30-19°	50-43°	7-6 mm	27-21°	9-16°	Grade IV-II	67-99
Foot 18	6	F	28-18°	58-46°	9-5 mm	26-17°	9-16°	Grade IV-III	78-90
Foot 19	10	M	20-15°	55-40°	7-4 mm	17-10°	10-18°	Grade III-II	74-90
Foot 20	12	M	16-18°	47-52°	7-7 mm	22-24°	11-11°	Grade IV-IV	68-79
Foot 21	9	F	20-12°	43-35°	8-5 mm	18-11°	10-16°	Grade IV-II	70-93
Foot 22	8	F	19-15°	50-41°	7-6 mm	22-17°	8-12°	Grade III-II	73-93
Foot 23	8	F	22-18°	54-49°	9-7 mm	25-19°	8-13°	Grade IV-II	74-90

DISCUSSION

Flexible flatfoot is a relatively common alteration in pediatric patients, diagnosed in 10% of the children.[1,15] The indication of surgical treatment in a child is based on the conjunction of symptoms, morphological criteria and failure of conservative treatment well conducted for at least six months.[16]

The ideal age for surgery is widely debated. Several authors justify the surgical indication for children between eight and 14 years old, due to clinical signs such as fatigue, cramps or activity limitation.[1,4,9] In this study, surgery was performed on a five-year-old patient. There is substantial variation in age between studies, some including children from two to six years old.[17,18] In these cases, bone maturity should be considered.[1,18] Considering that the foot is physiologically flat up to the age of four and then gradually transformed into a helical structure.

The results of the study showed that the arthroereisis in cases of symptomatic flexible valgus flatfoot with the interposition of synthetic material in the sinus tarsi were satisfactory. The efficacy of this procedure has been reported by several studies in literature, with an average follow-up time.[16,19]

In this study, it was possible to observe excellent results in relation to the polyethylene implant used, considering that in only two cases (8.69%) the removal of the material was required. Similar results to those were found by Faldini et al.,[4,19] with the use of a synthetic bio-absorbable implant.

Some studies[9,20] have shown that even the implant being prematurely removed, the foot position was maintained with a certain degree of correction, which enabled good clinical results. This fact corroborates our findings, in which patients who had loosening of implants, even with implant removal, did not report other postoperative changes, complications such as pain or difficulty to walk.

Arthroereisis is a good alternative to osteotomies and arthrodesis for the treatment of symptomatic flexible valgus flatfeet refractory to clinical treatment. The benefits of this technique include ease execution, little or none interference with osteoarticular tissue of the sinus tarsi, it does not hinder other surgical options in the future, less surgical morbidity, faster return to rehabilitation, and stabilization of the subtalar joint (considering the principle of correction of the initial deformity in valgus plane).

CONCLUSION

Surgical treatment by arthroereisis with the interposition of synthetic polyethylene material in the sinus tarsi showed to be a simple, minimally invasive, and effective technique for flexible flatfoot in symptomatic pediatric patients, with a low complication rate, important clinical improvement, and high degree of satisfaction.

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REFERENCES

1. Giannini BS, Ceccarelli F, Benedetti MG, Catani F, Faldini C. Surgical treatment of flexible flatfoot in children: a four-year follow-up study. J Bone Joint Surg Am. 2001;83-A Suppl 2 Pt 2:73-9.
2. Corte-Real N, Felicíssimo P. Pé plano infantil. Acta Ped Port. 1995;26(4):191-6.
3. Smith SD, Millar EA. Arthrorisis by means of a subtalar polyethylene peg implant for correction of hindfoot pronation in children. Clin Orthop Relat Res. 1983;(181):15-23.
4. Faldini C, Nanni M, Traina F, Fabbri D, Borghi R, Giannini S. Surgical treatment of hallux valgus associated with flexible flatfoot during growing age. Int Orthop. 2016;40(4):737-43.
5. Faldini C, Mazzotti A, Panciera A, Perna F, Stefanini N, Giannini S. Bioabsorbable implants for subtalar arthroereisis in pediatric flatfoot. Musculoskelet Surg. 2018;102:11-9.
6. Scher DM, Bansal M, Handler-Matasar S, Bohne WH, Green DW. Extensive implant reaction in failed subtalar joint arthroereisis: report of two cases. HSS Jrnl. 2007;3(2):177-81.
7. Crawford AH, Kucharzyk D, Roy DR, Bilbo J. Subtalar stabilization of the planovalgus foot by staple arthroereisis in young children who have neuromuscular problems. J Bone Joint Surg Am. 1990;72(6):840-5.
8. Giannini S. Operative treatment of the flatfoot: why and how. Foot Ankle Int. 1998;19(1):52-8.
9. Giannini S, Cadossi M, Mazzotti A, Persiani V, Tedesco G, Romagnoli M, et al. Bioabsorbable calcaneo-stop implant for the treatment of flexible flatfoot: a retrospective cohort study at a minimum follow-up of 4 years. J Foot Ankle Surg. 2017;56(4):776-82.
10. Pavone V, Costarella L, Testa G, Conte G, Riccioli M, Sessa G. Calcaneo-stop procedure in the treatment of the juvenile symptomatic flatfoot. J Foot Ankle Surg. 2013;52(4):444-7.
11. Koning PM, Heesterbeek PJ, de Visser E. Subtalar arthroereisis for pediatric flexible pes planovalgus. J Am Podiatr Med Assoc. 2009;99(5):447-53.
12. Rossi C. A incidência de pé cavo, plano e normal em indivíduos com classe I, II e III de Angle [dissertation]. Cascavel: Faculdade Assis Gurgacz; 2006. 91 p.
13. Craveiro WA. Perfil das superfícies plantares de atletas amadores de corrida de rua em Brasília [dissertation]. Brasília, DF: Universidade Paulista, 2009.20 p.
14. The R Project for Statistical Computing [Internet]. [Vienna]: The R Foundation; [cited 2020 Mar 23]. Available from: https://www.r-project.org/
15. Fernández de Retana P, Álvarez F, Viladot R. Subtalar arthroereisis in pediatric flatfoot reconstruction. Foot Ankle Clin. 2010;15(2):323-35.
16. Dana C, Péjin Z, Cadilhac C, Wicart P, Glorion C, Aurégan JC. Long-term results of the "horseman" procedure for severe idiopathic flatfoot in children: a retrospective analysis of 41 consecutive cases with mean 8.9 year duration of follow-up. J Foot Ankle Surg. 2019;58(1):10-6.
17. Kelikian A, Mosca V, Schoenhaus HD, Winson I, Weil L Jr. When to operate on pediatric flatfoot. Foot Ankle Spec. 2011;4(2):112-9.
18. Metcalfe SA, Bowling FL, Reeves ND. Subtalar joint arthroereisis in the management of pediatric flexible flatfoot: a critical review of the literature. Foot Ankle Int. 2011;32(12):1127-39.
19. Faldini C, Mazzotti A, Panciera A, Persiani V, Pardo F, Perna F, et al. Patient-perceived outcomes after subtalar arthroereisis with bioabsorbable implants for flexible flatfoot in growing age: a 4-year follow-up study. Eur J Orthop Surg Traumatol. 2018;28(4):707-12.
20. Zaret DI, Myerson MS. Arthroereisis of the subtalar joint. Foot Ankle Clin. 2003;8(3):605-17.

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ORIGINAL ARTICLE

INTER- AND INTRA-OBSERVER RELIABILITY OF SCHATZKER, AO, AND LUO CLASSIFICATIONS FOR TIBIAL PLATEAU FRACTURES

AVALIAÇÃO INTER E INTRAOBSERVADORES DAS CLASSIFICAÇÕES DE SCHATZKER, AO E LUO PARA FRATURAS DO PLATÔ TIBIAL

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ABSTRACT

Objective: To verify inter- and intra-observer agreement of three classification systems for tibial plateau fractures – Schatzker, AO/ASIF, and Luo's – among orthopedic surgery residents. Methods: This cross-sectional study was conducted with 29 observers. Radiographic and tomographic imaging of the knee of 15 patients presenting with fractures were evaluated. After six weeks, the test was reapplied. The level of agreement was calculated by the Kappa index. Results: In test 1, inter-observer agreement of all residents, according to the Kappa index, for Schatzker classification was 0.226, for AO 0.431, and Luo's 0.319. In test 2, values were 0.316, 0.333, and 0.347, respectively ($p < 0.001$). Regarding intra-observer analysis, the mean Kappa indexes of 1st-year residents were: Schatzker, 0.20; AO, 0.32; and Luo's, 0.3. For 2nd-year residents, means were: 0.51, 0.58, and 0.38, respectively. As for 3rd-year, results were 0.42, 0.42, and 0.41, respectively ($p < 0.001$). Conclusion: AO/ASIF showed a better reproducibility than other classifications, with substantial inter- and intra-observer agreement. We also found a stronger agreement among 2nd- and 3rd-year residents. ***Level of Evidence III, Diagnostic Studies – Investigating a Diagnostic Test.***

Keywords: Tibial Fractures. Classification. Correlation Analyses.

RESUMO

Objetivo: Verificar a concordância interobservador e intraobservador de três classificações utilizadas nas fraturas do platô tibial: Schatzker, AO/ASIF e a de Luo entre residentes de ortopedia. Métodos: estudo transversal, por conveniência, com 29 observadores. Foram avaliadas imagens radiográficas de joelho e tomografia computadorizada em 15 pacientes com fraturas de platô tibial, submetidos a tratamento cirúrgico, sendo reaplicado o teste após seis semanas. O nível de concordância foi calculado através do índice Kappa. O estudo foi submetido ao Comitê de Ética em Pesquisa em humanos da instituição. Resultados: A concordância interobservador dos residentes dos três anos juntos de acordo com o índice Kappa para a classificação Schatzker, AO e tomográfica no teste 1 foi 0,226, 0,431 e 0,319 respectivamente e no teste 2 0,316, 0,333, 0,347 respectivamente. Na análise intraobservador, foi calculada a média dos índices Kappa dos residentes do 1º ano: classificação Schatzker, 0,20; AO 0,32; e tomográfica 0,3. Já a média para os residentes do 2º ano Schatzker foi 0,51, 0,58 e 0,38, respectivamente. Os resultados para os residentes do 3º ano foram 0,42, 0,42 e 0,41 respectivamente. Conclusão: A classificação AO/ASIF mostrou-se ter uma melhor reprodutibilidade em relação as outras com uma concordância substancial na análise interobservador e intraobservador. Evidenciou-se também que os residentes do 2º e 3º ano tem uma concordância maior. ***Nível de Evidência III, Estudos diagnósticos – Investigação de um exame para diagnóstico.***

Descritores: *Fraturas da Tíbia. Classificação. Análises de Correlação.*

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INTRODUCTION

Tibial plateau fractures account for 1 to 2% of all fractures and involve the articular surface of the proximal tibia.[1,2] Such trauma has a bimodal distribution, affecting mainly young adults and individuals between the fourth and sixth decades of life, and may be sustained in high- or low-energy mechanisms.[3,4] They result from axial compression associated with varus or valgus deviation, which may cause depression or shearing of the load-bearing area.[1,5] This type of fracture requires a deep understanding of the lesion pattern and, consequently, classification systems for surgical planning and prognosis estimates.[1] These evaluations often entails radiographs, especially in the Schatzker classification, the most used method worldwide.[6]

Although many possible classification systems for tibial plateau fractures are available, the most employed are: Schatzker, the Association for Osteosynthesis/Association for the

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The study was conducted at Instituto Dr. José Frota, Orthopedics and Traumatology Service.
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Study of Internal Fixation (AO/ASIF) classification, and Luo's tomographic classification.

The Schatzker classification is based on anteroposterior plain radiographs and divides injuries into six types, ranging from grade 1 to 6.[7-9] In turn, AO/ASIF classifies fractures according to the alphanumeric code 41 (4 – tibia, 1 – proximal region) into the following standards: A (non-articular), B (partial articular), and C (total articular), whereby the higher the standard, the greater the severity and energy of the injury.[10] Luo's classification draws on tomography sections to classify fractures according to their localization within the axial plane, subdividing them into fractures of the lateral, medial, and posterior column. These subgroups may eventually intersect.[11]

When selecting the ideal treatment, the classification of fractures gains increasing relevance. Schatzker classification, still important in the field of tibial plateau fractures, provides a definition of the pathological anatomy and suggests therapeutic strategies. The AO/ASIF classification has an adequate performance for the proximal third of the tibia and remains the leading international method for classifying fractures. Luo's tomographic classification emerged as an alternative method for visualizing the fracture in three dimensions and defining appropriate treatment strategies.

This study aimed to evaluate the levels of intra- and inter-observer reliability for the Schatzker, AO/ASIF, and Luo's classification systems in a group of resident physicians in different years of their residency at a tertiary-care trauma hospital to reproduce the behavior of different surgeons from heterogeneous groups.

MATERIALS AND METHODS

A total of 15 patients presenting with tibial plateau fractures who attended to the traumatology service of a level-I trauma hospital from April 2016 to June 2016 were selected by non-probability, convenience, and consecutive sampling.

In that period, 29 observers (resident physicians, of which nine were from the 1st year, ten from the 2nd, and ten from the 3rd) independently and randomly classified radiographs (anteroposterior and profile) and computed tomography (CT) scans of the knee, with 0.6 mm axial slices. A Philips® digital radiography system and a Siemens CT Scan machine with 16 multi-slice channels for sections width of 0.6 mm were used. Images were obtained by photographs taken with an iPhone® 6 with 8-megapixel resolution, and displayed using PowerPoint® 2016 on an Epson overhead projector. After six weeks, the test was reapplied. The level of agreement was calculated by the Kappa index for intra- and inter-observer reliability and interpreted according to Landis and Koch.

All observers had access to the same images and categorized the fractures according to Schatzker, AO/ASIF, and Luo's classification systems. Data were recorded on a specific paper questionnaire.

Before each application, an orthopedist specialized in knee trauma briefly reviewed the three classifications used. An illustration of each classification with subtitles was also provided to all observers.

After completion, results were collected and analyzed using the Statistical Package for Social Sciences – SPSS® v. 23.0 (Chicago, USA) to determine Kappa coefficient. Table 1 shows how intra- and inter-observer agreement was determined. Statistical analysis was performed using Cohen's Kappa (k) statistic to evaluate inter-observer reliability between tests, with 95% confidence interval (95%CI). When analyzing agreement among residents (1st, 2nd, and 3rd years), Fleiss' Kappa coefficient of agreement was adopted, with 95% confidence interval (95%CI) and tests to assess whether the coefficient was statistically different from zero. The tested hypothesis was: agreement (ρ) equal to zero indicated no inter-observer agreement, Kappa statistic equals 1 indicated perfect agreement, and close to or less than zero indicated disagreement, that is, the observed agreement is less suitable than by chance. This study was conducted following the basic principles for ethical researches involving humans – as autonomy of research participants, justness, beneficence, and non-maleficence, – according to Resolution 466/12. Participants agreed to participate by signing a consent form prior to the pilot test, usability test, and application effectiveness test.

The study was submitted to the Human Research Ethics Committee (CEP) and approved under protocol No. 2,087,850.

RESULTS

Among 1st-year residents, the results of tests 1 and 2 showed values close to the kappa coefficients in the Schatzker (0.125 and 0.114) and AO/ASIF (0.217 and 0.220) classifications. However, Luo's tomographic classification showed a higher value in test 1 (0.264 and 0.213). According to Landis and Koch, agreement for the Schatzker classification is considered slight, and for the AO and Luo's tomographic classifications it is fair.

As for 2nd-year residents, values were close to the kappa coefficients both in Luo's tomographic classification (0.390 and 0.364) and Schatzker (0.246 and 0.380). In test 2, AO/ASIF (0.453 and 0.538) showed higher coefficients values. According to Landis and Koch, the agreement in Schatzker and Luo's classifications was fair, and in AO/ASIF it was moderate.

Regarding 3rd-year residents, the kappa coefficient increased from test 1 to test 2 in Schatzker (0.226 and 0.316) and Luo's (0.319 and 0.347), but decreased in AO (0.431 and 0.333). For Landis and Koch, most agreements were fair, except in AO for test 1, in which it was moderate.

In the three classification systems, Fleiss' kappa coefficients of agreement were lower in test 1 for 1st-year residents and higher for 2nd-year residents. AO/ASIF presented the highest values, which, according to Landis and Koch, was considered a moderate agreement. As for test 2, Fleiss' kappa coefficients of agreement were also lower for 1st-year residents and higher for 2nd-year residents in all three classifications. AO/ASIL presented the highest observed value, which, according to Landis and Koch, was considered a moderate agreement (Table 1).

The mean kappa value from the two tests applied, calculated from the intra-observer analysis of 1st-year residents, was 0.25 for Schatzker, 0.32 for AO/ASIF, and 0.30, for Luo'stomographic classification. We found a stronger agreement in the AO/ASIF classification among 1st-year residents.

We performed an agreement analysis among 1st-year residents for tests 1 and 2. Resident 5 had the lowest kappa coefficient, in Schatzker classification (0.077), and resident 9 had the highest, in the AO/ASIF classification (1.000). In the Schatzker classification, resident 1 obtained 0.429, resident 6 obtained 0.634, and resident 9 0.511, considered moderate. As for kappa values in AO/ASIF, resident 3 obtained 0.405, resident 4 0.496, resident 8 0.455, and resident 9 1.0. In turn, kappa values in the Luo's tomographic classification were 0.420 for resident 3, 0.400 for resident 4, 0.457 for resident 6, and 0.630 for resident (Figure 1).

Table 1. Fleiss' kappa coefficients (K) of inter-observer agreement, with 95% confidence intervals (95%CI), and p-values according to resident group, test, and classification system of patients treated at the tertiary hospital from April to June 2016.

Resident	Test	Aspect	K	95%CI		p-value
1st year	1	Schatzker	0.125	0.086	0.164	< 0.001
		AO	0.217	0.147	0.288	< 0.001
		Tomographic	0.264	0.221	0.307	< 0.001
	2	Schatzker	0.114	0.072	0.157	< 0.001
		AO	0.220	0.148	0.293	< 0.001
		Tomographic	0.213	0.172	0.254	< 0.001
2nd year	1	Schatzker	0.246	0.206	0.285	< 0.001
		AO	0.453	0.385	0.522	< 0.001
		Tomographic	0.390	0.348	0.433	< 0.001
	2	Schatzker	0.380	0.339	0.422	< 0.001
		AO	0.538	0.469	0.607	< 0.001
		Tomographic	0.364	0.321	0.408	< 0.001
3rd year	1	Schatzker	0.226	0.187	0.266	< 0.001
		AO	0.431	0.354	0.508	< 0.001
		Tomographic	0.319	0.276	0.362	< 0.001
	2	Schatzker	0.316	0.275	0.358	< 0.001
		AO	0.333	0.262	0.403	< 0.001
		Tomographic	0.347	0.304	0.389	< 0.001

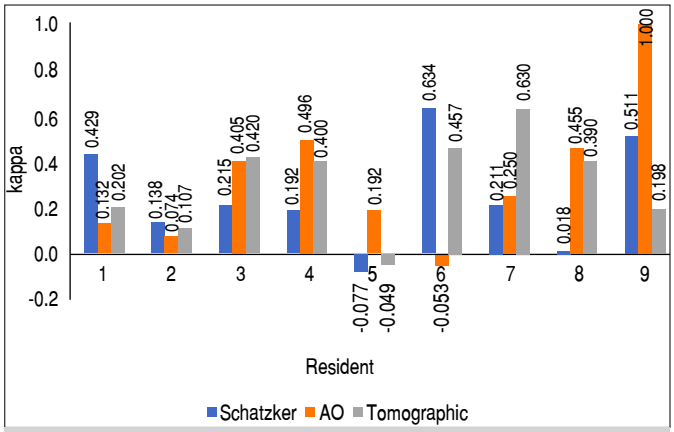

Figure 1. Cohen's kappa coefficients of agreement (k) between tests in 1st-year residents according to classification system and resident.

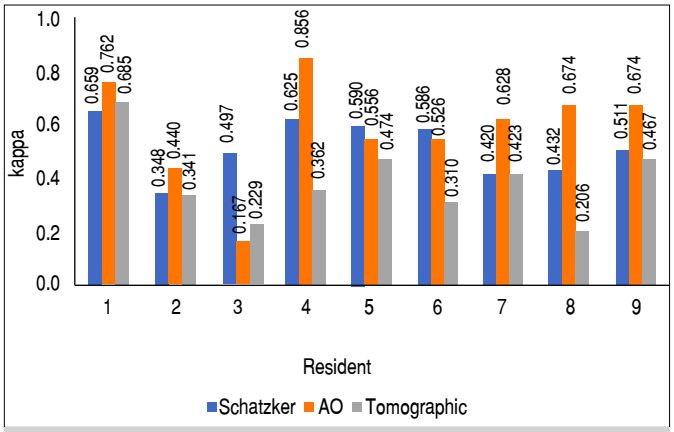

Figure 2. Cohen's kappa coefficients of agreement (k) between tests in 2nd-year residents according to classification system and resident.

The mean kappa value from the two tests applied, calculated from intra-observer analysis among 2nd-year residents, was 0.518 in the Schatzker classification, 0.587 in the AO classification, and 0.306 in the Luo's tomographic classification. We found a more significant agreement in the AO/ASIF classification.

Considering test 1 and 2, kappa coefficients varied less among 2nd-year residents than among 1st-year residents in the three classifications (Figure 2). Schatzker and AO classifications had the least pronounced difference. The lowest value of the kappa coefficient of agreement (0.167), as well as the highest (0.856) occurred in the AO classification for residents 3 and 4. The following residents were classified as moderate or substantial agreement: 1, 5, 7, and 9, in the three classifications; 4, 6, and 8, in the Schatzker and AO classifications; resident 2, in the AO classification, and resident 3, in the Schatzker classification.

The mean kappa value from the two tests applied, calculated in the intra-observer analysis among 3rd-year residents, was 0.426 in the Schatzker classification, 0.426 in the AO/ASIF classification, and 0.415 in the Luo's tomographic classification. We found a stronger agreement in Schatzker and AO classifications among 3rd-year residents, and a smaller difference between absolute kappa values in the three classifications.

Figure 3 shows the differences in the kappa coefficients between tests 1 and 2, both among 3rd- and 1st-year residents, in the three classifications. Resident 7 had the lowest kappa coefficient, in the Schatzker classification (0.052), and resident 1 had the highest in the AO/ASIF classification (0.872). The following residents were classified as moderate or substantial agreement: 1 and 8, in the three classifications; 4 in the Schatzker and AO classifications; 7 in the AO and Luo's tomographic classifications; 3 and 5 in the Luo's tomographic classification; resident 6 in the Schatzker classification, and resident 9 in the AO classification.

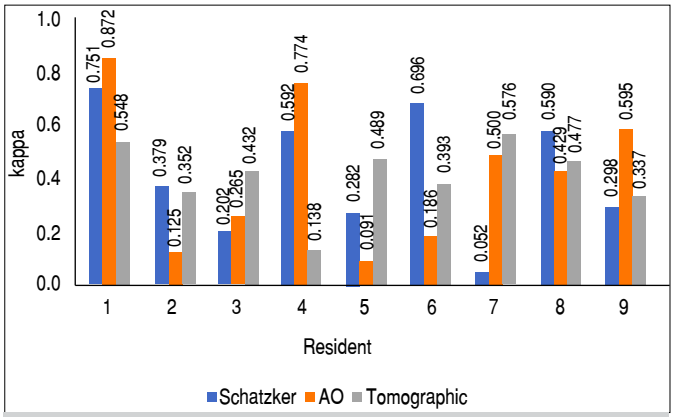

Figure 3. Cohen's kappa coefficients of agreement (k) between tests in 3rd-year residents according to classification system and resident.

DISCUSSION

Classification systems in the fields of orthopedics and traumatology play a key role in the treatment of observed injuries. They assist in standardizing an international classification of lesions, in defining treatment strategies (be it operative or nonoperative), and in predicting outcomes related to the types of fractures presented. When managing a fracture, such criteria must be rigorously fulfilled to obtain a better diagnosis, treatment, and prognosis. For this purpose, our study aimed to determine which classification system meets all requirements, facilitating the surgeon's management of the case.

According to Dirschl et al.,[12] classifications for of tibial plateau fractures present a low inter-observer reproducibility. In their study, 17 observers evaluated 56 fractures based on radiographs, 38 of which also had computed tomography scans. They found a large variability within the reliability of the assessments, as measured by kappa statistics. The higher kappa index was attributable to determining fracture location (0.68), while fracture stability (0.37) and energy (0.29) showed lower reliability. Our study was more focused in analyzing tibial plateau fractures. Yet, rigorous and specific evaluations show a lower inter-observer agreement, indicating a wide variation among evaluated criteria for classifying these fractures.

Walton et al.[9] evaluated 53 knee radiographs in patients presenting with tibial plateau fractures. In comparing Schatzker and AO/ASIF classifications by inter-observer analysis, the authors concluded that AO/ASIF was more reproducible than Schatzker, corroborating our findings. They also verified that both classifications were originally based on radiographic studies.

Mandarino et al.[10] adopted a method similar to ours: they selected 20 examiners to evaluate 20 cases of tibial plateau fractures, in a single application test, using the Schatzker classification. Their study group was composed of 10 orthopedic residents, 5 knee specialists, and 5 general orthopedists. By performing an inter-observer analysis and obtaining a kappa agreement of 0.526, the authors concluded that the Schatzker classification is moderately reproducible, even after grouping them into more homogeneous groups, as showed in our study. As 50% of Mandarino et al.[10] study group consisted of graduated orthopedists, a strong inter-observer agreement (kappa between 0.61 and 0.8) was expected, which was not reflected in the study results.

Martin et al.[13] analyzed the inter-observer reproducibility of the AO/ASIF classification in 56 radiographs of tibial plateau fractures, concluding that this classification system is reproducible within this type of fractures, and that the level of agreement in conventional radiographic evaluation depends on the observer 's experience. In our study, 2nd-year residents showed a stronger agreement than 3rd-year residents, diverging from the results found by Martin et al. However, we also found that 2nd- and 3rd-year residents showed a stronger agreement than 1st-year residents, corroborating Martin's survey.

Our study poses some limitations, as the difficulty faced in interpreting data of the categorical variables in the Luo's tomographic classification, given they are qualitative variables. The kappa index is more easily applied into quantitative and ordinal (rather than nominal) variables, so qualitative variables demand transforming them into quantitative to enable a better organization.

Another limitation was the limited number of plateau fractures evaluated (n = 15) and observers submitted to the questionnaires (n = 29). Also, the values obtained were not compared with those of orthopedists, knee specialists, or even orthopedic trauma specialists, which could have influenced the results.

We suggest further researchers to proceed with the rigorous investigation on the applicability of existing classifications for tibial plateau fractures, extending the application of questionnaires to general orthopedists and in knee or orthopedic trauma specialists. We also recommend testing the applicability of the classification system that showed greater inter- and intra-observer reproducibility (AO/ASIF) to verify outcomes and complications related to the treatment of these types of fractures. It is also necessary to perform a thoroughly review of the concepts established by the Schatzker classification by testing its applicability and reliability among the evaluated sample, as a way of improving research on tibial plateau fractures.

CONCLUSION

Of the three analyzed classification system, AO/ASIF showed greater intra-observer and inter-observer reproducibility in evaluating tibial plateau fractures, with greater kappa indexes in most of the performed analyses.

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REFERENCES

1. Tomislav C, Cerovec T. Tibial plateau fracture management: arthroscopically--assisted versus ORIF procedure – clinical and radiological comparison. Injury. 2017;48(Suppl 5):S61-S64.
2. Albuquerque RP, Hara R, Prado J, Schiavo L, Giordano V, Amaral NP. Estudo epidemiológico das fraturas do planalto tibial em Hospital de Trauma nível I. Acta Ortop Bras. 2013;21(2):109-15.
3. Prat-Fabregat S. Instructional lecture: knee treatment strategy for tibial plateau fractures: an update. EFORT Open Rev. 2016;1(5):225-32.
4. Elsoe R, Larsen P, Nielsen NPH, Swenne J, Rasmussen S, Ostgaard SE. Population-based epidemiology of tibial plateau fractures. Orthopedics. 2015;38(9):e780-6.
5. Mthethwa J, Chikate A. A review of the management of tibial plateau fractures. Musculoskelet Surg. 2017;102(2):119-27.

6. Molenaars RJ, Mellema JJ, Doornberg JN, Kloen P. Tibial plateau fracture characteristics: computed tomography mapping of lateral, medial, and bicondylar fractures. J Bone Joint Surg Am. 2015;97(18):1512-20.
7. Schatzker J. Anterior approach to the knee with osteotomy of the tibial tubercle for bicondylar tibial fractures. J Bone Joint Surg Am. 1988;70(2):208-19.
8. Schatzker J, McBroom R, Bruce D. The tibial plateau fracture. The Toronto experience 1968-1975. Clin Orthop Relat Res. 1979;(138):94-104.
9. Walton NP, Harish S, Roberts C, Blundell C. AO or Schatzker? How reliable is classification of tibial plateau fractures? Arch Orthop Trauma Surg. 2003;123(8):396-8.
10. Mandarino M, Pessoa A, Guimarães JAM. Avaliação da reprodutibilidade da classificação de Schatzker para as fraturas do Planalto Tibial. Rev INTO. 2004;2(2):11-8.
11. Luo CF, Sun H, Zhang B, Zeng BF. Three-column fixation for complex tibial plateau fractures. J Orthop Trauma. 2010;24(11):683-92.
12. Dirschl DR, Dawson PA. Injury severity assessment in tibial plateau fractures. Clin Orthop Relat Res. 2004;(423):85-92.
13. Martin J, Marsh JL, Nepola JV, Dirschl DR, Hurwitz S, DeCoster TA. Radiographic fracture assessments: which ones can we reliably make? J Orthop Trauma. 2000;14(6):379-85.

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ORIGINAL ARTICLE

EVALUATION BY THE FELLOW IN KNEE SURGERY IN BRAZIL

AVALIAÇÃO DO ESPECIALIZANDO EM CIRURGIA DO JOELHO DO BRASIL

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ABSTRACT

Objective: To evaluate the fellow in knee surgery and the training offered by accredited programs in Brazil. Methods: This cross-sectional study administered a questionnaire to fellows in knee surgery. Results: Most fellows reported being assisted by the preceptor in theoretical, practical, and scientific activities. Conclusion: The training offered by accredited programs to fellows in knee surgery presented good results for their education. This study may propose educational measures for the Brazilian Society for Surgery of the Knee (SBCJ). ***Level of Evidence IIC, Cross-sectional study.***

Keywords: Internship and Residency. Knee. Orthopedics.

RESUMO

Objetivo: Avaliar o especializando em cirurgia de joelho e o treinamento oferecido pelos serviços credenciados no Brasil. Métodos: Estudo transversal por meio de um questionário enviado para os especializados em cirurgia de joelho responderem. Resultados: A maioria dos especializandos relataram assistência por parte da preceptoria nas atividades teórica, prática e científica. Conclusão: O treinamento dos serviços credenciados oferecido para os especializandos em cirurgia de joelho apresentou bons resultados para a formação deles. O estudo pode promover medidas educacionais para a Sociedade Brasileira de Cirurgia de Joelho (SBCJ). ***Nível de Evidência IIC, Estudo transversal.***

Descritores: *Internato e Residência. Joelho. Ortopedia.*

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INTRODUCTION

In Brazil, orthopedic training consists of three years of medical residency and approval in the examination for title license at its end, organized by the Brazilian Society of Orthopedics and Traumatology (SBOT). These are necessary steps for an orthopedist to improve within the subspecialties. Knee fellowship lasts one year and comprises an examination at the end of the residency to grant fellows, if approved, the title of specialist.

The Brazilian Society for Surgery of the Knee (SBCJ) has accredited 83 programs with an average of 134 vacancies/year for specialty training, which includes: clinical and surgical education, theoretical training, involvement in clinical trials, and doctor-patient relationship.[1] Although the country literature presents studies related to medical education and training,[2] those focused on orthopedics are scarce. Moreover, little is known about the profile of the candidate that chooses to specialize in knee surgery.

This cross-sectional study aims to determine the profile of fellows in knee surgery and services accredited by the SBCJ, understanding how this population's training is and whether it follows a national standard. In doing so, our results may eventually assist further educational and universal measures.

MATERIALS AND METHODS

This study was approved by the Research Ethics Committee of the Universidade Federal de São Paulo (UNIFESP).

This cross-sectional study (level of evidence IIC, according to the Oxford Classification) administered a questionnaire to fellows in knee surgery of programs accredited by the SBCJ in 2017. All fellows agreed to participate, and their data were obtained with SBCJ consent. Yet, participants' data were kept confidential.

Initially, each participant was contact by email, receiving an explanation about the study and the questionnaire attached by the

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

The study was conducted at Universidade Federal de São Paulo, Department of Orthopedics and Traumatology, Sports Traumatology Center (CETE).
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digital software SurveyMonkey. Three attempts were made, with an interval of two weeks between each.
When participants failed to provide a response, telephone contact would be attempted for three times. In the eventual lack of response, we would attempt to contact the fellow by letter, two times, with the questionnaire attached.

Fellows who did not answer the survey after all attempts by email, telephone, and letter and those who answered incompletely were excluded.
The questionnaire was composed of 26 questions divided into 4 blocks: fellow's personal information, training place, practical/surgical/clinical training, and involvement in scientific projects (Figure 1).

Evaluation of residency programs in knee surgery – 2017

CETE

Name (initials):
Age:
Gender:
Place of birth (state):
Email:

1- Have you done any other fellowship before?	Yes	No
2- Started fellowship in knee right after residency?	Yes	No
3- Same place of residency and fellowship in knee?	Yes	No
4- Same state of residency and fellowship?	Yes	No
5- Same state of your hometown and fellowship?	Yes	No
6- If the previous answer was negative, do you intend to return to your city after completing fellowship?	Yes	No

Place of fellowship

7- Is it connected to any university/faculty?	Yes	No
8- Is it connected to any person?	Yes	No
9- Is it established in a public institution?	Yes	No
10- Is it established in a private institution?	Yes	No
11- Is it established in both private and public institutions? What percentage each?	public	private
12- How many hospitals do you attend in a typical week (in average)?		
13- Do you hold a scholarship or are you paid somehow for assisting surgical procedures?	Yes	No
14- What is your weekly workload (in average)? Hours	Hours	
15- Do you have theoretical activities? How many hours a week?		
16- If the previous answer was positive, what do these theoretical activities consist of?		

Class Case Discussion Seminar Cadaver lab
(service or encouraged/sponsored) Congress Articles Discussion

17- Do you consider the load of theoretical activities appropriate to take tests? How about to your knowledge?

Place/practical portion (surgeries)

18- In a typical week, in approximately how many surgeries do you participate?
Arthroplasty, Anterior Cruciate Ligament (ACL)/Posterior Cruciate Ligament (PCL) Arthroscopy,
Simple Arthroscopy/Partial Meniscectomy Meniscorraphy, Complex injuries, Other trauma/fracture,
surgeries unrelated to the knee (fractures, arthroscopies, etc.) Specify:

19- Do you actually participate in surgical procedures?	Yes	No
20- Does your preceptor teach during surgeries?	Yes	No
21- Do you believe that, at the end of the fellowship, you will be able to perform surgical procedures? Arthroplasty, Anterior Cruciate Ligament, Posterior Cruciate Ligament Partial meniscectomy, Complex lesions, Other surgeries Specify:		
22- Does the program face financial difficulties in performing surgeries, such as lack of material, staff, etc.?	Yes	No

Research

23- Are you currently participating in any scientific research? How many?	Yes	No
24- Is the theme of your research related to knee surgery?	Yes	No
25- How interested are you in conducting scientific research? Very interested Interested Indifferent Not interested		
26- Do you feel that your program provides financial support/conditions for scientific activities?	Yes	No
27- If the previous answer was negative, why? Lack of financial conditions Lack of support (preceptor/knowledge) Other		

28- Do you think that the program provides knowledge for the performance of scientific work? Such as classes, work discussion, meetings?

Figure 1. Questionnaire administered to 2017 fellows in knee surgery.

Results were tabulated in the Microsoft Excel (Microsoft®,USA), analyzed, and interpreted. Data were presented in absolute numbers and percentages, in tables and graphs.

RESULTS

We evaluated data obtained from the questionnaires and compared them according to a division proposed by the SBCJ, which defines seven regional (São Paulo; Rio de Janeiro; South; Minas Gerais/ Espírito Santo; North; Northeast; and Midwest) for 83 accredited programs (Table 1).

Among the 134 fellows in knee surgery in 2017, 91 (68%) were included and completed the study, and 43 (32%) were excluded for not answering the survey or answering it incompletely. Table 2 shows the distribution according accredited programs location, number of fellows in the country, and number of participants in the study.

Table 1. Programs accredited by the SBCJ for fellowship training in knee surgery in Brazil.

São Paulo Regional	
39 Programs	**City**
Clínica Nunes Ortopedia Traumatologia (CNOT)	Campinas
Clínica de Traumatologia e Ortopedia (CTO)	Campinas
Centro de Estudos do Centro de Ortopedia e Reabilitação at Esporte do Hospital do Coração (CECORE)	Sao Paulo
Centro Médico Kawano (CEMKA)	Sao Paulo
Centro de Traumato-Ortopedia do Esporte (CETE) UNIFESP	Sao Paulo
Clínica Ortopédica Cidade Jardim	Sao Paulo
Knee Surgery Group of the Clínica Ortopédica Tatuapé	Sao Paulo
Clínica Pacheco	Piracicaba
Clínica Traumato-Ortopédica Prof. Dr. Hilário Maldonado/ Associação Beneficente Hospital Universitário (ABHU)	Marilia
Knee Group of the Complexo Hospital do Mandaqui	Sao Paulo
Centro de Tratamento do Joelho (CTJ)	Sao Paulo
Knee Surgery Group of the Faculdade de Medicina de São José do Rio Preto (FAMERP)	São J do Rio Preto
Knee Surgery Group of the Faculdade de Medicina do ABC (FMABC)	Santo Andre
Sports traumatology Group of the FMABC	Santo Andre
Hospital Israelita Albert Einstein	São Paulo
Sports Medicine Group of the IOT – HCFMUSP	Sao Paulo
Hospital das Clínicas of the Faculdade de Medicina de Ribeirão Preto – USP (HC FMRP-USP)	Ribeirao Preto
Knee Group of the Hospital das Clínicas da Faculdade de Medicina de Marília (HC-Famema)	Marilia
Knee Group of the Hospital de Clínicas da UNICAMP (HC-UNICAMP)	Campinas
Knee Group of the Orthopedic Trauma Service from the Hospital do Servidor Público Estadual Francismo Morato de Oliveira (HSPE-FMO)	Sao Paulo
Knee Surgery Group of the Hospital Nipo Brasileiro	Sao Paulo
Casa de Saúde Santa Marcelina	São Paulo
Knee Group of the Hospital São Bernardo do Campo (IFOR)	Sao Paulo
Hospital Novo Atibaia – Instituto do Joelho "Dr. Kenji Kawakami"	Atibaia
Knee Group of the Orthoservice Hospital Ortopédico	Sao Jose dos Campos
Knee Group of the Hospital Regional de Osasco – Dr. Vivaldo Martins Simões	Osasco
Instituto Cohen	Sao Paulo
Instituto Vita	Sao Paulo
Instituto de Ortopedia e Traumatologia (IOT) – HCFMUSP	Sao Paulo
Núcleo de Ortopedia e Medicina Esportiva	Sorocaba
Clinica ORTOTRAUMAESPORTE	Sao Paulo
Ortocity Serviços Médicos	Sao Paulo
Knee Group of the Department of Orthopedics PUC – Campinas	Campinas
Knee Group of the Hospital Santa Casa de Misericórdia de Marília	Marilia
Knee Surgery Group of the Department of Orthopedics and Traumatology of the Santa Casa de Misericordia de São Paulo	Sao Paulo
Knee Group of the DOT-EPM – UNIFESP	Sao Paulo
Unisa	Sao Paulo
Hospital Municipal Cármino Caricchio	Sao Paulo
Hospital Universitário São Francisco	Bragança Paulista

Table 1. Programs accredited by the SBCJ for fellowship training in knee surgery in Brazil. | Continuation

Rio de Janeiro Regional	
6 Programs	**City**
Knee Group of the Hospital Santa Teresa	Petropolis
Hospital Universitário Gaffrée e Guinle/Universidade Federal do Estado do Rio de Janeiro (UNIRIO)	Rio de Janeiro
Center for Knee Surgery of the Instituto Nacional de Traumatologia e Ortopedia	Rio de Janeiro
Knee Group of the Hospital da Polícia Militar do RJ	Rio de Janeiro
Knee Group of the Hospital Federal dos Servidores do Estado-RJ	Rio de Janeiro
Hospital Rios D'or	Rio de Janeiro
South Regional (SC/ PR/ RS)	
14 Programs	**City**
Instituto Balsini	Joinville
Instituto de Ortopedia e Traumatologia (IOT) from Santa Catarina	Joinville
Knee Group of the Hospital Ortopédico de Passo Fundo	Passo Fundo
Orthopedic Trauma Service of the Hospital São Lucas of PUC-RS	Porto Alegre
Knee Group of the Instituto de Ortopedia e Traumatologia de Passo Fundo	Passo Fundo
Knee Group of the Santa Casa de Misericórdia de Porto Alegre	Porto Alegre
Serviço de Ortopedia e Traumatologia Independente (SOTI)	Porto Alegre
Clínica do Joelho de Londrina	Londrina
Centro de Traumatologia Esportiva e Artroscopia (CTEA)	Curitiba
Knee Group of the Hospital das Clínicas da Universidade Federal do Paraná	Curitiba
Knee Group of the Hospital de Clinicas de Porto Alegre	Porto Alegre
Knee Group of the Hospital Universitário Cajuru – PUC-PR	Curitiba
Knee Group of the Hospital Universitário Evangélico de Curitiba	Curitiba
Uniort.e Ortopedia Especializada	Londrina
ES/MG Regional	
12 Programs	**City**
Knee Group of the Faculdade de Ciências Médicas de Minas Gerais	Belo Horizonte
Knee Group of the Hospital Mater Dei – BH	Belo Horizonte
Knee Group of the Hospital das Clínicas da Universidade Federal de Minas Gerais	Belo Horizonte
Knee Group of the Hospital de Clínicas da Universidade Federal de Uberlândia	Uberlandia
Knee Group of the Hospital Madre Teresa	Belo Horizonte
Hospital Ortopédico de Belo Horizonte	Uberaba
Hospital Universitário Mário Palmério	Uberaba
Hospital Felício Rocho	Belo Horizonte
OrtoLife – Centro Ortopédico Avançado	Belo Horizonte
Knee Group of the Santa Casa de Misericórdia de Belo Horizonte	Belo Horizonte
Knee Group of the Hospital Biocor	Belo Horizonte
Complexo Hospitalar São Franciso - Hospital Santa Lúcia (Serviço Nelson Baisi Cerqueira)	Belo Horizonte
Midwest Regional (TO, DF, GO, MS, MT)	
3 Programs	**City**
Knee Group of the Hospital das Forças Armadas	Brasilia
HOME/Brazilian Olympic Committee (COB)	Brasilia
Knee Advanced Surgery Training of the Orthopedics and Traumatology Medical Residency of the HC of the Universidade Federal de Goiás (UFG)	Goiania
North Regional (MA, PA, AM, RN, RO, AP, AC)	
2 Programs	**City**
Knee Group of the Hospital Adventista de Manaus	Manaus
Knee Surgery Service of the Fundação Hospital Adriano Jorge	Manaus

Table 1. Programs accredited by the SBCJ for fellowship training in knee surgery in Brazil. | Continuation

Northeast Regional (BA,SE,AL); (PE,PB,RN, CE,PI)	
7 Programs	**City**
COT	Salvador
Clínica Ortopédica de Acidentados	Recife
Instituto de Traumatologia e Ortopedia Romeu Krause (ITORK)	Recife
ORTOPED	Salvador
Knee Group of the Santa Casa de Misericórdia da Bahia	Salvador
Hospital São Rafael/Hospital Manoel Vitorino	Salvador
Physiotherapy Center of the Obras Sociais Irmã Dulce Serviço from the Hospital Santo Antonio	Salvador

Table 2. Distribution by SBCJ regional and number of programs, fellows, and participants in the study.

SBCJ Regional	Accredited Programs	2017 Fellows	Study Participants
São Paulo	39	70	56
South	14	15	8
Minas Gerais/Espírito Santo	12	13	6
Northeast	7	19	11
Rio de Janeiro	6	11	6
Midwest	3	5	3
North	2	1	1

Fellow's mean age was 31.27 years, ranging from 27 to 39 years (Figure 2).

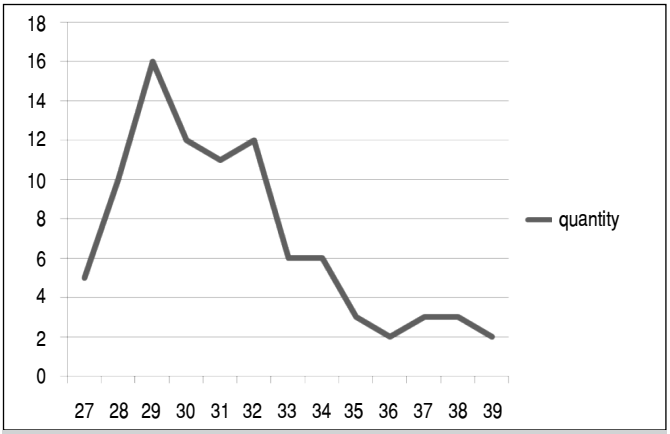

Figure 2. Number of fellows in knee surgery × age.

Only one of the 91 participants were women. All other participants were men (98.8%). Most fellows (41%) were born in the state of São Paulo (Table 3).

Regarding academic record, 84% of the participants started their fellowship right after finishing orthopedics residency. In total, 87% declared that knee surgery was their first fellowship. For 63%, the place where they undertook orthopedics residency was not the same as the fellowship training. But 74% reported that both programs were located within the same state.

The place of residence is the same as the fellowship program for 60% of participants. For those who places differ, 80% intend to return to their hometown after completion.

Regarding accredited programs, we found that: 46% of fellows reported their programs to be connected to a university and/or faculty, among which 60% work in a public institution, 71% in a private institution, and 60% in both public and private institutions. Participants who attend both institutions reported that 20 to 60% of the activities are in public services, whereas 30 to 80% are in private services.

A total of 58% reported attending 2 to 3 hospitals weekly (Figure 3).

Table 3. Place of birth of 2017 fellows in knee surgery.

Estados	Nº de especializando
SP	37
RJ	7
CE	6
MG	7
PA	2
TO	2
PI	2
SC	1
PR	5
RN	1
RS	5
PB	1
MA	2
RO	2
ES	2
PE	2
AM	1
BA	3
AL	3

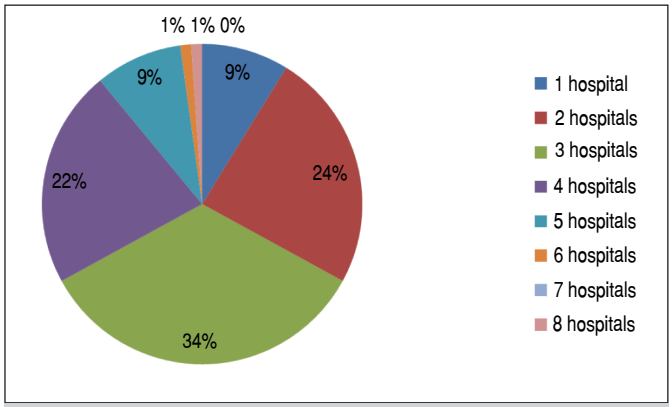

Figure 3. Number of hospitals attended by fellows in a week.

The average weekly workload was 42.07 hours (Figure 4).

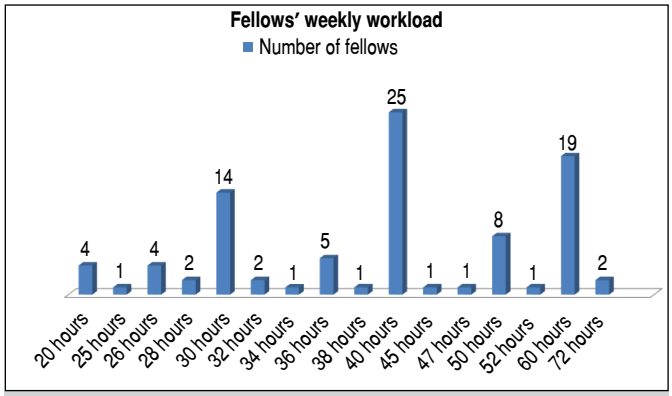

Figure 4. Fellows' workload per week.

Moreover, 89% of them receive no financial remuneration. Regarding theoretical activities, 11% reported having no theoretical activity, and the maximum theoretical load, reported by 5 participants, was 12 hours per week (Figure 5).

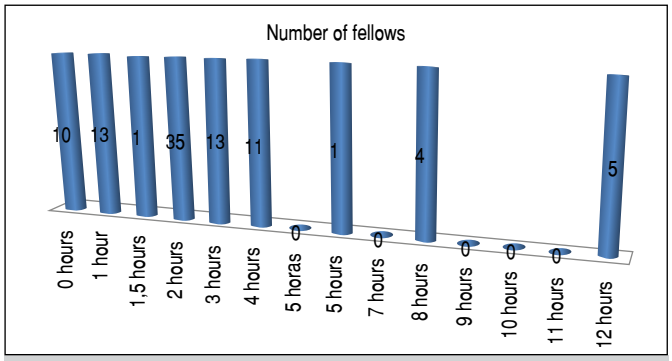

Figure 5. Weekly workload of theoretical activities.

We found 59% of fellows to consider the amount of theoretical activity adequate for both knowledge and examination. Participants distributed it as follows (Figure 6).
As for practical surgical activities, 94% of the participants reported effectively participating in surgical procedures, and 95% reported being supported and taught by preceptors.
Regarding the type of surgical procedures in which fellows participate weekly, 64% reported participating in one to two prostheses, 63% two to four arthroscopies, 76% two to four ACL, and 76% reported not participating in PCL. Percentages for meniscus were: 74% participate in one to three partial meniscectomy, and 39% participate in a meniscus suture repair per week, whereas 63% reported not participating in surgeries for complex lesions. Finally, 85% reported participating in other knee-related surgeries weekly, such as osteotomies, patellofemoral instability (PFI), chondral injuries, medial patellofemoral ligament reconstruction (MPFL), and 71% reported participating in one to two knee fractures (Table 4).

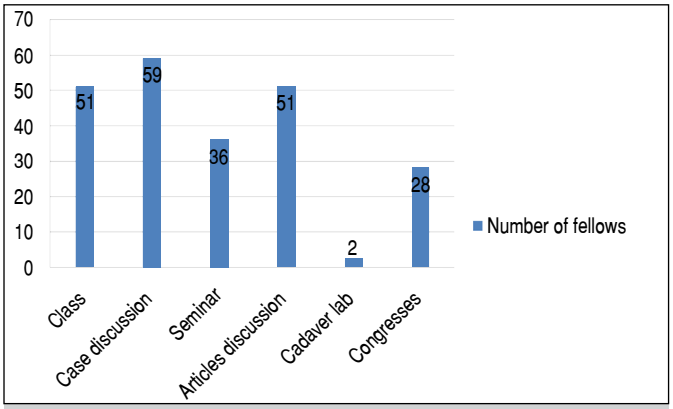

Figure 6. Number of fellows × theoretical activities.

Table 4. Number of surgical procedures performed by each fellow per week.

Types of surgical procedures per week X quantity	0	1	2	3	4	5	6	7	8	10	13	16
Arthroplasty	15	31	28	9	5	2	1	0	0	0	0	0
Arthroscopy	0	7	12	9	37	9	4	4	2	5	1	1
ACL	0	4	35	22	13	7	5	2	1	2	0	0
PCL	70	21	0	0	0	0	0	0	0	0	0	0
Partial meniscectomy	0	23	31	14	9	6	4	1	3	0	0	0
Meniscorraphy	44	36	7	4	0	0	0	0	0	0	0	0
Complex lesions	58	27	3	3	0	0	0	0	0	0	0	0
Other	13	38	28	12	0	0	0	0	0	0	0	0
Fractures	19	35	30	4	2	1	0	0	0	0	0	0

We found that 64% participated in one to two prostheses per week, and 63% from two to four.
However, fellows also reported participating in surgeries in joints other than the knee joint (Figure 7).

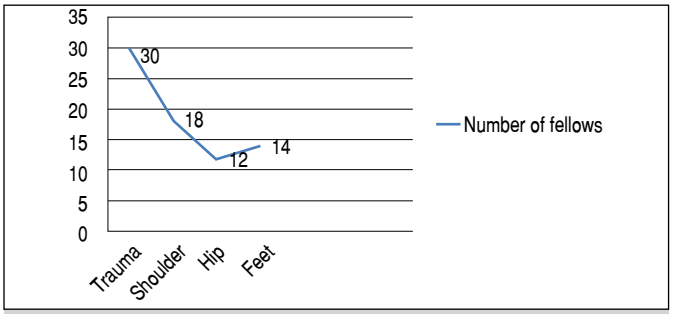

Figure 7. Surgeries in other joints performed by the fellows × number of fellows.

By the end of the fellowship, 100% of the participants believed to be capable of performing arthroscopic ACL reconstruction and partial meniscectomy, and 61% of performing prosthesis surgery (Figure 8).

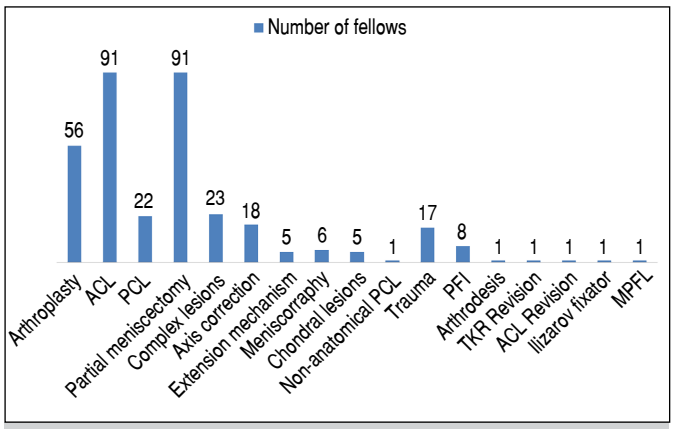

Figure 8. Surgeries fellows will be able to perform after fellowship completion.

As for financial difficulties, entailing the lack of material and team, 42% of fellows reported facing difficulties in their programs.
In total, 80% reported being involved in scientific research, among which 86% already address knee surgery as theme. Although 60% are interested in research, 28% have no support for performing it. Of these, 50% stated that the lack of support is due to having no advisor and/or knowledge.
According to 78% of the participants, their program offer support for scientific activity.

DISCUSSION

The Brazilian Society of Orthopedics and Traumatology (SBOT) is considered one of the most organized national medical specialty societies. It provides a guideline, approved by the National Medical Residency Commission by resolution No. 2/2006, for the training of residents. It also annually publishes the necessary contents and methods to their training.[3]
The Brazilian Society for Surgery of the Knee (SBCJ) is one of the SBOT's most traditional subspecialties, with many members in Brazil. Compared with other subspecialties, it has the largest number of applicants per vacancy for specialty training and presents numerous accredited programs throughout the country. Considering that, we deemed it would be interesting to conduct this evaluation with fellows in knee surgery.
Although there are 83 accredited programs in the country, their geographical distribution is unequal. The São Paulo regional alone has 39 programs, whereas the North regional has only two. Chaves et al.[4] evaluated the national demographics of medical residency vacancies and found that the highest number of vacancies and 54.5%[4] of specialists acting in the field are within the southeast region. Such inequality could be explained by the infrastructures present in the city centers, higher salary and better job opportunities, and the improved quality of life, which favor doctors' settlement.[4] However, more fellowship training programs and medical schools in poorer regions could attract and play a role in settling doctors within them.[5]
We found yet another discrepancy: the presence of a single female fellow in knee surgery. Women make up a larger percentage of residents in comparison to men, but men still prevail in surgical fields.[6] According to Neumayer et al.,[7] only 15% of women end up choosing a surgical specialty. Van Heest et al.[8] also showed that they represent 13% of orthopedic residents in the USA, and only 4% are members of the American Academy of Orthopedic Surgeons (AAOS).
Rohde et al.[9] found some explanations of why women tend not to choose by orthopedics, such as: lack of work-life balance, high demand of physical strength, and lack of guidance in graduation. Women who opt by orthopedics often act as general orthopedists, or choose subspecialties focused in hand, pediatric, or sports.
We also analyzed preceptors' performance towards fellows. The preceptor's role is to support students in developing problem-solving strategies, besides teaching them using case discussions, classes, and surgical procedures.[10,11,12] Our results indicate that fellows are satisfied with their preceptors and the theoretical teachings, esteeming SBCJ accredited programs – even though 11% of participants reported having no theoretical activities. Velho et al.[13] conducted a cross-sectional study with resident physicians in a university hospital, finding that 79.7% of them were satisfied with their preceptors' qualification and competence and 70% were unhappy or dissatisfied with the theoretical load.
Our results show that 60% of the participants work in public and private services. In Brazil, teaching hospitals reflect the issues in the public health system. The shortage of hospital beds and the lack of adequate materials and equipment compromises patient care and fellowship training in knee surgery.[14,15] Conversely, the private sector complements the abovementioned scarcity, playing a key role on these professionals' training.
The most common types of knee surgeries – as ACL reconstruction, total knee replacement, and arthroscopy – often feature in fellows' routine, as well as other types of surgery, such as osteotomies, patellofemoral instability, trauma around the knee joint, extensor mechanism injuries, and chondral injuries. Interestingly, 100% of the participants believed to be capable of performing arthroscopic ACL reconstruction and partial meniscectomy by the end of fellowship, but not other procedures. An alternative to complement this range and provide a more comprehensive training would be expanding fellows' training in simulators, cadaver activities, and workshops.
Malempati et al.[1] found that fellows specializing in spinal surgery also believe they need a longer time to learn certain surgeries. For Kim et al.,[16] a valid alternative for the training of new orthopedic surgeons would be practicing in pig knee. Martin et al.[17] reported that residents improved their skills after practicing in a shoulder arthroscopy simulator. According to Aïm et al.,[18] virtual training improves orthopedic surgeon's technical skills, although requiring additional trials to transfer virtual training into a real operating room.
Scientific articles are the main channel for spreading medical knowledge and its advances.[19] In the US, the number of scientific publications for each fellow in sports medicine increased almost 5.42 publication/year between 2016 and 2017.[20] Although most of the participants in our study are involved in a scientific research, the number of publications is still not very high. Considering that, providing incentives for fellows would help increase their interest in scientific research.
Our study impose some limitations, such as the sample size, which could have comprised every 2017 fellow in knee surgery, as well as the lack of an evaluation performed by preceptors on these fellows, which could corroborate or diverge from the found results.

CONCLUSION

Most fellows in knee surgery are concentrated in the Southeast region. Our results indicate that fellows are satisfied with the theoretical, practical, and scientific activities of their programs. This study may propose educational measures for the SBCJ to standardize knee fellowship training in Brazil.

AUTHORS' CONTRIBUTIONS: Each author contributed individually and significantly to the development of this article. DMHH: wrote the article, reviewed and prepared the research project; DCA: wrote the article, reviewed and prepared the research project; MAS: wrote the article, reviewed and prepared the research project; CCK: reviewed and prepared the research project; MC: reviewed and prepared the research project; APN: wrote the article and reviewed the text.

REFERENCES

1. Malempati H, Wadey VMR, Paquette S, Kreder HJ, Massicotte EM, Rampersaud R, et al. Spinal surgery fellowship education in Canada: evaluation of trainee and supervisor perspectives on cognitive and procedural competencies. Spine. 2013;38(1):83-91.
2. Santos RA, Snell L, Nunes MPT. Evaluation of the impact of collaborative work by teams from the National Medical Residency Committee and the Brazilian Society of Neurosurgery: retrospective and prospective study. Sao Paulo Med J. 2016;134(2):103-9.
3. Karam FC, Lopes MHI. Orthopedics: historical origin, teaching in Brazil, and methodological studies worldwide. Sci Med. 2005;15(3):172-8.
4. Chaves HL, Borges LB, Guimarães DC, Cavalcanti LPG. Vagas para residência médica no Brasil: onde estão e o que é avaliado. Rev Bras Educ Med. 2013;37(4):557-65.
5. Pinto LF, Machado MH. Médicos migrantes e a formação profissional: um retrato brasileiro. Rev Bras Educ Med. 2000;24:53-64.
6. Jesus LE. Treinar cirurgiões: hoje como sempre? Rev Col Bras Cir. 2009;36(6):529-32.
7. Neumayer L, Kaiser S, Anderson K, Barney L, Curet M, Jacobs D, et al. Perceptions of women medical students and their influence on career choice. Am J Surg. 2002;183(2):146-50.
8. van Heest AE, Agel J. The uneven distribution of women in orthopaedic surgery resident training programs in the United States. J Bone Joint Surg Am. 2012;94(2):e9.
9. Rohde RS, Wolf JM, Adams JE. Where are the women in orthopaedic surgery? Clin Orthop Relat Res. 2016;474(9):1950-6.
10. Botti SHO, Rego STA. Docente-clínico: o complexo papel do preceptor na residência médica. Physis. 2011;21(1):65-85.
11. Botti SHO, Rego S. Preceptor, supervisor, tutor e mentor: quais são seus papéis? Rev Bras Educ Med. 2008;32(3):363-73.
12. Botti SHO, Rego S. Processo de ensino-aprendizagem na residência médica. Rev Bras Educ Med. 2010;34(1):132-40.
13. Velho MTAC, Haeffner LB, Santos FG, Silva LC, Weinmann AGM. Residência médica em um hospital universitário: a visão dos residentes. Rev Bras Educ Med. 2012;36(3):351-7.
14. Dubeux LS, Freese E, Felisberto E. Acesso a hospitais regionais de urgência e emergência: abordagem aos usuários para avaliação do itinerário e dos obstáculos aos serviços de saúde. Physis. 2013;23(2):345-69.
15. Batista KT, Pacheco LMS, Silva LM. Avaliação dos programas de residência médica em Cirurgia Plástica no Distrito Federal. Rev. Bras. Cir. Plast. 2013;28(1):20-8.
16. Kim HJ, Kim DH, Kyung HS. Evaluation of arthroscopic training using a porcine knee model. J Orthop Surg. 2017;25(1):1-5.
17. Martin KD, Patterson DP, Cameron KL. Arthroscopic training courses improve trainee arthroscopy skills: a simulation-based prospective trial. Arthrosc. 2016;32(11):2228-32.
18. Aïm F, Lonjon G, Hannouche D, Nizard R. Effectiveness of virtual reality training in orthopaedic surgery. Arthrosc. 2016;32(1):224-32.
19. Fonseca J. Para além do fator de impacto: o artigo científico e a disseminação de conhecimento em Medicina. Rev Port Imunoalergol. 2015;23(2):67-9.
20. DeFroda SF, Shah KN, Safdar O, Mulcahey MK. Trends in research productivity ofresidents applying for orthopedic sports medicine fellowship. Phys Sportsmed. 2017;46(1):61-5.

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ORIGINAL ARTICLE

RELATIONSHIP BETWEEN THE KNEE AND HINDFOOT AXES IN PATIENTS WITH SEVERE KNEE OSTEOARTHRITIS

RELAÇÃO ENTRE O EIXO ANATÔMICO DO JOELHO E O EIXO DO RETROPÉ EM PACIENTES COM GONARTROSE AVANÇADA

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ABSTRACT

Objective: To evaluate the correlation between knee axis and hindfoot axis in patients with advanced gonarthrosis, and the association between ankle function and angular deformities. Methods: 72 patients were enrolled in the study: 66% were women, and mean age was 58.7 years. The anatomical axis of the knee and hindfoot were measured by short knee radiographs and long axial view of the hindfoot. Results: Among the study group, 79.2% presented varus knee (mean $15^o \pm 7.69^o$) and 20.8% valgus (mean $15.9^o \pm 7.7^o$). 63.9% had hindfoot varus (mean $8.5^o \pm 6.07^o$) and 36.1% valgus (mean $3.9^o \pm 3.92^o$) ($p < 0.05$). The mean value for the American Orthopaedic Foot and Ankle Society (AOFAS) score was 74.26 points, and values were significantly higher among patients with hindfoot varus ($p < 0.05$). We found no correlation between gender or AOFAS score and knee and hindfoot axes, nor between deformities in the knee and hindfoot axes ($p > 0.05$). The subgroup genu valgum – hindfoot varus presented a moderate correlation ($r = 0.564$; $p < 0.05$). Conclusion: We found no association between the anatomical axes of the knee and hindfoot. Patients with gonarthrosis and hindfoot varus presented a better ankle function. ***Level of Evidence II, Prognostic Studies – Investigating the Effect of a Patient Characteristic on the Outcome of Disease.***

Keywords: Ankle Joint. Arthroplasty, Replacement, Knee. Radiography. Osteoarthritis, Knee.

RESUMO

Objetivo: Avaliar a correlação entre o eixo do joelho e o eixo do retropé em pacientes com gonartrose avançada, e a relação da função do tornozelo com as deformidades angulares. Métodos: 72 pacientes, sendo 66% mulheres, idade média 58,7 anos participaram do estudo. Mediu-se o eixo anatômico do joelho e do retropé por meio de radiografias curtas dos joelhos e a incidência axial longa do retropé. Resultados: da amostra, 79,2% apresentavam eixo do joelho em varo (média $15^o \pm 7,69^o$) e 20,8% valgo (média $15,9^o \pm 7,7^o$). 63,9% retropé varo (média $8,5^o \pm 6,07^o$) e 36,1% valgo (média $3,9^o \pm 3,92^o$) ($p < 0,05$). O valor médio do escore AOFAS foi 74,26 pontos, com valores significativamente maiores nos pacientes com retropé varo ($p < 0,05$). Não houve correlação entre o sexo ou o escore AOFAS e os eixos do retropé e do joelho, ou entre desvios no eixo do joelho e os desvios no eixo do retropé ($p > 0,05$). Observou-se uma associação moderada no subgrupo genuvalgo – retropé varo ($r = 0,564$; $p < 0,05$). Conclusão: Não houve associação entre os eixos anatômicos do joelho e do retropé. Pacientes com gonartrose e retropé varo apresentaram melhor função do tornozelo. ***Nível de Evidência II, Estudos prognósticos – Investigação do efeito de característica de um paciente sobre o desfecho da doença.***

Descritores: *Articulação do Tornozelo. Artroplastia do Joelho. Radiografia. Osteoartrite do Joelho.*

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INTRODUCTION

Approximately 300,000 total knee arthroplasties (TKA) are performed annually in the United States only.[1] TKA has proven to be a safe surgery with high success rates, improving patients' quality of life, and being increasingly indicated.[2-4] Some factors may affect TKA success, such as: age below 55 years, male gender, obesity, and presence of comorbidities.[1,4-6] The correlation between knee and hindfoot alignment is yet to be fully elucidated.[7-10] For Norton et al.,[11]

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

The study was conducted at Instituto Nacional de Traumatologia e Ortopedia.
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understanding the compensatory mechanisms between these joints would help guiding deformity correction during TKA.

Some authors have reported an association between genu varum and hindfoot valgus, as well as between genu valgum and hindfoot varus, especially among individuals without subtalar joint involvement.[11-14] Although it is unclear how the hindfoot and ankle joints compensate knee deformity, varus deformity of the knee is believed to promote a deviation of the subtalar in eversion and valgus.[10,14-16] In this sense, some studies reported an improvement in preoperative hindfoot valgus deformity after femorotibial joint realignment in patients with genu varum submitted to TKA.[10,12,13,17]

A study also reported that nearly 60% of patients with advanced gonarthrosis complained about foot pain before TKA and none of them exhibited radiographic evidence of ankle or subtalar arthrosis, what suggests that these pains were caused by deformities in the midfoot and hindfoot. Although the author has related foot and ankle pain in patients in preoperative TKA, he did not evaluate the function of the hindfoot and ankle within the sample.[18]

Understanding the compensatory association between knee and hindfoot alignment is important, especially among patients with advanced and symptomatic osteoarthritis with indication for TKA.[10] Associated with the evaluation of ankle function in these patients and its correlation with hindfoot and knee axes, this mechanism will play a key role in managing this deformity and planning its surgery. This study aimed to analyze the correlation between the knee joint and hindfoot axes to evaluate the ankle/hindfoot function in patients with advanced gonarthrosis.

MATERIALS AND METHODS

This study was approved by the Research Ethics Committee of the institution, and all participants signed an Informed Consent Form. This is a cross-sectional study conducted in 2015, composed of patients with advanced arthrosis with indication for TKA. Patients who failed in performing the requested imaging tests or disagreed to participate were excluded of this study.

The characteristics recorded were gender, age at the time of the surgery, and affected foot. The anatomical axis of the knee and hindfoot were measured by radiographs. The function and pain in the hindfoot were quantified using the American Orthopaedic Foot and Ankle Society (AOFAS) scale for ankle and hindfoot, translated to Portuguese.[19] This scale is composed of nine items summing a maximum score of 100, among which 50 points refer to function, 40 to pain, and 10 to joint alignment.

Patients were separated into subgroups according to the anatomical axis of the knee – genu varum and genu valgum – and hindfoot axis – varus or valgus. Demographic characteristics, AOFAS score, and radiographic parameters were compared among subgroups.

Radiographic Analysis

The anatomical axis of the femorotibial joint was measured by short knee radiographs in anteroposterior (AP) and profile, all with bipodalic support, maximum knee extension, and patellae facing forward. The anatomical axis of the knee was measured using two points in the femur: one in the center of the intercondylar fossa and another 10 cm proximal to the first, at the midpoint between the two outside cortical regions. Regarding the tibia, the points were set in the center of the tibial eminence and 10 cm distal, at the midpoint between the two outside cortical regions. After tracing lines that connected the points in the femur and tibia, their intersection represented the anatomical axis or femorotibial angle (FTA).[20]

For long axial view of the hindfoot, patients stood over the film in a plain bipodalic support and were imaged in the posteroanterior and craniocaudal direction under a 45° caudal angulation, 100 cm apart from the hindfoot. The film was positioned perpendicular to the central axis of the radiation beam (Figure 1). The hindfoot axis was calculated by the angle between two line: one representing the leg load-bearing axis and another representing the calcaneal axis. The load-bearing axis was represented by the longitudinal tibial axis, by bisecting the tibia into two diaphyseal points 10 and 15 cm proximal to the tibial pilon. The calcaneal axis was identified by bisecting the calcaneus into two points. These values were considered positive when the load-bearing axis was medial to the lowest point in the calcaneus (valgus axis) and negative when lateral (varus axis) (Figure 2).[21,22] In a normal radiograph of an aligned hindfoot, the calcaneal axis should be parallel to the longitudinal axis of the tibia (0°), although located 5-10 mm lateral to the tibial axis. Angular values of up to 1° for varus or valgus are considered ideal.[23]

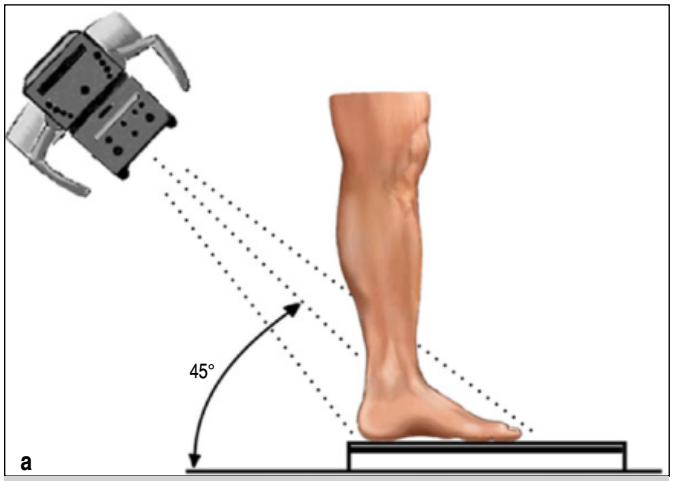

Figure 1. Illustration of patient positioning for long axial view of the hindfoot.[15]

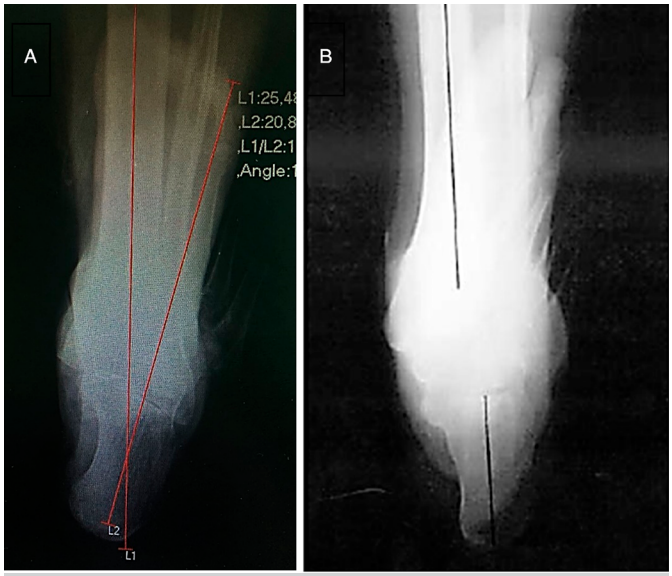

Figure 2. A: long axial view of the hindfoot, with hindfoot axis measure; B: illustration of hindfoot axis measurement in the long axial view of the hindfoot.[22]

A Shimadzu X-ray device, rated at 50 kV and 40 mA, was used. Angulations were determined using the DICOM® digital application. To ensure a greater reliability of angulations, scans were evaluated by two foot and ankle surgeons of the institution.

Statistical Analysis

Descriptive data analysis consisted of graphs construction, frequency distributions, and calculation of descriptive statistics (proportions of interest for all variables and calculation of minimum, maximum, mean, and standard deviation). Kolmogorov–Smirnov (KS) and Shapiro–Wilk (SW) tests were used to assess normality of the continuous variables. When unpaired measures of the same variable showed normality, Student's t-test was used to compare them. When they did not follow normal distribution, the Mann-Whitney's nonparametric test was used. The relationship between two quantitative variables was determined by calculating Spearman's or Pearson's rank correlation coefficient. Chi-Square test was used to verify a significant association between two qualitative variables. A database was built in a Microsoft Excel 2011 spreadsheet to analyze collected data using IBM SPSS (Statistical Package for the Social Science) version 21.0. All discussions considered a maximum significance level of 5% (0.05).

RESULTS

A total of 72 patients met the inclusion and exclusion criteria, among which women (66.7%) and left-foot affectation (56.9%) were predominant. The mean age was 58.7 ± 10,67 years.

Fifteen patients (20.8%) presented valgus deformity in the knee and 57 patients (79.2%) varus deformity. These proportions had a significant difference (p-value < 0.05). We observed that valgus knee had a mean of 15.9° (SD ± 7.7°) and varus knee of 15° (SD ± 7.69°), with no statistically significant difference (p > 0.05). Of the total sample, 26 patients presented hindfoot valgus (36.1%), with mean angular value of 3.98°, and 46 varus (63.9%), with mean angular value of 8.52°. This difference was statistically significant (p = 0). The mean value for the American Orthopaedic Foot and Ankle Society (AOFAS) score was 74.26 points, ranging from 40 to 97 points. We found a statistically significant difference (p = 0.01) when analyzing scores by hindfoot axis, with higher values among patients with hindfoot varus, but not by knee axis (p > 0.05) (Table 1).

Table 1. Mean values of the overall AOFAS score and by hindfoot and knee axes.

AOFAS score					
	Axis	**n (%)**	**Mean**	**SD**	**p-value**
Overall		72	74.26	13	
Hindfoot	Varus	63.9	77.41	11.70	p = 0.01 (MW)
	Valgus	36.1	68.69	13.53	
Knee	Varus	79.2	75.49	12.64	p > 0.05 (TT)
	Valgus	20.8	69.60	13.73	

SD: standard deviation; MW: Mann-Whitney's test; TT: T-test.

We found no correlation between gender and hindfoot and knee axis (both with p > 0.05 in Chi-Square Test). The correlation between the knee and hindfoot axes presented no statistical significance, i.e., we found no association between knee axis deformity and hindfoot axis deformity (p > 0.05). We also found no correlation between the knee and hindfoot axes and the AOFAS score (p > 0.05). In assessing the correlation between the knee and hindfoot axis for each subgroup (varus knee – hindfoot varus; varus knee – hindfoot valgus; valgus knee – hindfoot varus; and valgus knee – hindfoot valgus), we observed a moderate association in the genu valgum – hindfoot varus subgroup (r = 0.564; p < 0.05 Spearman's Rho).

DISCUSSION

The axes of the lower limb may be affected by deformities involving the hip, knee, and ankle joints. Deformities that occur in one of these joints are believed to cause compensatory changes in the others. However, such mechanisms are still unclear.[7,8,10,11]

Our study evaluated: (1) the presence of hindfoot deformity in patients with advanced knee osteoarthritis and the association between the knee and hindfoot axis; and (2) the ankle/hindfoot function in patients with advanced gonarthrosis, considering the knee and hindfoot axis. Our results indicate no association between the knee and hindfoot axes, except for a moderate association in the genu valgum – hindfoot varus subgroup. We also found no correlation between the ankle/hindfoot function and the knee and hindfoot axes. However, patients with hindfoot varus presented significantly higher values in the functional scale (p < 0.05).

Some studies have already verified the correlation between the hindfoot and ankle alignment but achieved conflicting results. Corroborating our findings, Chandler et al.[12] and Mullaji et al.[13] found no preoperative correlation between the alignment of the knee and hindfoot axes. In turn, Norton et al.[11] observed an association between valgus knee deformity and hindfoot varus, and varus knee and hindfoot valgus. However, such association was not observed in patients with mild deformities (lower than 10°) in the knee axis.[11] Another study, conducted with patients with rheumatoid arthritis, found a moderate correlation between femorotibial and tibial-calcaneal angles, especially among patients with little subtalar joint involvement.[10]

We found no significant correlation between the foot and ankle axes. However, 86.6% of the patients with genu valgum presented hindfoot varus, and 92.3% of the patients with hindfoot valgus presented varus knee. This is a key information to understand the lower limb compensatory mechanisms, particularly the adaptive capacity of the subtalar joint.[10] Clinically, for knee specialists, patients with advanced gonarthrosis and foot pain may benefit from the use of insoles until surgical correction of the knee axis is performed. As for foot and ankle surgeons, patients with knee deformities, hindfoot deviations, and acutely symptomatic feet that require surgical treatment must have hindfoot axis correction carefully planned to avoid hypercorrection in case an axial realignment is later performed on the knee.

Unlike previous studies, we subdivided patients into four groups – (genu varum – hindfoot varus; genu varum – hindfoot valgus; genu valgum – hindfoot varus; and genu valgum – hindfoot valgus) – to better understand the association between these lower limb axes. The only subgroup to present a significant correlation was genu valgum – hindfoot varus (p < 0.05). This might be explained because the subtalar joint is responsible for most of the hindfoot compensatory mechanism, in which the ankle play a small role.[11] As the mobility of the talocalcaneal joint ranges from 25-30° in inversion and 5-10° in eversion,[24] patients with genu valgum demand a greater subtalar compensation. Such mechanism was equally observed in patients with tibiotarsal arthrosis, in which the subtalar joint plays a key role in compensating the deformity and delaying the degenerative process.[25]

We found no other articles in the literature addressing ankle/hindfoot function association in patients with advanced knee osteoarthritis. Our study adopted the AOFAS scale to assess ankle/hindfoot function and obtained a final mean value of 74.26 points. We observed a significant difference (p < 0.05) in the scores of patients with hindfoot varus and valgus, with higher values in the first subgroup. However, the ankle function was not associated with the hindfoot or knee axis (p > 0.05). Elbaz et al.[26] verified the association between gonarthrosis and Achilles tendon involvement by analyzing gait and applying two scores: *Western* Ontario and McMaster Osteoarthritis Index (WOMAC) and 36-item Short-Form (SF-36) Health Survey. Both scores, although validated, are not specific for assessing ankle/hindfoot function, and can be applied for any joint with osteoarthritis. A different study,

conducted with patients submitted to TKA, analyzed the presence of foot pain in the preoperative and one-year postoperative. Among the 64 participants with advanced gonarthrosis, 59.4% reported preoperative pain and none exhibited radiographic evidence of ankle or subtalar arthrosis. Radiographic improvement of the midfoot pronation was related to the reduced foot pain one year after the surgery, suggesting that deformities in the midfoot and hindfoot cause pain in patients with gonarthrosis. In the same study, nearly 70% of patients still reported foot pain after one-year postoperative. This group presented no improvement in radiographic parameters nor in various foot plantar pressure measures.[18]

Our study poses some limitations, such as using the short knee bipodalic radiography to measure knee axis. However, this radiographic method is supported by several studies in the literature. Kraus et al.[27] evaluated 114 knee radiographs and compared the angles of anatomical axis measured by goniometer and X-ray in posteroanterior (PA) with flexed knee to the panoramic X-ray of the lower limb and found corresponding values without needing to use the higher cost examination. Another author[28] analyzed the alignment and joint wear of 608 knees with arthrosis using anteroposterior (AP) orthostatic X-ray and concluded that such incidence enables the evaluation of the axis and degree of joint involvement.

Considering the importance of the subtalar joint in the compensatory mechanisms of lower limb deformities, the lack of an specific physical examination for its mobility and imaging exams to measure its axis were also regarded as limitations. As the AOFAS score covers pain and hindfoot alignment, we believe that pain and misalignment in patients with more severe joint involvement have possibly decreased their functional scores.

Further studies evaluating the subtalar joint axis and mobility and analyzing ankle pain and function in patients with knee arthrosis are necessary. Likewise, prospective studies evaluating hindfoot axis behavior in patients undergoing total knee arthroplasty are fundamental to better understand the compensatory mechanisms of the lower limbs.

CONCLUSION

Our results show a correlation between knee and hindfoot axes in patients with advanced gonarthrosis, particularly in the genu valgum – hindfoot varus subgroup. We also observed an association between the AOFAS scale values and the hindfoot axis, in which patients with gonarthrosis and hindfoot varus presented a better ankle function.

AUTHORS' CONTRIBUTIONS: Each author contributed individually and significantly to the development of this article. HM: wrote the article, participated in the review process, and approved the final version; FAR: conceived and planned activities that led to the study, wrote the article, and approved the final version; PGTSF: planned the activities that led to the study and wrote the article; IMCJ: participated in the review process and approved the final version.

REFERENCES

1. NIH Consensus Statement on Total Knee Replacement. NIH Consens State Sci Statements. 2003;20(1):1-34.
2. Silva RR, Santos AAM, Carvalho JS Jr, Matos MA. Qualidade de vida após artroplastia total do joelho: revisão sistemática. Rev Bras Ortop. 2014;49(5):520-7.
3. Fernandes DA, Poeta LS, Martins CAQ, Lima F, Neto FR. Equilíbrio e qualidade de vida após artroplastia total de joelho. Rev Bras Ortop. 2018;53(6):747-53.
4. Kurtz S, Mowat F, Ong K, Chan N, Lau E, Halpern M. Prevalence of primary and revision total hip and knee arthroplasty in the United States from 1990 through 2002. J Bone Joint Surg Am. 2005;87(7):1487-97.
5. Mahomed NN, Barrett J, Katz JN, Baron JA, Wright J, Losina E. Epidemiology of total knee replacement in the United States Medicare population. J Bone Joint Surg Am. 2005;87(6):1222-8.
6. Kurtz S, Ong K, Lau E, Mowat F, Halpern M. Projections of primary and revision hip and knee arthroplasty in the United States from 2005 to 2030. J Bone Joint Surg Am. 2007;89(4):780-5.
7. Keenan MA, Peabody TD, Gronley JK, Perry J. Valgus deformities of the feet and characteristics of gait in patients who have rheumatoid arthritis. J Bone Joint Surg Am. 1991;73(2):237-47.
8. McLauren CAN, Wootton JR, Heath PD, Wynn Jones CH. Pes planus after tibial osteotomy. Foot Ankle. 1989;9(6):300-3.
9. Teitge RA, MacMahon E. Osteoarthritis of the knee: concepts behind osteotomy. Semin Arthroplasty. 1996;7(2):114-23.
10. Nakada I, Nakamura I, Juji T, Ito K, Matsumoto T. Correlation between knee and hindfoot alignment in patients with rheumatoid arthritis: the effects of subtalar joint destruction. Mod Rheumatol. 2015;25(5):689-93.
11. Norton AA, Callaghan JJ, Amendola A, Phisitkul P, Wongsak S, Liu SS, et al. Correlation of knee and hindfoot deformities in advanced knee OA: compensatory hindfoot alignment and where it occurs. Clin Orthop Relat Res. 2015;473(1):166-74.
12. Chandler JT, Moskal JT. Evaluation of knee and hindfoot alignment before and after total knee arthroplasty: a prospective analysis. J Arthroplasty. 2004;19(2):211-6.
13. Mullaji A, Shetty GM. Persistent hindfoot valgus causes lateral deviation of weightbearing axis after total knee arthroplasty. Clin Orthop Relat Res. 2011;469(4):1154-60.
14. Hayashi K, Tanaka Y, Kumai T, Sugimoto K, Takakura Y. Correlation of compensatory alignment of the subtalar joint to the progression of primary osteoarthritis of the ankle. Foot Ankle Int. 2008;29(4):400-6.
15. Reilingh ML, Beimers L, Tuijthof GJM, Stufkens SAS, Maas M, van Dijk CN. Measuring hindfoot alignment radiographically: the long axial view is more reliable than the hindfoot alignment view. Skeletal Radiol. 2010;39(11):1103-8.
16. Desai SS, Shetty GM, Song HR, Lee SH, Kim TY, Hur CY. Effect of foot deformity on conventional mechanical axis deviation and ground mechanical axis deviation during single leg stance and two leg stance in genu varum. Knee. 2007;14(6):452-7.
17. Hara Y, Ikoma K, Arai Y, Ohashi S, Maki M, Kubo T. Alteration of hindfoot alignment after total knee arthroplasty using a novel hindfoot alignment view. J Arthroplasty. 2015;30(1):126-9.
18. Saito I, Okada K, Wakasa M, Abeb H, Saito A. Foot pressure pattern, hindfoot deformities, and their associations with foot pain in individuals with advanced medial knee osteoarthritis. Gait Posture. 2018;59:83-8.
19. Rodrigues RC, Masiero D, Mizusaki JM, Imoto AM, Peccin MS, Cohen M, et al. Tradução, adaptação cultural e validação do "American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Scale". Acta Ortop Bras. 2008;16(2):107-11.
20. Matos LF, Giordano M, Cardoso GN, Farias RB, Albuquerque RP. Análise radiográfica comparativa do eixo anatômico na osteoartrite do joelho: avaliação inter e intraobservadores. Rev Bras Ortop. 2015;50(3):283-9.
21. Kleiger B, Mankin HJ. A roentgenographic study of development of the calcaneus by means of the posterior tangential view. J Bone Joint Surg Am. 1961;43(7):961-9.
22. Lamm BM, Mendicino RW, Catanzariti AR, Hillstrom HJ. Static rearfoot alignment: a comparison of clinical and radiographic measures. J Am Podiatr Med Assoc. 2005;95(1):26-33.
23. Mendicino RW, Catanzariti AR, Reeves CL, King GL. A systematic approach to evaluation of the rearfoot, ankle, and leg in reconstructive surgery. J Am Podiatr Med Assoc. 2005;95(1):2-12.
24. Sarrafian SK. Biomechanics of the subtalar joint complex. Clin Orthop Relat Res. 1993;(290):17-26.
25. Krähenbühl N, Horn-Lang T, Hintermann B, Knupp M. The subtalar joint: a complex mechanism. EFORT Open Rev 2017;2(7):309-16.
26. Elbaz A, Magram-Flohr I, Segal G, Mor A, Debi R, Kalichman L. Association between knee osteoarthritis and functional changes in ankle joint and Achilles tendon. J Foot Ankle Surg. 2017;56(2):238-41.
27. Kraus VB, Vail TP, Worrel T, McDaniel G. A comparative assessment of alignment angle of the knee by radiographic and physical examination methods. Arthritis Rheum. 2005;52(6):1730-5.
28. Khan FA, Koff MF, Noiseux NO, Bernhardt KA, O'Byrne MM, Larson DR, et al. Effect of local alignment on compartimental patterns of knee osteoarthritis. J Bone Joint Surg Am. 2008;90(9):1961-9.

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ORIGINAL ARTICLE

UNICOMPARTIMENTAL KNEE ARTHROPLASTY – 15 YEARS FOLLOW UP

ARTROPLASTIA UNICOMPARTIMENTAL DO JOELHO – 15 ANOS DE SEGUIMENTO

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ABSTRACT

Objective: To evaluate clinically and radiologically the long-term follow-up of patients with anteromedial osteoarthritis who underwent unicompartmental knee arthroplasty surgery. Methods: This study included 36 patients who underwent unicompartmental knee arthroplasty surgery for medial compartmental osteoarthritis with a minimum of 15-year post-operative follow-up. All surgeries were performed by a single surgeon (G.L.C) using the Miller-Galante unicompartmental knee implant. Patients were analyzed regarding their clinical functional and implant radiographic conditions. Results: From the 46 patients who could have completed 15 years of follow-up, three required revision surgery with conversion to total knee arthroplasty (6.5%), 36 completed the 15-year follow-up period, and the others were lost to follow-up for reasons not related to unicompartmental arthroplasty. Conclusion: In these 36 patients, the result was satisfactory after follow-up, with complaints and sign of progression of osteoarthritis in some cases. ***Level of Evidence IV, Case series.***

Keywords: Knee. Arthroplasty. Arthrosis.

RESUMO

Objetivo: Avaliar clínica e radiologicamente o acompanhamento a longo prazo de pacientes com osteoartrite anteromedial do joelho que passaram por cirurgia de artroplastia total do joelho. Métodos: Este estudo incluiu 36 pacientes que se submeteram à artroplastia unicompartimental do joelho por lesão do compartimento medial provocada por artrose com, no mínimo, 15 anos de acompanhamento pós-operatório. Todas as cirurgias foram realizadas pelo mesmo cirurgião (G.L.C.) utilizando uma prótese unicompartimental tipo Miller-Galante. Os pacientes foram analisados quanto as suas condições clínicas e condições radiográficas do implante. Resultados: Dos 46 pacientes que poderiam ter concluído 15 anos de acompanhamento, 3 necessitaram de revisão com artroplastia total (6,5%); 36 concluíram os 15 anos de acompanhamento, e o restante abandonou o acompanhamento por razões independentes da artroplastia unicompartimental. Conclusão: Nestes 36 pacientes, o resultado foi satisfatório após o acompanhamento, com queixas e sinais de progressão da artrose em alguns casos. ***Nível de Evidência IV, Série de casos.***

Descritores: *Joelho. Artroplastia. Artrose.*

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INTRODUCTION

Arthrosis of the medial compartment of the knee is an evolutionary pathology in most cases. This disease occurs due to a muscle imbalance, resulting in the prevalence of flexor medial muscles and internal rotators on the quadriceps and external rotator lateral flexors. The loss of muscle strength, physiological with age, firstly affects larger muscles at the beginning, and quadriceps atrophy is the most important in lower limb.

There are several stages, but while the knee remains stable, that is, with the anterior cruciate ligament integrated, valgus osteotomy is a good indication in young patients and in older adults, unicompartmental knee arthroplasty (UKA) is the best indication. Unicompartmental knee arthroplasty has a variable concept in the orthopedic environment. Firstly, some issues were reported in the Brazilian and American orthopedic literature. In Brazil, Veiga et al.,[1] in 1997, published discouraging results in Brazilian literature. Survival has always been questioned and it was considered that the limit would be 10 years, short in relation to total arthroplasty.

We performed 94 unicompartmental knee arthroplasties over 25 years, for several indications, but medial arthrosis was the most frequent indication.

We publish the results[2] to 10 years of follow-up, we will study in this paper the evolution of 36 patients who reached 15 years or more.

MATERIALS AND METHODS

We considered 36 patients operated by us who reached at least 15 years of evolution after undergoing unicompartmental knee arthroplasty.

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

The study was conducted at Hospital das Clínicas.

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Regarding the distribution according to sex, 21 patients are women, and the most affected side was the left side in 19 patients.
The age ranged between 76 and 91 years, with a higher concentration in the 85-year age group.
We had 46 patients who would have had 15 years of UNI arthroplasty:

- three underwent total arthroplasty due to problems in the unicompartmental prosthesis, and they did not complete 15 years of follow-up.
- one suffered tibial plateau fracture after fall and underwent total arthroplasty
- six died from causes other than the surgery
- 36 were studied in this study, as they have completed 15 years of follow-up.

Our intention was to evaluate UKA behavior in patients with 15 years of evolution of the surgery.
Patients had surgical indication due to cartilage involvement of the medial compartment of the knee, they were selected to undergo UKA, because they had stable knees, according to Ahlbäck classification.[3]
All patients were operated by the author using a Miller-Galante unicompartmental prosthesis, marketed by Zimmer and they were initially followed every 3 months in the first year, and thereafter each year, or when they had any complaint.
We considered for this study patients with follow-up of at least 15 years and who had at least one radiograph after the 15th year of follow-up.
We analyzed patient satisfaction and radiographs regarding the progression of arthrosis and deformity. We did not use the Knee International Society system, because they are patients of advanced age and the have limitations on age-specific locomotion.
Regarding satisfaction, we use the following criteria: spontaneous pain, pain at rest, limitation to walk more than 100 meters, use of cane for balance.
Regarding for radiography, the criteria used were lateral arthrosis, patellofemoral arthrosis, worsening of varus deviation, prosthesis loosening.

RESULTS

Regarding satisfaction

Spontaneous pain	4/36
Pain at rest	1/36
Limitation 100m	5/36
Cane	3/36

Radiography

Lateral arthrosis	2/36
Patellofemoral Arthrosis	5/36 (Figure 1)
Worsening of varus	2/36 (Figure 2)
Prosthesis loosening	0/36

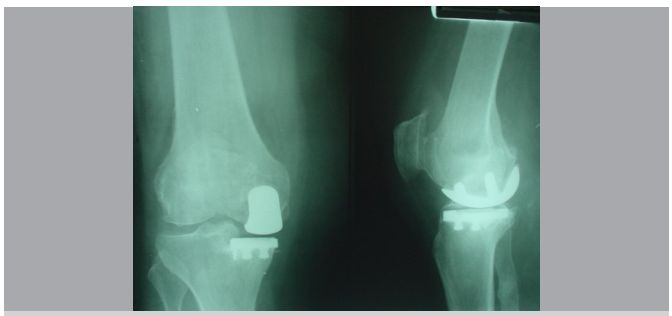

Figure 1. Patient with 186 months of UKA evolution with x-ray signs of patellofemoral arthrosis.

Figure 2. Anterior-posterior radiographs of knees , demonstrating the worsening of varus deformity.

Most patients complaining of pain are patients with patellofemoral arthrosis with radiographic imaging.

DISCUSSION

In 2007 we published[2] our experience with UKA, this work already presented evidence that the results over the first 10 years were favorable.
In 2004 we published[4] a specific study, only on cases of primary osteonecrosis of the knee, as at the time it was called the insufficiency fracture. We also had favorable results in the treatment of this specific pathology.
The indication is rigid, we operate patients with medial arthrosis and stable knees, that is, without anterior cruciate ligament degeneration. The Ahlbäck[3] classification guides us regarding knee stability, up to grade III and some grade IV cases can be considered as stable knees (Figure 3).

Figure 3. Lateral radiography of knee demonstrating anteriorization of the tibia due to ACL failure. The osteophyte in tibia is characteristic of this degree.

Berger et al.,[5] with whom we learned the technique, reported results similar to ours in patients up to 10 years of follow-up.
In our study we included patients with 15 years of minimum follow-up, and we found that the distribution, regarding sex is very similar, but obviously age is still more advanced.
Out of the 46 patients who would have reached 15 years of evolution, six died of natural causes, one suffered a fracture and only three required revisions, due to UKA failures (6.5%). There was one case of varus worsening, but without patient's complaints (Figure 2).
In the first indications of UKA in the literature, the authors stated that the patient should be older than 60 years. Some of our patients were operated before the age of 60. Pennington et al.[6] report 98% of good

results in patients under 60 years old, operated with the Miller-Galante prosthesis, the same prosthesis we have used in all cases.
Kennedy et al.[7] in a long study report that age does not worsen the evolution of UKA, authors believe that the lower demand for age is the cause of this good evolution.
In our initial material, UKA accounted for 10 to 15% of all arthroplasties we operate, and this trend continues,
There is a very strict limitation of indication, especially regarding Ahlbäck's criteria of anterior knee stability.
Murray et al.[8] believe that in some procedures the review rate is higher than in total arthroplasty, because there are few UKA surgeries, and surgeons have less training in procedure.
Mohammad et al.,[9] in an extensive review with 8,000 cases made by metanalysis, report that reviews resulting from problems with the prosthesis are more frequent in total arthroplasties than in cases of UKA.
In our results, the pain reported by the patients was bearable, no patient required any additional measure to minimize pain and the most frequent cause of pain was presented in patients with patellofemoral arthrosis, with radiographic imaging. Hamilton et al.[10] report their experience with the Oxford prosthesis and 15 years of follow-up, the authors believe that patellofemoral arthrosis cannot be considered as a cause of pain in these patients or as a contraindication for UKA. We considered patellofemoral arthrosis with radiographic imaging, a contraindication for UKA.
Motor limitations, which we included the use of cane, were not attributed to problems with UKA in any case. There were imbalances and instabilities appropriate to the patients' age.
With a different model, but with the same concept, the Oxford unicompartmental prostheses present good results with long-period follow-ups. This type of prostheses has mobile plastic, unlike Miller-Galante, in which plastic is fixed.
We had no case of release, nor cases of neccessary change of the prosthesis plastic (Figure 4).
A curious case occurred with the second patient who made the UKA with the Miller-Galante prosthesis. Without noticing us, the patient sought the knee outpatient clinic of the Institute of Orthopedics of the Hospital da Clinicas of USP, with a 21-year history of surgery and knee pain.
As the x-rays were normal, a surgical exploration was performed, which found that the plastic was still normal.
An interesting fact, we found a low incidence of arthrosis evolution, a fact that we had already observed in the 2007 series, with up to 10 years of follow-up (Figure 5).

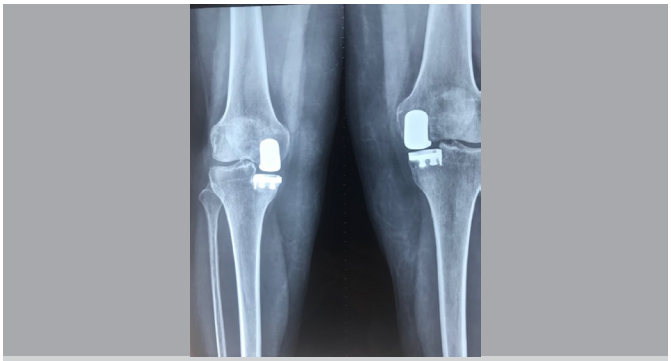

Figure 4. Bilateral unicompartmental arthroplasty, with radiography of the left reader with 184 months of evolution. The one on the right is 96 months old.

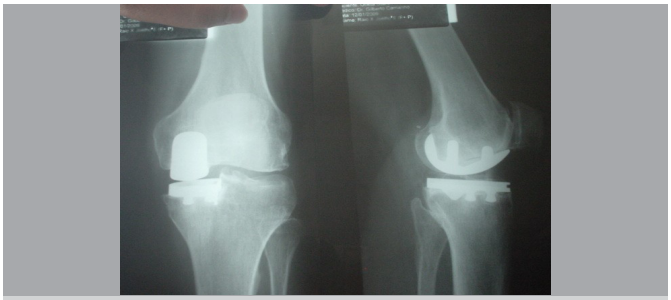

Figure 5. Radiography of a patient with 192 months of evolution, no signs of arthrosis in the knee.

We believe that medial arthrosis is an evolutionary process[11] and the correction with UKA prevents the evolution to knee arthrosis. Regarding the solidity of the results, we believe that the correct indication is fundamental, the limit is the anterior stability and the degree of deviation clearly defined by Ahlbäck's work.

CONCLUSION

Unicompartmental knee arthroplasty is efficient to treat medial knee arthrosis after the 15-year evolution of surgery in older patients.

AUTHORS' CONTRIBUTIONS: The author contributed individually and significantly to the development of this article. GLC: wrote and reviewed the article and contributed to the intellectual concept of the study.

REFERENCES

1. Veiga LT, Villardi AM, Palma IM, Vieira LAM, Leite JER, Dias MSS. Artroplastia unicompartimental do joelho: experiência após 22 casos. Rev Bras Ortop. 1997;32(5):374-6.
2. Camanho LM, Viegas AC, Camanho LF, Camanho CR, Forgas A. Artroplastia unicompartimental no tratamento da artrose medial do joelho. Rev Bras Ortop 2007;42(9):285-9.
3. Ahlbäck S. Osteoarthrosis of the knee. A radiographic investigation. Acta Radiol Diagn (Stockh). 1968;Suppl 277:7-72.
4. Camanho GL, Rossetti AC, Camanho LF, Albuquerque RP. Artroplastia unicompartimental do joelho no tratamento da osteonecrose primária do côndilo femoral medial. Rev Bras Ortop. 2004;39(9):486-91.
5. Berger RA, Meneghini RM, Jacobs JJ, Sheinkop MB, Della Valle CJ, Rosenberg AG, et al. Results of unicompartmental knee arthroplasty at a minimum of ten years of follow-up. J Bone Joint Surg Am. 2005;87(5):999-1006.
6. Pennington DW, Swienckowski JJ, Lutes WB, Drake GN. Unicompartmental knee arthroplasty in patients sixty years of age or younger. J Bone Joint Surg Am. 2003;85(10):1968-73.
7. Kennedy JA, Matharu GS, Hamilton TW, Mellon SJ, Murray DW. Age and outcomes of medial meniscal-bearing knee arthroplasty. J Arthroplasty. 2018;33(10):3153-9.
8. Murray DW, Parkinson RW. Usage of unicompartmental knee arthroplasty. Bone Joint J. 2018;100-B(4):432-5.
9. Mohammad HR, Strickland L, Hamilton TW, Strickland L, Murray DW. Long-term outcomes of over 8,000 medial Oxford phase 3 unicompartmental knees – a systematic review. Acta Orthop. 2018; 89(1):101-7.
10. Hamilton TW, Pandet HG, Maure DW, Jerkins C, Murray DW. Anterior knee pain and evidence of osteoarthritis of the patellofemoral joint should not be considered contra indication to mobile-bearing unicompartmental knee arthroplasty. Bone Joint J. 2017;99-B(5):632-9.
11. Camanho GL. Artrose medial do joelho, uma patologia de evolução progressiva. Rev Bras Ortop. In press.

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ORIGINAL ARTICLE

QUALITY OF LIFE IN ADULTS WITH SARCOMAS UNDER CONSERVATIVE SURGERY OR AMPUTATION

QUALIDADE DE VIDA EM ADULTOS COM SARCOMAS EM CIRURGIA CONSERVADORA OU AMPUTAÇÃO

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ABSTRACT

Objective: To understand the perception of quality of life, functionality, and psychological aspects of adults with lower limb sarcoma who underwent conservative surgery or amputation. Methods: Sociodemographic data were collected, and the following questionnaires were used: EORTC QLQ – C30 for quality of life, the Functional Assessment System (MSTS) for functionality and the Beck Depression Inventory (BDI) for depression symptoms. Results: The sample consisted of 45 young adults with sarcoma, divided into two groups: amputation (29) and conservative surgery (16). Most were male, single and students. Average family income before and after the disease did not differ, but those that were employed had a better perception of general quality of life, as well as those with higher family income after the disease. Regarding the type of surgery, there was a predominance of amputation; osteosarcoma was the most common histological type and the most affected region was the femur. All participants participated in social, cultural, sporting or religious activities. MSTS and Beck scale values did not differ between procedures. Conclusion: Given the scarcity of studies on the subject at the national level, further investigations are suggested to explore aspects related to quality of life for patients with sarcomas. ***Level of Evidence III, Retrospective comparative study.***

Keywords: Quality of Life. Surgical Oncology. Limb Salvage. Amputation.

RESUMO

Objetivo: Conhecer a percepção da qualidade de vida, funcionalidade e aspectos psicológicos de adultos com sarcoma de membros inferiores, submetidos à cirurgia conservadora ou amputação. Métodos: Foram coletados dados sociodemográficos, e utilizados os questionários: EORTC QLQ-C30 para a qualidade de vida; o Sistema de Avaliação Funcional (MSTS) para a funcionalidade; e o Inventário de Depressão de Beck (BDI) para sintomas de depressão. Resultados: A amostra foi constituída por 45 adultos jovens com sarcoma, divididos em dois grupos: amputação (29) e cirurgia conservadora (16). Predominaram jovens do sexo masculino, solteiros e estudantes. A média da renda familiar antes e após a doença não diferiu, porém os que estavam trabalhando apresentaram melhor percepção de qualidade de vida global, assim como os com maior renda familiar após a doença. Quanto ao tipo de cirurgia, houve predomínio da amputação, o osteossarcoma foi o tipo histológico mais comum e a região do fêmur a mais acometida. Todos os participantes participavam de atividades sociais, culturais, esportivas ou religiosas. Os valores do MSTS e da escala de Beck não diferiram entre os procedimentos. Conclusão: Visto a escassez de estudos sobre o tema em nível nacional, sugerem-se novas investigações, a fim de explorar aspectos relacionados com a qualidade de vida para pacientes com sarcomas. ***Nível de Evidência III, Estudo retrospectivo comparativo.***

Descritores: *Qualidade de Vida. Cirurgia Oncológica. Salvamento de Membro. Amputação.*

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INTRODUCTION

Sarcomas are solid malignant tumors, with rare occurrence (< 1%), highly aggressive, with a higher incidence in childhood, adolescence and young adults (accounting for the 5th cause of death in this population).[1] They are more frequent in the extremities (60%), especially in the lower limbs (three times more than the upper limbs). The most common histological types are osteosarcoma, Ewing's sarcoma and chondrosarcoma.[1]

Until the 1970s, survival was limited (mortality of 80% in the first year), mainly due to pulmonary metastases. In 90% of cases, limb amputation was necessary.[2] Currently, with advances in diagnostic tests, staging, chemotherapy protocols and surgeries, five-year disease-free survival can be achieved in 70% ofcases.[3]

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

The study was conducted at Rede SARAH de Hospitais de Reabilitação
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Treatment of sarcoma is multimodal, with surgery (amputation or conservative limb surgery), chemotherapy, and radiotherapy in some cases. Much is discussed about which type of surgical procedure is most appropriate for tumor resection with wide margins together with healthy tissues.[2,4] Due to complexity, the patient may present physical, functional limitations, psychological and emotional alterations.[5]
As such, this study is justified by the impact that sarcoma can have on the quality of life of affected people and their families. There is still a gap in the literature on how these people experience the process of coping with sarcomas in the Brazilian population. Therefore, the study aims to understand the perception of the quality of life of adults with sarcomas in the lower limbs, after either amputation or conservative surgery; in addition to analyzing functional and psychological aspects that may interfere with their quality of life.

MATERIALS AND METHODS

The study has a cross-sectional design (quantitative approach) of adults with lower limb sarcoma, on the oncology program of the Rede SARAH de Hospitais de Reabilitação – Brasília, who underwent amputation or conservative surgery. Inclusion criteria: diagnosis of lower limb sarcoma, referral to amputation or conservative surgery at least six months before the study, and at least 18 years or older. Exclusion criteria: cognitive impairment to the understanding of the assessment instruments (no participant was excluded). Data collection was carried out between September 2017 and February 2019. We opted for the face-to-face interviews, ensuring not only the understanding of the questions but also the obtaining of the answers. All of them signed the free and informed consent form.
For the research, we analyzed the data of interest from the clinical records of each participant, as well as sociodemographic information. Instruments were used to assess quality of life, functionality and psychological aspects. To assess quality of life, the EORTC QLQ-C30 instrument was used,[6] which includes thirty questions divided into: 1. General health status, 2. Symptoms (fatigue, pain and nausea/vomiting) and 3. Additional items related to dyspnea, insomnia, loss of appetite, constipation, diarrhea and financial difficulties. The MSTS scoring system for functional evaluation was used to assess postoperative functioning,[7] divided into two parts: 1. Pain, function and emotional acceptance and, 2. Specific factors for the studied limb. For the evaluation of psychological aspects, the Beck Depression Inventory (BDI) was used,[8] in which the participant performs a self-assessment of depressive symptoms.
The data obtained through the questionnaires were analyzed according to criteria established by the instruments themselves and statistically analyzed for the comparison between the two groups (amputation versus conservative). To compare the two groups, Student's t-test was used for variables with normal distribution and Mann-Whitney Test for variables with non-normal distribution. The percentages between the procedures were compared using the chi-square test. To determine the factors associated with quality of life, simple and multiple linear regression models were adjusted. The following possible predictive factors for quality of life were considered: gender, age, occupation, histological type of sarcoma, chemotherapy, prosthesis or orthotic devices, social, cultural, sporting, or religious activities, family income before and after the disease and type of surgery. All variables with $p < 0.05$ remained in the final model. This research was approved by the Ethics Committee of the Association of Social Pioneers (CAAE: 63724217.5.0000.0022).

RESULTS

The sample consisted of 45 participants, divided into two groups: 29 in group 1 (amputation) and 16 in group 2 (conservative surgery). The sociodemographic characteristics by type of surgery are described in Table 1. Amputation was the most common method (64.5%). Mean age was homogeneous; 32.2 years in group 1 and 27.8 years in group 2. Most participants were male and single. The students were expressively represented in both groups. Only 27.5% of group 1 and 18.7% of group 2 reported working, contributing to family income, and few were retired. Mean family income before and after the disease did not show significant changes. None of the sociodemographic variables was significantly associated with the type of surgery. Association between religious activity and type of surgery was statistically significant. Of the 16 who underwent conservative surgery, 93.7% participated in religious activities, a percentage significantly higher when compared to 44.8% among those that underwent amputation ($p = 0.0012$).

Table 1. Sociodemographic variables by type of surgery.

Variable	Amputation – Group 1		Conservative – Group 2		P-value
	N (%)	mean (SD)	N (%)	mean (SD)	
Sample	29	(100%)	16	(100%)	
Age (years)	32	(12.8)	27	(12)	
Sex					0.7993
Female	12	(41.38)	6	(37.50)	
Male	17	(58.62)	10	(62.50)	
Marital status					0.319
Single	16	(55.17)	10	(62.50)	
Married	13	(44.83)	5	(31.25)	
Other	0		1	(6.25)	
Schooling level					0.4652
Did not complete elementary school	4	(13.79)	1	(6.25)	
Elementary school	5	(17.24)	5	(31.25)	
High school	16	(55.17)	6	(37.50)	
Higher education	4	(13.79)	4	(25.00)	

Table 1. Sociodemographic variables by type of surgery.

Variable	Amputation – Group 1		Conservative – Group 2		P-value
	N (%)	mean (SD)	N (%)	mean (SD)	
Occupation					0.3096
On social security leave	1	(3.45)	3	(18.75)	
Currently under employ	8	(27.59)	3	(18.75)	
Student	9	(31.03)	7	(43.75)	
Unemployed	9	(31.03)	2	(12.50)	
Retired	2	(6.90)	1	(6.25)	
Social Welfare					0.2446
Yes	4	(13.79)	5	(31.25)	
No	25	(86.21)	11	(68.75)	
Household income (minimum-wages)					
Before the disease	4.31	(2.16)	5.75	(3.94)	0.6884
After the disease	4.03	(2.58)	5.94	(3.84)	0.1711
Type of practiced activity (if any)					
Social					0.6596
No	9	(31.03)	6	(37.50)	
Yes	20	(68.97)	10	(62.50)	
Sporting					0.1891
No	16	(55.17)	12	(75.00)	
Yes	13	(44.83)	4	(25.00)	
Cultural					0.9118
No	14	(48.28)	8	(50.00)	
Yes	15	(51.72)	8	(50.00)	
Religious					**0.0012***
No	16	(55.17)	1	(6.25)	
Yes	13	(44.83)	15	(93,75)	

* $p < 0.05$

Table 2 describes the variables related to sarcoma by type of surgery. Osteosarcoma predominated in both groups, and the femur was the most affected region. Regarding cancer treatment, 95.5% underwent chemotherapy, and of these, 88.8% had already completed chemotherapy. One participant, in addition to chemotherapy, underwent adjuvant radiotherapy.

Table 2. Sarcoma-related variables by type of surgery.

Type of surgery			
Pathological Variable	**Amputation – Group 1** N (%) mean (SD)	**Conservative surgery – Group 2** N (%) mean (SD)	**P-value**
Type of cancer			0.6338
Osteosarcoma	16 (55.1)	10 (62.5)	
Others	13 (44.8)	6 (37.5)	
Tumor Site			1.0000
Femur	24 (82.76)	14 (87.50)	
Fibula/Tibia	4 (13.79)	2 (12.50)	
Feet	1 (3.45)	0 (0.00)	

Table 2. Sarcoma-related variables by type of surgery.

	Type of surgery		
Pathological Variable	**Amputation – Group 1 N (%) mean (SD)**	**Conservative surgery – Group 2 N (%) mean (SD)**	**P-value**
Cancer Treatment			0.2738
Chemotherapy	27 (93.10)	15 (93,75)	
Chemo/Radiotherapy	0 (0.00)	1 (6.25)	
Surgery Only	2 (6.90)	0 (0.00)	
On Chemotherapy Treatment			1.0000
Yes	3 (10.34)	2 (12.50)	
No	26 (89.66)	14 (87.50)	
Use of Prosthesis/Orthotic Devices			**< 0,0001***
Yes	26 (89.66)	1 (6.25)	
No	3 (10.34)	15 (93,75)	

* $p < 0.05$

Amputees used prostheses or orthotic devices for locomotion more often than those submitted to conservative surgery ($p < 0.0001$). The other variables related to sarcoma did not present a statistically significant association with the type of surgery.

At the time of the interview, the mean follow-up in years of the participants undergoing conservative surgery was 7.1 (SD = 3.21) and of amputees 10.6 (SD = 2.25). Of the 16 participants submitted to conservative surgery, only 3 (18.7%) had been discharged from cancer follow-up and the others were still in reviews with the oncology team. Two participants in this group (conservative surgery) were still undergoing chemotherapy. In relation to the 29 amputees, 17 (58.6%) had already been discharged and the others remained under follow-up. Still in relation to this group, three participants were on chemotherapy. It is noteworthy that the participants who were undergoing chemotherapy were not free of cancer (sarcoma). None of the participants in both groups presented local tumor recurrence and there was no need for a new surgical approach for this purpose. Among postoperative complications, only one participant (6.2%) submitted to conservative surgery (knee endoprosthesis), presented infection, which required a new surgical approach and use of antibiotic therapy. Also at the time of the postoperative period, the occurrence of healing difficulties of the surgical wound occurred in five non-amputated participants (31.2%) and in three (10.3%) amputees, without the need for surgical reapproach.

Regarding pulmonary metastases, 26 (58%) among the 45 participants presented it, 18 in the amputation group and eight in the conservative surgery group. All patients underwent thoracotomy for resection of pulmonary metastases. In the amputation group, of the 29 participants, 18 (62%) were submitted to thoracotomy for metastectomy (44.5% in the right hemithorax, 11% in the left hemithorax and 44.5% bilateral). The mean number of surgeries was 1.6 (minimum of 1 and maximum of 6 surgeries in the same patient). In the conservative surgery group, of the 16 participants, 8 (50%) required metatectomy (18.75% in the right hemithorax, 6.25% in the left and 25% had bilateral thoracotomy). The mean number of surgeries was also 1.6 (minimum of one and maximum of six surgeries in the same patient).

The linear regression models of possible predictors of overall quality of life are set out in Table 3. Only occupation and family income after the disease were considered significant predictors for better perception of quality of life and overall health. Participants who were currently employed had an average perception of general quality of life 28% better than participants that were either retired or on social security leave ($p = 0.0053$). Participants with higher family income after the disease had a higher perception of overall quality of life; for each increase in one minimum wage in family income, the perception of overall quality of life increased by an average of 3.17% ($p = 0.0063$).

Table 3. Linear Regression Models of possible predictors of General Quality of Life.

	Simple Linear Regression		Multiple Linear Regression	
Explanatory variables	**Estimated Parameter (β)**	**p-value**	**Estimated Parameter (β)**	**p-value**
Gender				
Male x Female	7.41	0.2969	-	-
Age	–0.19	0.503	-	-
Occupation				
Employed x Retired	21.64	0.038	28.23	0.0053*
Student x Retired	2.23	0.8147	12.62	0.1884
Unemployed x Retired	–9.41	0.3566	7.84	0.4825
Type of cancer				
Osteosarcoma x Others	–2.34	0.7407	-	-

Table 3. Linear Regression Models of possible predictors of General Quality of Life.

	Simple Linear Regression		Multiple Linear Regression	
Explanatory variables	**Estimated Parameter (β)**	**p-value**	**Estimated Parameter (β)**	**p-value**
Social Welfare				
Yes x No	–10.18	0.2408	-	-
Tumor Site				
Distal Femur Extremity x Other	4.45	0.6497	-	-
Proximal Femur Extremity x Other	4.37	0.6737	-	-
On Chemotherapy Treatment				
No x Yes	16.04	0.1449	-	-
Use of Prosthesis/Orthotic Devices				
Yes x No	–3.39	0.6343	-	-
Social Activity				
Yes x No	7.22	0.3281	-	-
Sporting Activity				
Yes x No	17.89	0.01	-	-
Religious Activity				
Yes x No	–13.95	0.0481	-	-
Cultural Activity				
Yes x No	13.97	0.041	-	-
Family Income After Disease	3.22	0.0023	3.17	**0.0063***
Group				
Amputation x Conservative Surgery	–0.83	0.9101	-	-

* $p < 0.05$

The results obtained via the Instruments EORTC QLQ-C30, MSTS and BDI are presented in Table 4. The mean values of the EORTC QLQ-C30 did not differ for all dimensions, except constipation, higher in the amputation group than in conservative surgery ($p = 0.0116$). The mean MSTS values did not differ between the procedures ($p = 0.2135$), as well as the BDI levels ($p = 0.3179$).

Table 4. Distribution of the mean scores of the Functional Assessment System, questionnaires, EORTC QLQ-C30 and the Beck Depression Inventory.

	Procedure		
Indicators	**Amputation – Group 1**	**Conservative Surgery – Group 2**	**P-value**
	Mean SD	**Mean SD**	
MSTS (%) – Functioning	59.31 26.52	68.75 18.41	0.2135
EORTC (%) – QoL			
General Health	68.97 23.98	69.79 22.13	0.9522
Physical function	28.05 21.26	25.83 20.35	0.7737
Functional Performance	27.01 34.33	32.29 34.68	0.5418
Emotional function	33.05 24.95	28.13 24.13	0.4962
Cognitive function	15.52 19.89	18.75 23.47	0.7486
Social function	17.82 27.07	27.08 23.47	0.0799
Fatigue	24.14 22.82	28.47 22.58	0.492
Nausea/Vomiting	4.60 11.70	4.17 12.91	0.7208
Pain	22.41 26.46	23.96 21.92	0.6123
Dyspnea	13.79 26.00	18.75 24.25	0.3398
Insomnia	19.54 28.89	22.92 35.94	0.9236
Loss of appetite	10.34 25.36	18.75 36.45	0.4863
Constipation	25.29 34.10	4.17 16.67	0.0116*
Diarrhea	3.45 13.64	4.17 16.67	0.9781

Table 4. Distribution of the mean scores of the Functional Assessment System, questionnaires, EORTC QLQ-C30 and the Beck Depression Inventory.

Financial difficulty	18.39 35.17	35.42 42.98	0.1029
Beck – Depression			0.3179
No Depression	19 (65.52)	9 (56.25)	
Mild to moderate	9 (31.03)	4 (25.00)	
Moderate to severe	1 (3.45)	1 (6.25)	
Severe	0 (0.00)	2 (12.50)	

*$p < 0.05$

DISCUSSION

The study describes a series of 45 adults with lower limb sarcoma undergoing conservative amputation or surgery, their sociodemographic and clinical aspects, and their quality of life. In clinical practice, conservative surgery has been the preferred indication and amputation is performed only for cases when it is not possible to preserve thelimb.[9] Oftentimes, patients are admitted to health services already with large tumors and/or advanced disease, and limb amputation in these cases is indicated.[9]

The scientific production on quality of life of patients with sarcoma is small. Silva et al.[10] in an integrative review on quality of life in sarcoma patients undergoing different types of surgery (amputation versus conservative) found only ten studies in the main databases (LILACS, SciELO, Pepsic, EMBASE and PubMed). No Brazilian studies had been published. The country with the highest number of publications on the subject was the United States, and the studies were predominantly quantitative (90%).[3,9,11-18]

Regarding the sociodemographic data of the present study, the results were similar to those in the literature, with prevalence of young adults, mostly male, single and students. In this phase, corresponding to the period of high school or college, self-esteem is valued, as well as personal/professional interests and/or relationships, with the beginning of productive life, which, in most cases, is interrupted due to prolonged cancer treatment. Schooling did not influence the perception of better quality of life among the groups. Some studies in the field of oncology have identified that low schooling decreases access to specialized health services, delays the diagnosis of cancer, decreases adherence to treatment and, consequently, reduces the chances ofcure.[19]

The low occupational rate may also be explained by the low level of education. Few participants reported changes in relation to work after the disease, an event that could be related to the fact that they were not working at the beginning of treatment, probably due to the young age at diagnosis. Regardless of the type of surgery performed, the participants who were working and those with higher family income presented better perception of overall quality of life. New cancer therapies have increased patient survival and, in many cases, led to the cure of the disease. However, many face difficulties to return to the workforce or stay in it. In recent years, national and international studies have sought to understand the obstacles involved in this return to work, which is important not only financially, but also from the emotional point of view, because it symbolizes the overcoming of the disease as well as the return of routine and social life.[20] Teston et al.[21] reported that diseases such as cancer also compromise family financial power, especially if the patient is primarily responsible for the family's income, given the additional expenses related to the disease andtreatment.

In the present study, amputation surgery was more common. Silva et al.,[10] in their integrative review, observed that the number of patients undergoing amputation was similar to conservative surgery; however, in the last publications, there was a tendency to prioritize conservative surgery when possible.[12,21]

All participants reported participating in some type of social, cultural, sporting or religious activity. In the amputation group, social and cultural activities stood out and, in the conservative surgery group, religious activity stood out. There are reports in the literature that coping through religion provides cognitive/behavioral strategies for stressful events. Health-related religiosity has been increasingly investigated, with a positive relationship between religious involvement and mental health. Religious coping can be presented as an element that contributes to treatment adherence, reduction of stress/anxiety, and in the search for meaning in the patient's current situation.[22]

Femoral osteosarcoma was the most prevalent in both groups, corroborating the findings in the literature regarding the high prevalence in long bones, especially the femur, as the most common site.[12] In relation to chemotherapy, the literature shows worse quality of life during chemotherapy treatment.[23] In our sample, as the most participants in both groups had already completed chemotherapy at the time of the interview, it was not possible to compare our data with those in the literature.

Regarding the presence of pulmonary metastases and the need for thoracotomy for metastectomy, 62% of the participants in the amputation group and 50% of the conservative surgery group required the surgical procedure. There was no significant difference between the groups regarding the mean number of surgeries per patient. Thoracotomies were performed after resection of the primary tumor and no patient underwent pneumectomy. In addition, no patient required surgical reapproach or presented severe complications that led to the need for intubation and the use of invasive mechanical ventilation. At the time of the interview, no participant was in the recent postoperative period of the surgery (thoracotomy), which probably led the surgical approach not influencing our results.

Of the 29 amputated participants, 26 used prostheses for functional locomotion. The others reported greater functionality without the use of the prosthesis, using only locomotion aids. The evaluation of functionality was not different between surgical procedures, suggesting that amputees have functional capacity similar to those submitted to conservative surgery. Our results may be related to the fact that all patients were followed by a multidisciplinary team since their admission. In the postoperative period, patients participate in rehabilitation programs aimed at restoring gait functionality, activities of daily living, return to work, as well as educational, social and sporting activities. In addition, most amputation patients use prostheses for locomotion, which provides greater functionality for walking and performing daily activities. The studies by Rougraff et al.[14] and Alan et al.[11] observed the importance of preserving anatomical structures necessary for better functionality and the rehabilitation program in an interdisciplinary team, regardless of thetype of surgery (amputation or conservative), in patients with sarcoma.[11] Yonemoto et al.[17] observed that amputee and non-amputee patients did not present differences in functionality for gait or activities of daily living, as in the present study.

We know that the association between cancer, depressive conditions and other mood disorders is frequent and may be related to lower adherence to treatment, worse clinical evolution and decreased quality of life. In our study, only two participants presented symptoms of severe depression in the conservative surgery group, and were already being treated with specialists. In the review by Silva et al.,[10]

among the ten studies found, only two investigated the association of psychological aspects using specific instruments. Ottaviani et al.,[3] in a study with osteosarcoma survivors, did not observe differences related to psychological or depressive aspects between groups (amputated and non-amputated). The same results were found in the study by Rougraff et al.[14]

In the perception of quality of life, only constipation was higher in amputees than in those undergoing conservative surgery. According to data by Silva et al.,[10] there are no publications so far in patients with sarcoma, which may justify such findings. Wickham[24] in a review study concluded that constipation is common in cancer patients and its frequency is high in those with advanced disease and using opiate drugs to treat pain. Considering that data collection for the research was performed at least six months after the surgical procedure to control the primary tumor (amputation or conservative surgery), none of them at the time of the interview reported the presence of pain that required the use of opioids.

The perception of the overall health status and quality of life did not differ between the groups, and the results were similar to those in the literature, where most do not find differences in quality of life in participants amputated or submitted to conservative surgery.[3,9,11-18] Only two studies concluded that participants undergoing conservative surgery had a higher quality of life than amputees.[16,17]

Patients submitted to amputation initially undergo a painful process, and may present psychological alterations, related to self-image and temporary loss of locomotion. Depending on the level of lower limb amputation, prosthetization can provide the resumption of functional locomotion. On the other hand, patients undergoing conservative surgery may chronically present a reduction in the potential for locomotion due to the procedure (e.g., joint arthrodesis). In addition, more than 50% of patients that underwent conservative limb surgery also undergo a second surgical procedure after ten years due to failure of the initial surgery (surgical rods or stents).[25] Thus, the multiprofessional approach in patient care is essential, regardless of the type of surgery.

CONCLUSION

In this study, quality of life, functionality and psychological aspects did not differ between the procedures performed. Occupation and family income after the disease were associated with the perception of better quality of life and general health in both groups. Therefore, productive social participation had a positive and significant impact on the quality of life of these participants. In addition, participation in religious activities was also relevant in adherence and coping with treatment, and reduction of stress and anxiety.

Given the scarcity of studies on the subject, especially at the national level, further studies are suggested in order to explore subjective aspects related to the meaning of quality of life for patients with sarcomas.

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REFERENCES

1. Shreyaskumar RP, Robert SB. Soft tissue and bone sarcomas and bone metastases. In: Jameson JL, Fauci AS, Kasper DL, Hauser SL, Longo DL, Loscalzo J. Harrison's Principles of Internal Medicine. New York: McGraw-Hill Education; 2015. p. 1-14.
2. Garcia Filho RJ. Tumores ósseos e sarcomas dos tecidos moles. Einstein. 2008;6(1):S102-19.
3. Ottaviani G, Jaffe N. The epidemiology of osteosarcoma. In: Jaffe N, Bruland OS, Bielack S. Pediatric and adolescent osteosarcoma: cancer treatment and research. Chicago: Springer; 2010. p. 573-5.
4. Puri A. Limb salvage in musculoskeletal oncology: recent advances. Indian J Plast Surg. 2014;47(2):175-84.
5. Machado SM, Sawada NO. Avaliação da qualidade de vida de pacientes oncológicos em tratamento quimioterápico adjuvante. Texto Contexto Enferm. 2008;17(4):750-7.
6. Aaronson NK, Ahmedzai S, Bergman B, Bullinger M, Cull A, Duez NJ, et al. The European organization for research and treatment of cancer QLQ-C30: a quality-of-life instrument for use in international clinical trials in oncology. J Natl Cancer Inst. 1993;85(5):365-76.
7. Rebolledo DCS. Tradução e validação do instrumento Musculoskeletal Tumor Society Rating Scale (MSTS) para avaliação da função em pacientes com sarcomas ósseos dos membros inferiores [dissertation]. São Paulo: Universidade de São Paulo; 2012. 94 p.
8. Gorenstein C, Andrade L. Validation of a Portuguese version of the Beck Depression Inventory and the State-Trait Anxiety Inventory in Brazilian subjects. Brazilian J Med Biol Res. 1996;29(4):453-7.
9. Aksnes LH, Bauer HCF, Jebsen NL, Follerås G, Allert C, Haugen GS, et al. Limb-sparing surgery preserves more function than amputation: a Scandinavian sarcoma group study of 118 patients. J Bone Joint Surg Br. 2008;90(6):786-94.
10. Silva RS, Guilhem DB, Batista KT, Tabet LP. Quality of life of patients with sarcoma after conservative surgery or amputation of limbs. Acta Ortop Bras. 2019;27(5):276-80.
11. Yasko AW, Reece GP, Gillis TA, Pollock RE. Limb-salvage strategies to optimize quality of life: the M.D. Anderson Cancer Center experience. CA Cancer J Clin. 1997;47(4):226-38.
12. Beck LA, Einertson MJ, Winemiller MH, DePompolo RW, Hoppe KM, Sim FF. Functional outcomes and quality of life after tumor-related hemipelvectomy. Phys Ther. 2008;88(8):916-27.
13. Zahlten-Hinguranage A, Bernd L, Ewerbeck V, Sabo D. Equal quality of life after limb-sparing or ablative surgery for lower extremity sarcomas. Br J Cancer. 2004;91:1012-4.
14. Rougraff BT, Simon MA, Kneisl JS, Greenberg DB, Mankin HJ. Limb salvage compared with amputation for osteosarcoma of the distal end of the femur: a long-term oncological, functional, and quality-of-life study. J Bone Joint Surg Am. 1994;76(5):649-56.
15. Barr RD, Wunder JS. Bone and soft tissue sarcomas are often curable: but at what cost? A call to arms (and legs). Cancer. 2009;115(18):4046-54.
16. Mason GE, Aung L, Gall S, Meyers PA, Butler R, Krüg S, et al. Quality of life following amputation or limb preservation in patients with lower extremity bone sarcoma. Front Oncol. 2013;3:210.
17. Yonemoto T, Ishii T, Takeuchi Y, Kimura K, Hagiwara Y, Iwata S, et al. Evaluation of quality of life (QOL) in long-term survivors of high-grade osteosarcoma: a Japanese single center experience. Anticancer Res. 2007;27(5B):3621-4.
18. Griesser MJ, Gillette B, Crist M, Pan X, Muscarella P, Scharschmidt T, et al. Internal and external hemipelvectomy or flail hip in patients with sarcomas: quality-of-life and functional outcomes. Am J Phys Med Rehabil. 2012;91(1):24-32.
19. Mascarello KC, Silva NF, Piske MT, Viana KCG, Zandonade E, Amorim MHC. Perfil sociodemográfico e clínico de mulheres com câncer do colo do útero associado ao estadiamento inicial. Rev Bras Cancerol. 2012;58(3):417-26.
20. Blinder V, Patil S, Eberle C, Griggs J, Maly RC. Early predictors of not returning to work in low-income breast cancer survivors: a 5-year longitudinal study. Breast Cancer Res Treat. 2013;140(2):407-16.
21. Teston EF, Fukumori EFC, Benedetti GMS, Spigolon DN, Costa MAR, Marcon SS. Feelings and difficulties experienced by cancer patients along the diagnostic and therapeutic itineraries. Esc Anna Nery. 2018;22(4):e20180017.
22. Matos TDS, Meneguin S, Ferreira MLS, Miot HA. Quality of life and religious-spiritual coping in palliative cancer care patients. Rev Lat Am Enferm. 2017;25:e2910.
23. Sawada NO, Nicolussi AC, Paula JM, Garcia-Caro MP, Marti-Garcia C, Cruz-Quintana F, et al. Quality of life of Brazilian and Spanish cancer patients undergoing chemotherapy: an integrative literature review. Rev Lat Am Enferm. 2016;24:e2688.
24. Wickham RJ. Managing constipation in adults with cancer. J Adv Pract Oncol. 2017;8(2):149-61.
25. Nagarajan R, Clohisy DR, Neglia JP, Yasui Y, Mitby PA, Sklar C, et al. Function and quality-of life of survivors of pelvic and lower extremity osteosarcoma and Ewing's sarcoma: the Childhood Cancer Survivor Study. Br J Cancer. 2004;91(11):1858-65.

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ORIGINAL ARTICLE

BARE SPOT LOCATION IN GLENOID CAVITY: COMPARISON BETWEEN ARTHROSCOPY AND CT SCAN

POSICIONAMENTO DO BARE SPOT NA CAVIDADE GLENOIDAL: COMPARAÇÃO ENTRE ARTROSCOPIA E TOMOGRAFIA COMPUTADORIZADA

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ABSTRACT

Objective: To assess whether Bare Spot is previously displaced by proportion (MEASURE BP-A × 1.25/MEASURE BP-P = 1). Methods: 35 patients with surgical indication for rotator cuff injury repair were evaluated. The distances from the Bare Spot to the anterior edge of the glenoid cavity (BS-A) and to the posterior edge (BS-P) were measured by arthroscopy and computed tomography with three-dimensional reconstruction of the scapula. Results: The distance from the Bare Spot to the anterior border (BS-A tc) was 11.6 mm with a median 12 mm; The distance to the posterior border (BS-P tc) was on average 15.5 mm with a median 15 mm. The distances from BS to anterior cavity edge measured by arthroscopy were on average (BS-A video) 12.25 mm with a median of 12 mm, and from BS to posterior edge (BS-P video) 16.25 mm on average with median 16 mm ($p < 0.005$). Conclusion: Bare Spot is displaced anteriorly at a proportion of 40% of the anterior margin and 60% of the posterior margin. ***Level of Evidence II - Development of diagnostic criteria on consecutive patients (with universally applied reference "gold standard").***

Keywords: Joint Instability. Shoulder Joint. Pathology. Cadaver. Humans.

RESUMO

Objetivo: Avaliar in vivo *se o Bare Spot (BS) se encontra deslocado anteriormente conforme a proporção (MEDIDA BP-A × 1,25/MEDIDA BP-P = 1). Métodos: 35 pacientes com indicação cirúrgica de reparo de lesão do manguito rotador foram avaliados. As distâncias do Bare Spot à borda anterior da cavidade glenoidal (BS-A) e à borda posterior (BS-P) foram mensuradas na artroscopia e na tomografia computadorizada com reconstrução tridimensional da escápula. Resultados: A distância do BS à borda anterior (BS-A tc) foi de 11,6 mm com mediana de 12 mm; a distância à borda posterior (BS-P tc) foi, em média, 15,5 mm com mediana de 15 mm. As distâncias do BS à borda anterior da cavidade medidas na artroscopia foram, em média (BS-A vídeo), 12,25 mm com mediana de 12 mm e do BS à borda posterior (BS-P vídeo) de 16,25 mm, em média, com mediana de 16 mm ($p < 0,005$). Conclusão: O BS se encontra deslocado anteriormente a uma proporção de 40% da margem anterior e 60% da margem posterior.* ***Nível de Evidência II - Desenvolvimento de critérios diagnósticos em pacientes consecutivos (com padrão de referência "ouro" aplicado).***

Descritores: *Instabilidade Articular. Articulação do Ombro. Patologia. Cadáver. Humanos.*

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INTRODUCTION

Shoulder dislocation is a very common condition in orthopedic practice, accounting for about 2% of traumatic injuries of the upper limb, with anterior displacement being more frequent (85 to 90%).[1] Recurrence of dislocation, degree of soft tissue injury, and occurrence of bone injury (in the humeral head or anterior edge of the scapular glenoid cavity) determine joint instability.[1] Affecting young individuals in their productive range, this condition directly impacts the career of a professional athlete or people's ability to work.[1,2]

Over the centuries, anatomopathological knowledge and treatment of shoulder instability have evolved constantly. The advent of imaging and surgical technologies improved the treatment of this lesion.[2,3] The recognition of the essential lesion by Bankart in 1923 has made great progress in the treatment of glenohumeral instability and serves as a central pillar to this day.[1,2,4,5]

There are several surgical techniques to treat shoulder instability; the most used one is the arthroscopic anterior-inferior glenoid lip reconstruction, but it has a high recurrence rate (65%) in patients with bone loss greater than 25% in the anterior margin of the glenoid cavity.[3-5] In these cases, bone block surgery such as the transfer of the coracoid process becomes the best option.[5,6] Therefore, the precise definition of the residual bone portion in the glenoid cavity is fundamental for the correct treatment.[3,4,6,7]

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

The study was conducted at Hospital Universitário Gafrée-Guinle.
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In 2002, Burkhart et al.[2] published a study on the quantification of bone loss and suggested the need to determine a constant anatomical landmark present in the glenoid cavity to define the bone loss required to produce the "inverted pear." In this article, the author defines the "Bare Spot" (BS) as an arthroscopic visualization anatomical accident, located in the center of the inferior portion of the glenoid cavity, which would serve as a parameter for measuring bone loss at the antero-inferior border. The Bare Spot equidistaria the bottom edges of lower anterior and posterior inferior cavity. Thus, during the surgery, the identification of this point would allow the reliable measurement of bone loss, which would have a direct impact on treatment.[2-4,6,7]

Burkhart's study motivated a number of other studies that aimed to prove the usefulness of BS, to redefine it anatomically or to refute it as a central landmark of the cavity.[4,5,8-11]

In our previous study, we compared the measurements of the distances from the "Bare Spot" to the anterior and posterior edges of the glenoid cavity and observed that BS is previously dislocated according to the formula (MEASURE BP-A $\times$ 1.25/MEASURE BP-P = 1). In this study, we reproduced these measurements in vivo by comparing those obtained during arthroscopy and computed tomography of the shoulder with three-dimensional reconstruction and humeral head suppression.

MATERIALS AND METHODS

The study was approved by the Ethics Committee (CAAE 54343916.2.0000.5258) and performed under the care of the Department of Orthopedics. Thirty-five patients diagnosed with rotator cuff injury with indication for surgical treatment were recruited. Patients with history of glenohumeral dislocation or instability, presence of osteophytes at the edge of the glenoid cavity, history of shoulder fractures, as well as those in which Bare Spot was not identified on computed tomography were excluded. After their consent to participate in the project, we requested a computed tomography of the shoulder to be surgically treated, with three-dimensional reconstruction of the scapula and suppression of the humeral head. With the examination, we identified BS and measured the distances from BS to the anterior and posterior edge of the glenoid cavity. The circumscription method described by Burkhart was used to define the BS positioning in relation to the cavity. Measurements were performed using the Microdata mConnect web version 2013.1.6.3 program (Figure 1).

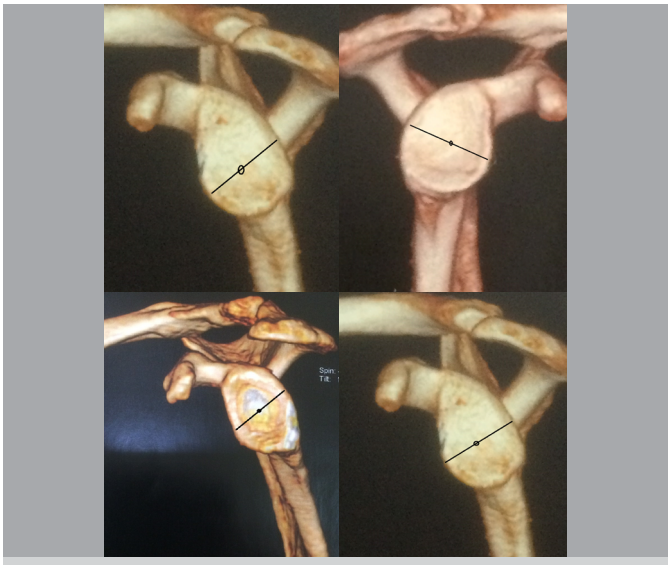

Figure 1. Measurement of the distances on the computed tomography.

The patient was then submitted to surgical treatment under arthroscopic visualization. The patients were positioned in a "beach chair," with the upper limb in 30º abduction. The posterior angle of the acromion was identified. The posterior portal will be established 2 cm inferior and 2 cm medial to the vertex of the angle. Through the posterior portal we will perform arthroscopic inspection of the joint with the *Smith & Nephew*[R] equipment (4.0 $\times$ 160.0 mm 30º direct view arthroscope, camera *Smith & Nephew*[R] 560 H; 5 mm fiber optic *Germinicable*[R]).

During the procedure, we inspected the joint where the BS point was identified, and the distances from BS to the anterior and posterior edges were measured. Starting from the intraarticular environment, we established the anterior portal (inside-out) by introducing the probe through the posterior portal and progressing in a line perpendicular to the anterior edge of the glenoid cavity, in alignment with BS, tangent to the upper edge of the subscapularis tendon and progressing to the skin. Through the previous portal, a probe millimeter was introduced. With the probe tip, BS was marked, and the distances from BS to the posterior edge of the cavity (BS-P video) and from the anterior edge of the glenoid cavity to the BS (BS-A video) were measured. Measurements were performed by two independent evaluators (Figure 2).

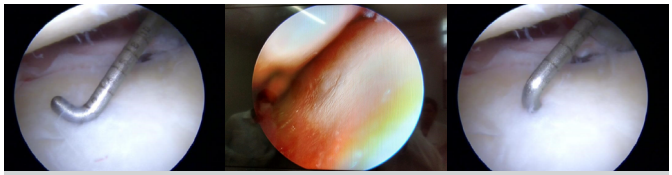

Figure 2. Measurement under arthroscopic visualization of the distances from Bare Spot to the anterior (BS-A) and posterior (BS-P) edge of the glenoid cavity.

Data were statistically analyzed using the online physics program of Saint John's University (USA). Two t-tests – student's t-test and the Kolmogorov-Smirnov test – were used to determine the statistical correlation, which was considered relevant $p < 0.05$. For statistical analysis, the software statistical openSUSE online (freeware) wessa was used.[12]

We will carry out the kolmogorov-smirnov test for non-pared variables, which allows us to analyze whether the two samples (of finite quantities) are similarly distributed, thus refuting the null hypothesis. The kolmogorov-smirnov test allows great sensitivity for values of a finite sample with little dispersion and is more reliable than the Anderson-Darling test for points near the median.

RESULTS

The total of 42 patients underwent arthroscopy with indication for surgical treatment of the rotator cuff injury. Of these, 7 were excluded from the study, remaining 35 patients. Bare Spot was not identified in 6 patients. One patient had osteophytes on the glenoid border. We analyzed 21 women (60%) and 14 men (40%). Lesions were in the dominant shoulder in 24 patients (68.57%) and in the counter-dominant in 11 (31.42%). Ages ranged from 40 to 65 years, with an average of 53.66 years and a median of 57 years.

Regarding the measurements obtained on tomography, the distance from the Bare Spot to the anterior border (BS-A tc) was 11.6 mm with a median 12 mm; The distance of the posterior border (BS-P tc) was on average 15.5 mm with a median 15 mm. The distances from Bare Spot to the anterior cavity edge measured on arthroscopy were on average (BS-A video) 12.25 mm with a median 12 mm, and from BS to posterior edge (BS-P video) 16.25 mm on average with a median 16 mm (Figure 3).

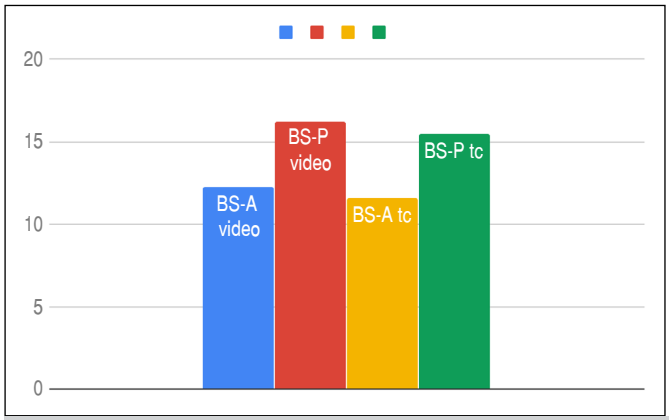

Figure 3. Result of the comparisons of measurements of the distances from Bare Spot to the anterior and posterior edge, on the computed tomography and arthroscopy. The distance from Bare Spot to the anterior edge (BS-A) was 11.6 mm with median 12 mm; the distance to the posterior edge (BS-P) was on average 15.5 mm with median 15 mm. The distances from BS to the anterior cavity edge measured by arthroscopy (BS-A vídeo) was on average 12.25 mm with median 12 mm, and BS to the posterior edge (BS-P vídeo) was on average 16.25 with median 16 mm ($p < 0.005$).

Comparison between measurements Bare Spot at the anterior edge by video or tomography showed no statistical difference ($p = 0.84749$), suggesting similarity between the measurements. Comparison of measurements Bare Spot at the posterior edge also showed no statistically significant difference ($p = 0.51755$). By comparing the distance from Bare Spot to the anterior and posterior margins, either by video or computed tomography, we obtained a *p-value* of 0.00068234.

DISCUSSION

Anterior shoulder instability is a relatively common clinical entity, whose prevalence has increased today, mainly due to the increasing sports demands for athletes and non-athletes. Faced with the installed lesion, there are several treatments available, each with its precise indications, advantages and disadvantages. One of the central questions in the therapeutic definition is to determine bone loss in the antero-inferior border of the glenoid cavity. In 2000, Burkhart et al.[3] published a retrospective study evaluating the causes of Bankart lesion repair failure under arthroscopic visualization. In this study, the authors launched the concept of "inverted pear" and concluded that bone losses greater than 25% of the cavity diameter modify this pattern, leading to recurrence of dislocation after Bankart repair.[13]

The quantification of bone loss has since become fundamental to guide the therapeutic approach. In 2002, Burkhart et al.[2] concluded that Bare Spot could be used as a reference for the reliable anatomical landmark of the inferior glenoid center, thus allowing the arthroscopic measurement of the anterior and posterior rays of the glenoid cavity, facilitating the quantification of bone loss. In 2004, Lo et al.[4] then performed a retrospective study using the Bare Spot to identify the glenoid center during arthroscopy, thus estimating bone loss.

Several studies have attempted to replicate Burkhart's results but were unsuccessful. De Wilde et al.[5] describe BS or Assaki tuber as a thinning of the subchondral bone. Vogt et al.[6] describe a point of origin of the eccentric distribution of collagen fibers of the glenoid cartilage. Fealy et al.[7] suggest BS is not present in immature skeletons, suggesting this point is not a constant anatomical landmark.

In 2004, Aigner et al.[8] attempted to confirm Burkhart's findings by dissecting 10 cadavers. In this study, they realized that Bare Spot was not present in all specimens. In addition, they concluded that Bare Spot diverges significantly from the center of the glenoid. The distance from BS to the anterior glenoid margin (9.7 mm) was significantly smaller than the distance to the posterior border (13.71 m).

In 2006, Huysmans et al.[9] analyzed 40 skeletally mature cadaver shoulder blades and found that Bare Spot was present in 35 of the 40 glenoids. They also realized there was a significant difference between the distances from the center of BS to the anterior and posterior edges of the glenoid. In this study, the average distance from BS to the anterior border was 11.04 mm and to the posterior was 12.96 mm.

Kralinger et al.,[10] in 2006, evaluated 20 scapulae using computed multislice tomography and concluded that the distance from BS to the anterior border was 9.7 mm (6.5 to 13.7 mm), to the inferior border was 10.9 mm (9.1 to 13.8 mm) and the posterior was 13.7 mm (11.3 to 19.2 mm).

In 2013, Gagliardi et al.[14] conducted a retrospective study by reviewing the tomographic images of 50 patients and found that the Bare Spot was not present in skeletally immature individuals under 10 years. A 14-year-old patient presented an image that could identify BS.

Miyatake et al.,[15] in 2014, published a series of cases evaluating the shoulder of 40 patients diagnosed with anterior glenohumeral instability and recurrent dislocations, comparing intraoperative arthroscopic measurements and computed tomography. They concluded that BS does not coincide with the center of the inferior glenoid cavity, and the estimation of bone loss under arthroscopic visualization was not accurate, suggesting that computed tomography with three-dimensional reconstruction and preoperative humerus suppression would be the most accurate way of defining bone loss.

In our previous study, we looked at 20 shoulders. Measurements of the distance from the Bare Spot to the anterior and posterior edges were performed under arthroscopic visualization and open. We noticed that the Bare Spot approached the anterior edge discreetly, being the BS-P (12.8 mm) measurement slightly larger than the BP-A (9.15 mm) measurement, suggesting a more anterior BS positioning, therefore not coinciding with the center of the glenoid cavity.

In this study, we compared the measurements obtained during surgery under arthroscopy with those obtained by computed tomography of the shoulder. We did not observe significant difference between the rays measured through arthroscopy or computed tomography. When comparing the distances from the Bare Spot to the anterior and posterior edges of the glenoid cavity, we observed that the anterior displacement pattern is repeated, with the BS distance to the posterior edge slightly larger than the distance to the anterior edge. In the computed tomography measurements, the anterior radius represented 42.98% of the cavity diameter, while in arthroscopy measurements, the anterior radius represented 42.8% of the glenoid cavity diameter. Thus, the same proportion between the distances from Bare Spot to the anterior and posterior margins were observed.

The relevance of this study lies in the fact that Bare Spot has been previously displaced. Disregarding this information may induce the surgeon to overestimate bone loss, since the BS-A distance is by nature slightly smaller than BS-P. This difference may cause the specialist to adopt a more aggressive approach, opting for the transscapular osteotendinous transfer, rather than the arthroscopic labral repair technique, so a correction factor should always be used for a correct evaluation of this measurement. When associated with Hill-Sachs injury, the definition of bone loss at the anterior edge of the glenoid cavity becomes crucial.

In cases of bipolar bone injury off-track, accurate quantification of the bone remnant in the glenoid cavity is critical for correct treatment and prevention of recurrence.

The limitations of this study were the small sample and the angle of attack of the anterior portal, which may lead to an overestimated measurement of the anterior radius, although we tried to minimize this bias through as perpendicular positioning, even if the subscapularis tendon needed to be displaced caudally.

CONCLUSION

This study suggests Bare Spot is previously displaced by a ratio of 1/1.25, as previously suggested.

AUTHORS' CONTRIBUTIONS: Each author contributed individually and significantly to the development of this article. MRFR: study conception and design, data collection, analysis and interpretation, project advisor, revision; PFH: surgeries, data, tomography and statistical analysis, and writing of the article; DF: surgeries, data analysis and writing of the article; YACSJ: surgeries, data analysis, writing of the article, statistical analysis, writing of the article and critical review of its intellectual content, revision of the article and final approval of the manuscript version to be published.

REFERENCES

1. Lech O, Freitas JR, Piluski P, Severo A. Luxação recidivante do ombro: do papiro de Edwin Smith à capsuloplastia térmica. Rev Bras Ortop. 2005;40(11/12):625-37.
2. Burkhart SS, DeBeer JF, Tehrany AM, Parten PM. Quantifying glenoid bone loss arthroscopically in shoulder instability. Arthrosc. 2002;18(5):488-91.
3. Burkhart SS, DeBeer JF. Traumatic glenohumeral bone defects and their relationship to failure of arthroscopic Bankart repairs: significance of the inverted-pear glenoid and the humeral engaging Hill-Sachs lesion. Arthrosc. 2000;16(7):677-94.
4. Lo IKY, Parten PM, Burkhart SS. The inverted pear glenoid: an indicator of significant glenoid bone loss. Arthrosc. 2004;20(2):169-74.
5. De Wilde LF, Berghs BM, Audenaert E, Sys G, van Maele GO, Barbaix E. About the variability of the shape of the glenoid cavity. Surg Radiol Anat. 2004;26(1):54-9.
6. Vogt S, Eckstein F, Schön M, Putz R. Preferential direction of the collagen fibrils in the subchondral bone of the hip and shoulder joint. Ann Anat. 1999;181(2):181-9.
7. Fealy S, Rodeo SA, Dicarlo EF, O'Brien SJ. The developmental anatomy of the neonatal glenohumeral joint. J Shoulder Elbow Surg. 2000;9(3):217-22.
8. Aigner F, Longato S, Fritsch H, Kralinger F. Anatomical considerations regarding the "bare spot" of the glenoid cavity. Surg Radiol Anat. 2004;26(4):308-11.
9. Huysmans PE, Haen PS, Kidd M, Dhert WJ, Willems JW. The shape of the inferior part of the glenoid: a cadaveric study. J Shoulder Elbow Surg. 2006;15(6):759-63.
10. Kralinger F, Aigner F, Longato S, Rieger M, Wambacher M. Is the bare spot a consistent landmark for shoulder arthroscopy? A study of 20 embalmed glenoids with 3-dimensional computed tomographic reconstruction. Arthrosc. 2006;22(4):428-32.
11. Calandra JJ, Baker CL, Uribe J. The incidence of Hill-Sachs Lesions in initial anterior shoulder dislocations. Arthrosc. 1989;5(4):254-7.
12. Holliday IE. Kolmogorov-Smirnov Test (v1.0.4) in Free Statistics Software (v1.2.1) [Internet]. Chicago: Office for Research Development and Education; 2017 [cited 2020 June 23]. Available from: https://bit.ly/3dplqAh.
13. Shibata H, Gotoh M, Mitsui Y, Kai Y, Nakamura H, Kanazawa T, et al. Risk factors for shoulder re-dislocation after arthroscopic Bankart repair. J Orthop Surg Res. 2014;9(1):53.
14. Gagliardi JA, Carino M. Glenoid bare spot. Appl Radiol. 2013;10(1):29-31.
15. Miyatake K, Takeda Y, Fujii K, Takasago T, Iwame T. Validity of arthroscopic measurement of glenoid bone loss using the bare spot. Open Access J Sports Med. 2014;5:37-42.

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ORIGINAL ARTICLE

CHANGES IN BONE MINERAL DENSITY AFTER TOTAL KNEE ARTHROPLASTY

ALTERAÇÕES NA DENSIDADE MINERAL ÓSSEA APÓS ARTROPLASTIA TOTAL DO JOELHO

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ABSTRACT

Objective: We aimed to investigate the change in bone mineral density (BMD) in the first postoperative year in patients that underwent total knee arthroplasty (TKA) due to primary osteoarthritis of the knee. Methods: Preoperative and first postoperative year dual-energy X-ray absorptiometry measurements of 76 patients with knee osteoarthritis, who undergone surgery between 2016 and 2018 due to the recommendation for TKA, were statistically evaluated in the study. Results: Of the 19 patients with a normal BMD in the preoperative period, 73.7% ($n = 14$) continued to have a normal BMD in the postoperative period. Of the 34 patients with a low BMD (osteopenia) in the preoperative period, 91.2% ($n = 31$) did not show any change, whereas osteoporosis was observed in two patients (5.9%) in the postoperative period. Of the 23 patients with osteoporosis in the preoperative period, 95.7% ($n = 22$) did not show any change, whereas osteopenia was observed in one patient (4.3%) in the postoperative period. Both the T and Z scores of the spine (L1-L4) and proximal femur showed a slightly positive trend, however, with an insignificant statistical difference ($p \geq 0.05$). Conclusion: Patients that underwent TKA experienced a statistically insignificant bone gain at the spine and proximal femur twelve months after the surgery. ***Level of Evidence III, Therapeutic Studies Investigating the Results of Treatment.***

Keywords: Bone Density. X-Rays. Absorptiometry, Photon. Osteoarthritis, Knee. Osteoporosis. Arthroplasty, Replacement, Knee.

RESUMO

Objetivo: O objetivo foi investigar a alteração na densidade mineral óssea (DMO) no primeiro ano pós-operatório em pacientes submetidos à Artroplastia Total do Joelho (ATJ) por osteoartrite primária do joelho. Métodos: As medidas de absortiometria radiográfica com dupla energia no pré-operatório e no primeiro ano pós-operatório de 76 pacientes com osteoartrite do joelho, operados entre 2016 e 2018 devido à indicação de ATJ, foram avaliadas estatisticamente no estudo. Resultados: Dos 19 pacientes com DMO normal no pré-operatório, 73.7% ($n = 14$) continuaram com DMO normal no pós-operatório. Dos 34 pacientes com baixa DMO (osteopenia) no pré-operatório, 91.2% ($n = 31$) não apresentaram alteração, enquanto osteoporose foi observada em dois pacientes (5.9%) no pós-operatório. Dos 23 pacientes com osteoporose no pré-operatório, 95.7% ($n = 22$) não apresentaram alteração, enquanto osteopenia foi observada em um paciente (4.3%) no pós-operatório. Os escores T e Z da coluna vertebral (L1-L4) e do fêmur proximal mostraram uma tendência levemente positiva, mas a diferença foi estatisticamente insignificante ($p \geq 0.05$). Conclusão: Os pacientes submetidos à ATJ apresentaram um ganho ósseo estatisticamente insignificante na coluna vertebral e no fêmur proximal doze meses após a cirurgia. ***Nível de Evidência III, Estudos Terapêuticos – Investigação dos resultados do tratamento.***

Descritores: *Densidade Óssea. Raios X. Absorciometria de Fóton. Osteoartrite do Joelho. Osteoporose. Artroplastia do Joelho.*

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INTRODUCTION

Total knee arthroplasty (TKA) is the most successful procedure in the treatment of osteoarthritis (OA) in orthopedic surgery to control pain, improve functional quality, and enhance the quality of life.[1] TKA surgery is usually performed when bone mineral density (BMD) starts to decrease due to normal aging.[2]

Several studies have aimed to specify the changes in the overall BMD of patients following TKA and researchers have reached different conclusions; some suggested an increase in BMD following TKA,[3] others, in turn, argued that no changes were observed.[4] It has also been suggested that there is a generalized loss of bone mineral density in the lower extremity after TKA as a result of immobilization and stress shielding effect of the femoral component.[5] This incidence may increase the risk of fractures later in a population that may be already affected by osteoporosis (OP).[6] Age-related OP, usually measured by BMD loss, is a known risk factor for fractures in older adults with significant negative consequences.[6]

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

The study was conducted at Namık Kemal University, Faculty of Medicine, Department of Orthopedics and Traumatology.
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The load distribution in the bone results in stress-adaptive bone remodeling (stress-protective effect) after TKA.[7] This stress-protective effect is considered the primary determinant of BMD reduction in the early postoperative phase. Bone atrophy of up to 36% has been reported for the anterior aspect of the distal femur.[8] The results of the periprosthetic BMD in the proximal tibia contradict each other. BMD had shown no change in some studies,[9] whereas it either decreased[10] or increased in others.[11] It has been hypothesized that periprosthetic bone loss due to stress shielding may lead to the loosening of the implant and promote periprosthetic fractures.[12] To our knowledge, although an empirically-represented negative relationship between BMD and fracture risk supports this theory, there is no evidence for this correlation.

Since there is no consensus on the change in the BMD of patients following TKA, we aimed to investigate the change in BMD in the first postoperative year in patients that underwent unilateral TKA due to Kellgren-Lawrence Stage 4 primary OA of the knee.

MATERIALS AND METHODS

This is a retrospective study including only information from the patients' files and hence no written consent from the patients was considered necessary.

A total of 76 patients (70 women, 6 men) that underwent TKA due to the diagnosis of advanced stage primary gonarthrosis between November 2016 and February 2018 were included in our study. Ethical committee approval numbered 1111 and dated 05.17.2018 was obtained from the Local Ethics Committee of Clinical Studies at the Department of Orthopedics and Traumatology, Faculty of Medicine, Namık Kemal University.

Patients with secondary gonarthrosis due to rheumatologic, traumatic or septic reasons and patients with a history of knee, hip or ankle surgery were excluded. Patients' age, records of previous knee surgery and the age of menopause were recorded on the FRAX (Fracture Risk Assessment Tool) table. The patients had a mean age of 65.67±7.70 (range: 51 to 84) years. Their body mass index (BMI) ranged between 26.29 and 47.26, with a mean of 36.55. The females suffering from menopause had a mean age of 45.38 (range: 30 to 56) years. There were no differences in the descriptive characteristics (age, height, weight) of the patients.

The patients were operated on using the same brand prosthesis (Zimmer-Nexgen®; Zimmer Biomet, Warsaw, IN, USA) by four surgeons in our clinic with sequential randomization. All patients got the same rehabilitation program after the surgery. Dual-energy X-ray absorptiometry (DXA) control was added to the preoperative and first postoperative year follow-up assessments.

DXA scan quantitatively analyzes the local metabolic activity of bone tissue, being considered a valuable tool to evaluate the integration between bone and prosthetic components, allowing for early detection of any changes between prosthesis and bone interface in TKA and for following up on the remodeling of the bone between the bone and the prosthetic interface.[13]

Preoperative and postoperative DXA measurements of the patients were performed at the spine (between L1 and L4) and proximal femur (femoral neck). The Horizon DXA System (Hologic Inc., Marlborough, MA, USA) was used in the DXA measurements of the patients and conducted at the Physical Therapy and Rehabilitation Department of the Faculty of Medicine of Namık Kemal University.

Statistical evaluation

The preoperative and first postoperative year DXA measurements of the patients were statistically evaluated. The SPSS v.25 software (SPSS Inc., Chicago, IL, USA) was used in the statistical analysis. The normality of the data was analyzed using the Kolmogorov-Smirnov test. The paired-sample t-test was used to compare the differences between two pairs in intergroup comparisons and the chi-square analysis was used to compare the categorical variables. A p value of less than 0.05 was considered statistically significant.

RESULTS

Of the 19 patients with a normal BMD in the preoperative period, 14 (73.7%) continued with a normal BMD in the postoperative period (Table 1).

Table 1. Postoperative changes of the patients with normal bone mineral density in the preoperative course (n = 19).

	Postoperative normal	Postoperative osteopenic	Postoperative osteoporotic
Number of patients	14	4	1
Percentage of patients (%)	73.7	21.1	5.3

Of the 34 patients with a low BMD (osteopenia) in the preoperative period, 31 (91.2%) did not show any change, whereas osteoporosis was observed in two patients (5.9%) in the postoperative period (Table 2).

Table 2. Postoperative changes of the patients with osteopenia in the preoperative course (n = 34).

	Postoperative normal	Postoperative osteopenic	Postoperative osteoporotic
Number of patients	1	31	2
Percentage of patients (%)	2.9	91.2	5.9

Of the 23 patients with osteoporosis in the preoperative period, 22 (95.7%) did not show any change, whereas osteopenia was observed in one patient (4.3%) in the postoperative period (Table 3).

Table 3. Postoperative changes of the patients with osteoporosis in the preoperative course (n = 23).

	Postoperative normal	Postoperative osteopenic	Postoperative osteoporotic
Number of patients	0	1	22
Percentage of patients (%)	0	4.3	95.7

Although both the T and Z scores of the spine showed a mild positive trend, the difference between the pre- and postoperative periods was statistically insignificant ($p \geq 0.05$) (Table 4).

Table 4. Postoperative changes in the T and Z scores of the L1-L4 section and Ward's area.

	Preoperative	Postoperative
T score	– 0.6934	– 0.6763
Z score	0.9816	0.9947

The T and Z scores of the proximal femur similarly showed a slightly positive trend in the postoperative course, but the change was statistically insignificant ($p \geq 0.05$) (Table 5).

Table 5. Postoperative changes in the T and Z scores of the proximal femur.

	Preoperative	Postoperative
T score	– 1.5763	– 1.5513
Z score	– 0.0461	– 0.0632

DISCUSSION

Since there is no consensus on the change in BMD in patients following TKA,[3,4] we aimed to comparatively investigate the

preoperative and first postoperative year bone mineral densities in our study. Although we observed a slightly positive BMD trend in the spine and proximal femur, we could not find statistically significant different T and Z scores between the preoperative and first postoperative periods.

To date, no positive correlation has been established between OP and OA.[14] Whereas the accepted risk factors for OP are old age and a low BMD, the accepted risk factors for OA are old age and high BMI.[15] However, both diseases can be seen concomitantly related to patient's age, body weight, and living conditions such as long-term inactivity.[15] The mean femoral BMD in the proximal femur with a low stage knee OA was 5-9% higher compared to those without knee OA.[15] It was reported that the mean BMD of the femur in patients in the final stage of OA was not higher than those without OA.[15] In other study that investigated the BMD of both hips in advanced stage OA patients, Lingard et al.[16] reported that the BMD of the hip on the side of the symptomatic knee was lower and it showed a positive correlation with the degree of the radiographic change and a negative correlation with the knee functionality.[16] The authors investigated the prevalence of OP in patients with severe hip and knee OA subjected to joint arthroplasty and reported that 23% and 43% of the overall rate of OP was classified as osteopenia. In our study, of the patients with preoperative advanced OA, 34 (44.7%) were diagnosed with osteopenia and 23 (30.2%) with OP. The prevalence of OP in our study was similar to that in a study by Lingard et al.[16]

The L1-L4 section and Ward's area (total section) are valuable as the BMD measurements performed in the axial skeleton and outside the implantation site. Compression fractures in senile osteoporosis of the lumbar region are common. We did not find this type of fracture in our study (Table 4). Due to the BMD measurements in the proximal femur, the trochanteric region was predominantly evaluated and no changes that would affect the results were observed (Table 5). We did not find any fractures in the proximal femur, which is a common site of fracture in senile osteoporosis.

Considering all the results of our study, although it is not statistically significant, we can understand that the course of a patient with a normal BMD may turn to osteopenic and even osteoporotic, whereas it is harder to state the otherwise. Only one of the osteopenic patients returned to normal (Table 2). Likewise, only one of the osteoporotic patients returned to an osteopenic course (Table 3). On the other hand, of five patients found to be normal in the preoperative measurement, four became osteopenic and one osteoporotic, postoperatively (Table 1). Two patients with preoperative osteopenic findings became osteoporotic postoperatively (Table 2).

Most of the studies evaluating the BMD changes after TKA have focused on measuring the BMD changes in the periprosthetic region. Ishii et al.[3] studied the BMD changes in the bilateral hips of 24 patients (4 men, 20 women; mean age: 69 [range: 60 to 83] years) with TKA. Despite the decrease in the total BMD of the hip found in the first six months, the authors concluded that the BMD reached the basal level by the postoperative second year and that TKA prevented BMD loss due to increased postoperative mobility. Van Loon et al.[4] measured the BMD change in the bilateral hips and spine in 12 patients after TKA and reported that the BMD measurements at the 12th postoperative month were similar to the preoperative measurements. Soininvaara et al.[6] measured the bilateral hip BMD in 69 patients (20 men, 49 women; mean age: 67 $\pm$ 6.8 years) that had undergone TKA and detected a change in BMD at the ipsilateral hips up to −2.7% and a change at the contralateral hips up to −1.18% at the first postoperative year. The BMD reduction observed in all these studies was within the range of the expected age-related BMD changes. However, none of these studies showed compliance with differences in age and sex due to the limited sample size, and compared their results according to the normative data adjusted to age and sex published on the expected changes in BMD.

The duration of the follow-up period of patients that underwent TKA for the changes in BMD measurements has been a matter of debate. In our study, we preferred a one-year follow-up period, since the average duration of follow-up in the previous studies varied between 6 and 24 months. Despite the slight decrease in BMD after 12 months, an insignificant difference was reported after a follow-up period of 12 to 24 months.[17]

In our study, the patients were not given the preoperative treatment, since we aimed to observe the change in BMD after TKA application. This issue has been widely studied in the literature. In a study by Jiang et al.,[18] treatment with bisphosphonates was initiated with surgery and regional BMD reductions were detected during the 3rd or 6th month measurements. The BMD levels at the 12th and 24th months follow-ups were either the same as or higher than the preoperative period measurements. On the other hand, the BMD levels of the untreated group were low at the 24th month follow-up. It was asserted that bisphosphonate therapy may prevent aseptic loosening before joint replacement surgery and would reduce the fractures of cancellous bone formed during the postoperative period.[19]

In our study, the BMD measurements of the spine and proximal femur localization showed no significant difference. In a study by Beaupre et al.,[20] the first postoperative year BMD values of both the hips and the spine showed a negative change compared to the preoperative period. In some other studies, the BMD change in the hip at the operated side was significantly higher than the other parts of the body.[20] In our study, both the T and Z scores of the spine and proximal femur measured in the postoperative course showed a mild positive trend compared to those in the preoperative period ($p \geq 0.05$).

The limitations of our study are the lack of BMD measurements at the third, sixth and ninth postoperative months and the lack of evaluation of the BMD changes in the knee, although the orthoroentgenograms of the patients were taken. We measured the BMD in the first postoperative year so we could not interpret the trajectory of bone loss or the long-term effects of TKA on BMD. Moreover, few patients had a history of antiaggregant use that could negatively affect the bone structure. However, this drug interaction was not investigated, since it would not cause a statistically significant change in the results of the group of patients included in our study. Although the femoral neck and intertrochanteric region have been measured separately in BMD measurement of the hip region in several publications, the fact that no such distinction was made by us and the incapability of the device used in our study was another limiting aspect. In addition, since our study was designed to evaluate the effect of knee arthroplasty on BMD, postponing the treatment of the osteoporotic patient for a period of one year is another limitation for our study.

CONCLUSION

The subjects that underwent primary cemented TKA experienced a statistically insignificant bone gain at the spine and proximal femur within the first postoperative year. Future studies with long-lasting and more frequent follow-ups are needed to understand the impact of post-fracture changes in BMD on fracture risk.

AUTHORS' CONTRIBUTIONS: Each author contributed individually and significantly to the development of this article. YMD: conceptualization and data analysis; AS: data analysis, study supervision and article review; CT: conceptualization, data analysis and article review; BG: conceptualization, data analysis and article review; MUC: conceptualization and article review; YZA: statistical analysis, study supervision and article review.

REFERENCES

1. Innocenti M, Matassi F, Carulli C, Nistri L, Civinini R. Oxidized zirconium femoral component for TKA: a follow-up note of a previous report at a minimum of 10 years. Knee. 2014;21(4):858-61.
2. Warming L, Hassager C, Christiansen C. Changes in bone mineral density with age in men and women: a longitudinal study. Osteoporos Int. 2002;13(2):105-12.
3. Ishii Y, Yagisawa K, Ikezawa Y. Changes in bone mineral density of the proximal femur after total knee arthroplasty. J Arthroplasty. 2000;15(4):519-22.
4. van Loon CJ, Oyen WJ, Waal Malefijt MC, Verdonschot N. Distal femoral bone mineral density after total knee arthroplasty: a comparison with general bone mineral density. Arch Orthop Trauma Surg. 2001;121(5):282-5.
5. Levitz CL, Lotke PA, Karp JS. Long-term changes in bone mineral density following total knee replacement. Clin Orthop Relat Res. 1995;(321):68-72.
6. Soininvaara TA, Miettinen HJ, Jurvelin JS, Alhava EM, Kröger HP. Bone mineral density in the proximal femur and contralateral knee after total knee arthroplasty. J Clin Densitom. 2004;7(4):424-31.
7. Saari T, Uvehammer J, Carlsson LV, Regnér L, Kärrholm J. Posterior stabilized component increased femoral bone loss after total knee replacement: 5-year follow-up of 47 knees using dual energy X-ray absorptiometry. Knee. 2006;13(6):435-9.
8. Minoda Y, Kobayashi A, Iwaki H, Ikebuchi M, Inori F, Takaoka K. Comparison of bone mineral density between porous tantalum and cemented tibial total knee arthroplasty components. J Bone Joint Surg Am. 2010;92(3):700-6.
9. Petersen MM, Gehrchen PM, Ostgaard SE, Nielsen PK, Lund B. Effect of hydroxyapatite-coated tibial components on changes in bone mineral density of the proximal tibia after uncemented total knee arthroplasty: a prospective randomized study using dual-energy x-ray absorptiometry. J Arthroplasty. 2005;20(4):516-20.
10. Chen SH, Chiang MC, Hung CH, Lin SC, Chang HW. Finite element comparison of retrograde intramedullary nailing and locking plate fixation with/without an intramedullary allograft for distal femur fracture following total knee arthroplasty. Knee. 2014;21(1):224-31.
11. McClung MR. The relationship between bone mineral density and fracture risk. Curr Osteoporos Rep. 2005;3(2):57-63.
12. Cummings SR, Melton LJ. Epidemiology and outcomes of osteoporotic fractures. Lancet. 2002;359(9319):1761-7.
13. Piscitelli P, Iolascon G, Innocenti M, Civinini R, Rubinacci A, Muratore M, et al. Painful prosthesis: approaching the patient with persistent pain following total hip and knee arthroplasty. Clin Cases Miner Bone Metab. 2013;10(2):97-110.
14. Foss MV, Byers PD. Bone density, osteoarthritis of the hip, and fracture of the upper end of the femur. Ann Rheum Dis. 1972;31(4):259-64.
15. Mont MA, Gwam C, Newman JM, Chughtai M, Khlopas A, Ramkumar PN, et al. Outcomes of a newer-generation cementless total knee arthroplasty design in patients less than 50 years of age. Ann Transl Med. 2017;5(Suppl 3):S24.
16. Lingard EA, Mitchell SY, Francis RM, Rawlings D, Peaston R, Birrell FN, et al. The prevalence of osteoporosis in patients with severe hip and knee osteoarthritis awaiting joint arthroplasty. Age Ageing. 2010;39(2):234-9.
17. Dobbs MB, Buckwalter J, Saltzman C. Osteoporosis: the increasing role of the orthopaedist. Iowa Orthop J. 1999;19:43-52.
18. Jiang G, Kang L, Wang H, Zhang J. The influence of bisphosphonate on bone mineral density after total knee arthroplasty: a randomised controlled trial. Int J Surg Open. 2017;7:17-21.
19. Aspenberg P. Bisphosphonates and implants: an overview. Acta Orthop. 2009;80(1):119-23.
20. Beaupre LA, Rezansoff A, Clark M, Jen H, Lambert RG, Majumdar S. Bone mineral density changes in the hip and spine of men and women 1-year after primary cemented total knee arthroplasty: prospective cohort study. J Arthroplasty. 2015;30(12):2185-9.

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ORIGINAL ARTICLE

INNERVATION OF THE MEDIAN NERVE MOTOR BRANCHES IN THE FOREARM AND ITS CLINICAL SIGNIFICANCE

INERVAÇÃO DOS RAMOS DO NERVO MEDIANO NO ANTEBRAÇO E SUA SIGNIFICANCIA CLÍNICA

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ABSTRACT

Objective: To analyse the anatomical variations of the median nerve motor branches in the elbow region. Methods: Twenty upper limbs of 10 adult male cadavers were prepared by intra-arterial injection of a solution of 10% glycerol and formaldehyde. All cadavers belonged to the institution anatomy laboratory. Results: We found a great variability within the distribution of median nerve branches leading to forearm muscles. Only three limbs (14%) presented the normal standard of innervation described in anatomy treatises. The pronator teres muscle (PTM), flexor carpi radialis (FCR), palmaris longus (PL), and the flexor digitorum superficialis (FDS) received exclusive innervation from the median nerve in all forearms. The anterior interosseous nerve (AIN) also originated from the median nerve in all dissected limbs. Conclusion: A thorough understanding of the anatomy of the median nerve branches is important for performing surgeries such as: approach to the proximal third of the forearm, alleviation of pronator teres and anterior interosseous nerve compression syndromes, and distal nerve transfers. It also enables a better understanding the recovery of muscle function after a nerve injury. ***Level of Evidence IV, Case series.***

Keywords: Peripheral Nerve Injuries. Nerve Transfer. Mewdian Nerve.

RESUMO

Objetivo: Analisar as variações anatômicas dos ramos motores do nervo mediano na região do cotovelo. Avaliamos origem, curso, comprimento, terminações nervosas dos ramos e suas relações com estruturas vizinhas. Métodos: Selecionamos 20 membros de 10 cadáveres adultos dissecados, preparados por injeção intra-arterial com solução de glicerina e formol a 10%. Todos do sexo masculino, pertencentes ao laboratório de anatomia da instituição. Resultados: O primeiro ramo do nervo mediano no antebraço foi o músculo pronador redondo. A distribuição dos ramos do nervo mediano para os músculos do antebraço mostrou grande variabilidade. Apenas 3 membros (14%) apresentaram padrão normal de inervação descrito nos tratados de anatomia. Os músculos pronador redondo, flexor radial do carpo, palmar longo e flexor superficial dos dedos receberam inervação exclusiva do nervo mediano em todos os antebraços. O nervo interósseo anterior originou-se do nervo mediano nos membros dissecados. Conclusão: Conhecer a anatomia dos ramos motores do nervo mediano é importante para realizar procedimentos cirúrgicos na região como a abordagem do terço proximal do antebraço, por exemplo a liberação das síndromes compressivas do pronador redondo e do nervo interósseo anterior; as transferências nervosas distais; também entender a ordem de recuperação da função muscular após uma lesão nervosa. ***Nível de Evidência IV, Série de casos.***

Descritores: *Traumatismos dos Nervos Periféricos. Transferência de Nervo. Nervo Mediano.*

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INTRODUCTION

The median nerve (MN) is formed by the union of the lateral and medial cords of the brachial plexus and contains the nerve fibres from the spinal roots, from C5 to T1. In the proximal third of the arm, it is located in the middle part of the biceps, alongside the brachial artery and vein. In the proximal arm, it is situated next to the brachial artery. In the middle third of the arm, it crosses the brachial artery in front from lateral to medial side, lying on its middle. In the distal humerus, it runs the antecubital fossa through the brachial muscle (BM) and the intermuscular septum, underneath the bicipital aponeurosis (lacertus fibrosus). It then passes between the two heads of the pronator teres muscle (PTM) and penetrates the arch formed by the proximal muscle insertions of the flexor digitorum superficialis (FDS).[1,2]

Nerves associated with forearm muscles, named primary, separate from the main branch of the median nerve in the distal third of the

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

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arm and from the proximal forearm. From these, secondary branches emerge. Primary and secondary branches penetrate muscle mass by the radial nerve motor branch.[3] The normal innervation pattern of forearm muscles by the MN is described as follows: two branches (upper and lower) to the PTM, a common trunk to the flexor carpi radialis (FCR) and palmaris longus (PL), a branch to the flexor digitorum profundus, and a branch to the anterior interosseous nerve (AIN), which innervates the flexor digitorum profundus (FDP), flexor pollicis longus (FPL), and pronator quadratus (PQ).[4,5]

Later anatomical studies reported that MN distribution may differ from this classic pattern.[3,6-11] Gunther et al.[9] classified the branches into six groups, considering location and ramification. Canovas et al.[6] found considerable variability in the branches to muscles innervated by the MN, without a clear innervation pattern. Chantelot et al.[10] observed that the classic distribution was applicable to only 26% of the their studied limbs. Safwat et al.[7] studied the radial nerve motor branch for all forearm muscles, defined as nerve branch entry points into muscle.

Knowing MN motor branches is important for performing surgical procedures in the region of the forearm, such as: (1) approach to the proximal third of the forearm; (2) alleviation of PTM compressive syndromes; (3) distal nerve transfers of redundant nerve branches; and (4) a better understanding of the recovery of muscle function after a nerve injury.

This study aimed to analyse the anatomic variations of median nerve motor branches in the elbow region considering origin, course, length, ramifications, motor points, and relation to adjacent structures using 20 cadaver limbs. Considering that our results differ from various anatomic studies, the variability within this region should be emphasized.

MATERIALS AND METHODS

Twenty upper body limbs of ten male cadavers were prepared by intra-arterial injection of a solution of 10% glycerol and formaldehyde solution. Each forearm was dissected with the elbow extended and forearm supinated. Limbs showed no evidence of previous deformities, surgical procedures, or traumatic injuries in the studied area. The skin and fascia from the third distal of the arm and forearm were removed. The median nerve (MN) was identified and dissected from proximal to distal. The bicipital aponeurosis was sectioned and the humeral head of the pronator teres muscle (PTM) was distally removed and retracted. The tendons of the flexor carpi radialis (FCR) and palmaris longus (PL) were sectioned in their third distal to make their motor branches more visible. MN branches to PTM, FCR, PL, flexor digitorum superficialis (FDS), and anterior interosseous nerve (AIN) for flexor digitorum profundus (FDP), flexor pollicis longus (FPL), and pronator quadratus (PQ) were dissected and anatomical variations recorded. Vascular structures were not preserved to facilitate nerve dissection. A magnifying glass of 2,5 times magnification was employed at certain phases of the dissection.

Each muscle innervation order and the number of branches and motor points – defined as nerve branch entry points into the muscle – were recorded. Branch diameter and length to muscles PT, PL, FDS, AIN, and FCR were measured using a digital pachymeter and a millimetre ruler. All available specimens adhered to the ethical principles of the institution and the project was evaluated by the Ethics in Research Committee and registered in the Plataforma Brasil, under CAAE No. 14643419.5.0000.5373.

RESULTS

We described muscles following the order by which they emerged from the median nerve, from proximal to distal, in most limbs. Average forearm length was 26,2 ± 2,7 cm. Charts 1, 2, and 3 (Table 1, 2, and 3) summarizes average diameter, number of primary branches, and motor points of each muscle.

In all forearms, the pronator teres (PTM) was the first forearm muscle to be innervated and received exclusive innervation of the median nerve (MN) (Figure 1). PTM branches emerged from the MN in an interval 6,8 cm above and 2,8 cm below the humeral intercondylar line. We found more than one branch from the PTM in 14 limbs (70%) (Figure 2).

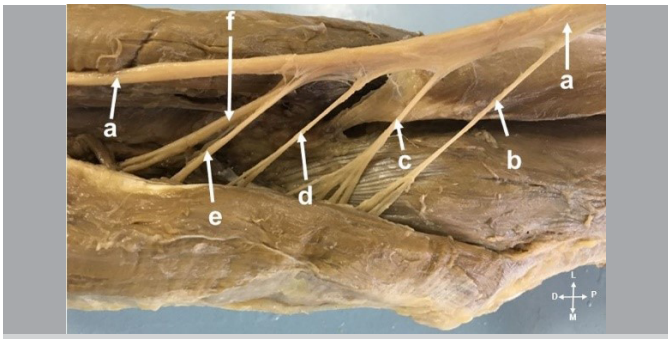

Figure 1. (a): Median nerve; (b): PT branch; (c): FCR branch; (d): PL branch; (e): FDS branch; (f): AIN.

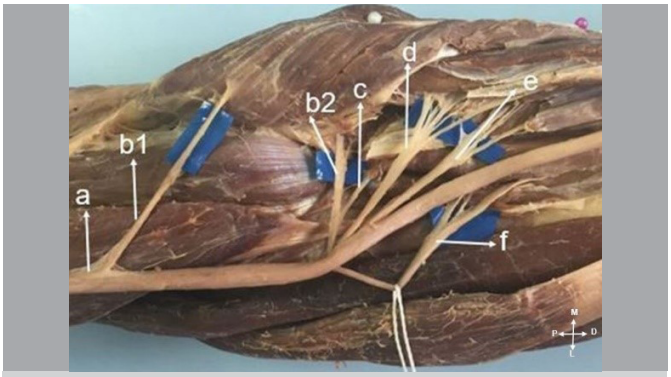

Figure 2. (a): Median nerve; (b1 and b2): PT branch; (c): PL branch; (d): FCR branch; (e): FDS branch; (f): AIN.

We found no palmaris longus (PL) muscle in 3 limbs (14%). However, when present, it was the second muscle innervated by the MN (Figure 1). In 5 limbs (19,7%), the PL received an exclusive innervation from a sole branch of the median nerve, shared with no other muscles. In 3 limbs, its origin was shared with the flexor carpi radialis (FCR) (Figure 3).

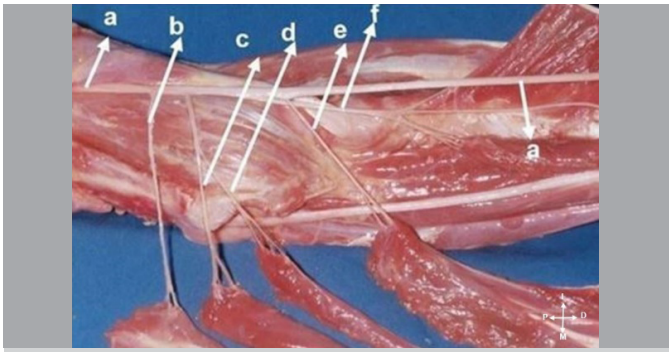

Figure 3. (a): Median nerve; (b): PT branch; (c): FCR branch; (d): PL branch; (e): FDS branch; (f): AIN.

All limbs presented the FCR with a sole branch. In most cases, it was the third forearm muscle innervated by the MN, receiving an exclusive innervation in all limbs (Figures 1 and 3).

In 14 limbs (70%), the anterior interosseous nerve (AIN) originated in the nervous fascicles of the MN posterior region, whereas in 6 limbs (30%) it originated in the posterolateral fascicles of the MN (Figure 4). Regarding the number of ramifications destined to the FPL and flexor digitorum profundus (FDP) muscles that penetrated in different points of their muscle masses, 6 limbs (305) presented two branches for the FMF and one for the FPL; 6 limbs (30%) had two branches for both FDP and FPL; 4 limbs (20%) three branches for the FDP and one for the FPL; and 4 limbs (20%) three branches for the FDP and two for the FDS. In all cases, the longest ramification always led to the FPL (Figure 5).

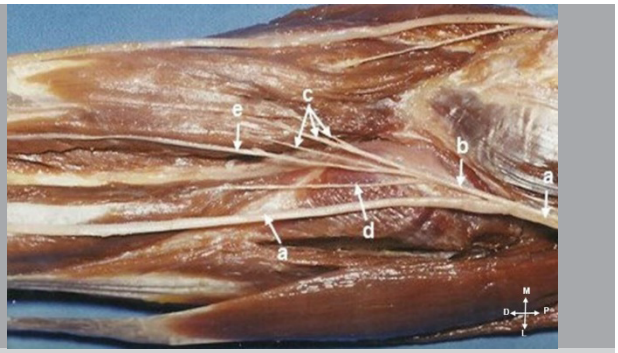

Figure 4. (a): Median nerve; (b): AIN; (c): branches to FDP; (d): branches to FPL; (e) branch to PQ.

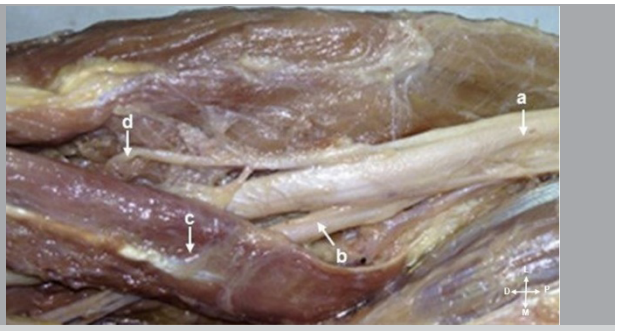

Figure 5. (a): Median nerve; (b): AIN; (c): superficial head of PT muscle; (d): PT branch.

In all limbs, the flexor digitorum superficialis (FDS) muscle received innervation by the MN, and was the last branch to emerge. In one limb (0,5%), the branch originated further up, slightly under the origin of the branch for the PTM. In two limbs (10%), despite receiving innervation of the MN, the FDS also received a branch from the AIN. As in 13 limbs (65%) the FDS received a sole branch of the MN, in 7 limbs (35%) it received two branches (Figure 6).

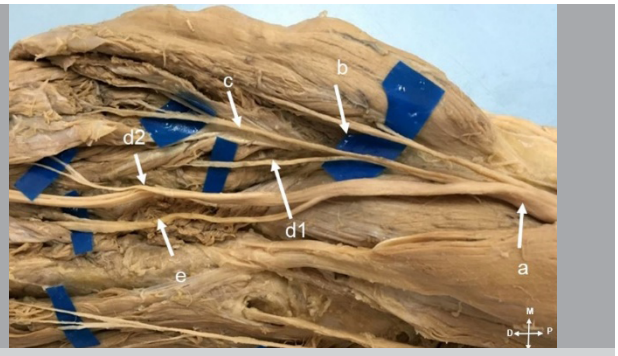

Figure 6. (a): Median nerve; (b): PT branch; (c): FCR branch; (d): PL branch; (d1 and d2): FDS branches; (e): AIN.

Table 1. Number, average diameter, and average length of median nerve branches in 20 limbs.

Muscle	Number of primary branches	Average nerve diameter (mm)	Average nerve lenght (mm)	Limbs
Pronator teres	1 to 3	1.5 ± 0.6	4.0 (3.0 ± 5.2)	20
Palmaris longus	1– absent in limbs	1.4 ± 0.7	3.7 (2.9 ± 4.7)	20
Flexor carpi radialis	1	1.5 ± 0.6	3.8 (3.0 ± 4.5)	20
Flexor digitorum superficialis	1 to 2	1.7 ± 0.6	4.2 (2.5 ± 5.0)	20
Anterior interosseous nerve	1	2.0 ± 1.2	10.0 (8.5 ± 11.0)	20
Flexor digitorum produnfus	1 to 3	1.0 ± 0.8	1.0 ± 0.5	20
Flexor pollicis longus	1 to 2	1.0 ± 0.6	1.0 ± 0.5	20
Pronador quadratus	1	1.2± 0.5	----------	20

Table 2. Summary of muscle motor points innervated by the median nerve in the middle proximal and distal third of the forearm.

Muscle	1 motor point	2 motor points	3 motor points	4 motor points	5 motor points	Average motor points
Pronator teres	2	8	6	4	----------	2.4 ± 0.8
Flexor carpi radialis	4	13	3	--------	----------	2.0 ± 0.4
Palmaris longus	10	8	2	--------		1.8 ± 0.8
Flexor digitorum superficialis	2	10	6	2	-------	2.0 ± 0.6
Anterior interosseous nerve	------	3	10	7		3.0 ± 0.7

Table 3. Summary of the median motor points distribution along the muscle. Number of muscle motor points innervated by the radial nerve in the middle proximal and distal thirds of the forearm.

Muscle name	Average motor points	Muscle proximal third	Proximal and third (%)	Distal third (%)	Entire muscle belly extension (%)
Pronator teres	2.4 ± 0.8	20 (100%)	----------	--------	----------
Flexor carpi radialis	2.0 ± 0.4	20 (100%)	----------	--------	----------
Palmaris longus	2.0 ± 0.6	20 (100%)		--------	----------
Anterior interosseous nerve	3.0 ± 0.7	6 (30%)	14 (70%)	--------	100%

DISCUSSION

Great anatomical treatises – such as those by Rouvière et al.,[4] and Paturet – often describe the distribution of the median nerve (MN) in the forearm as follows: two branches (upper and lower) for the pronator teres muscle (PTM), a common trunk to the flexor carpi radialis (FCR) and the palmaris longus (PL), and a branch to the flexor digitorum superficialis (FDS). However, recent studies revealed considerable anatomical variations within this pattern.[6-12] Dogan et al.[12] analysed MN motor branches in 200 extremities of 100 foetuses and observed different ramification patterns than

those classically reported by previous studies, suggesting that the latter variation should be revisited and reconsidered.

Sunderland et al.[8] studied 20 cadavers upper body limbs and provided the perhaps most detailed biometric description, although not mentioning the PL muscle. They identified, in 18 out of 20 limbs (90%), the presence of more than one branch for the FDS and, in 14 out of 20 limbs (70%), several branches for the PTM. Canovas et al.[6] dissected 10 limbs and found a significant variability among branches for muscles innervated by the MN, especially for the PTM, FCR, PL, and FDS with no clear innervation pattern, and a lower variation for the anterior interosseous nerve (AIN). El Zawawy et al.[3] analysed 20 cadaver limbs and found a great variety in MN distribution to the PT, FCR, PL, and FDS, stating that anatomical treatises classic description would hardly be found. Chantelot et al.[10] found variable ramification patterns in most of the 50 dissected limbs: in only 40% of the cases they found the classic distribution from a common trunk of the MN to the FCR and PL.

Gunther et al.[9] classified MN branches into six groups, according to their location and ramifications, whereby: group I included branches for the PTM; group II for the FCR, PL, and FDS; group III the AIN; group IV the distal branch for the FDS; and groups V and VI comprised small additional branches of the MN for the FDS in the middle and distal third of the forearm. They found a greater variability within group II, which often shared the branches of groups I and II, and a greater invariability within groups IV and VI. They also found that, in some cases, branches could be affected by proximal MN neurolysis along distances ranging from 7-9 cm. Tung et al.[11] results corroborate those reported by Gunther et al.[9] Raouf et al.[13] reported that such innervation variations by the MN may be associated with muscle anomalies, as the presence of duplicate or accessory muscles, or PL absence.

In our study, we found great variability within the distribution of the branches of the MN to forearm muscles. Only 3 limbs (15%) presented the classic innervation pattern described in anatomical treatises. In all dissected limbs, the PTM, FCR, PL, and FDS received exclusive innervation from the MN.

While the concept of nerve transfer to handle brachial plexus injuries is not new, distal nerve transfers is a novel technique. According to Tung et al.,[11] acknowledging these anatomical details is not an absolute clinical necessity when preparing for a nerve transfer to restore finger extension, but enables an identification of such nerve branches. They also provided a detailed description of what is required to perform a nerve transfer to restore forearm paralysed muscles: donor nerve must be dispensable (for instance, FCR function may be executed by the PL, if present, and by the ulnar carpi flexor) or redundant (for instance, 14 limbs presented more than one branch for the PTM and 11 limbs for the FDS).[11]

For Fuss et al.,[14] correlating clinical signs and symptoms to surgical anatomy may cause some confusion due to the controversies related to innervation sequence recorded in the literature. The classic description is prone to critics because it suggests that: (1) each muscle receives no more than one branch; and (2) ramifications follow a logical sequence (for instance, Chantelot et al.[10] identified the classic sequence described in the main anatomical treatises in 40% of their studied cases, and we identified it only in only 14%).

Most of our cases presented motor branches in the sequence: PTM, PL, FCR, FDS, and AIN. However one limb showed FDS origin slightly under the origin of the branch for the PTM and, in two limbs, despite the innervation by the MN, it received a branch from the AIN. Whereas in 13 limbs the FDS received only one branch of the MN, in 7 limbs it received two branches.

We analysed the number of motor points – nerve branches entry points in the muscle – of the PTM, FCR, PL, FDS, and AIN muscles, and observed that most of them were located in the proximal third of the muscles (Table 3). Segal et al.[15] addressed the association between the number of motor points and neuromuscular compartments, stating that each motor point corresponds to one neuromuscular compartment, which works independently from other compartments. This explains why muscles with more complex functions, such as finger flexors and extensors, have more motor points than other forearm muscles. Knowing the location of nerve branches and motor points facilitates the insertion of electrodes at the motor points of forearm muscles to functional electrical stimulation in upper motor neuron lesions.[3]

Our results may also be useful for procedures of selective denervation to rebalance spastic muscles.[3,7] Liu et al.[16] report that forearm injuries (even in cases where the main nerve trunks are intact), as crushing injuries in the in segmental, damage the muscles either by direct damage or by damage to their motor points.

We suggest surgical approaches of MN branches in the elbow region to be performed with the patient in supine, horizontal decubitus position, with the upper limb resting on a hand surgery table and the back of their elbow facing the surgeon. We recommend an incision of approximately 7 cm above the elbow flexion crease, alongside the middle of the biceps brachii. The surgeon should lean in front of the elbow towards its crease, somehow parallel to it. The incision is completed distal, running the back of the forearm alongside the middle edge of the brachialis (BR) muscle. The skin and subcutaneous cell tissue must be cut pulling apart the skin tears in the middle and lateral. The following structures will be identified on top of the brachial fascia crossing the elbow: cephalic vein, basilic vein, elbow medial, and forearm medial.

Provided other more important structures are not at risk, these structures must be preserved as much as possible. Then, the aponeurotic expansion of the biceps brachii muscle (lacertus fibrosus), which goes in the middle towards the ulna and crosses the brachial artery and vein and the MN, must be performed. At the cubital fossa level, the brachial artery is located next to the MN and the brachial vein. In this region, the MN branches to flexor-pronator muscles, originates the AIN, and continues through the two PTM heads. Then, it follows under the two heads, originating the upper flexor.

CONCLUSION

We found a great variability in the innervation of forearm muscles. Only 3 limbs (14%) presented the classic innervation patterns described by the main anatomical treatises. Knowing the anatomy of MN motor branches is important when performing surgical procedures in the region of the forearm, as in operations in the proximal third of the forearm, such as the alleviation of PTM and AIN compressive syndromes, distal nerve transfers. It also enables a greater understanding of the recovery of muscle function after a nerve injury.

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REFERENCES

1. Spinner M. Injuries to the major branches of the peripheral nerves of the forearm. Philadelphia: Saunders; 1978.
2. Johnson RK, Spinner M, Shrewsbury MM. Median nerve entrapment syndrome in the proximal forearm. J Hand Surg Am. 1979;4(1):48-51.
3. El Zawawy EM, El Sekily NM, Fouad WA, Emam MH, Hassan MM. Median nerve motor entry points in the forearm – clinical application. Eur J Anat. 2016;20(1):1-17.
4. Rouvière H, Delmas A. Anatomie humaine: descriptive, topographique et fonctionnelle. Paris: Masson; 1984.
5. Testut L, Latarjet A. Traité d'anatomie humaine. Paris: G Doin & Cie; 1930.
6. Canovas F, Mouilleron P, Bonnel F. Biometry of the muscular branches of the median nerve to the forearm. Clin Anat. 1998;11(4):239-45.
7. Safwat MD, Abdel-Meguid EM. Distribution of terminal nerve entry points to the flexor and extensor groups of forearm muscles: an anatomical study. Folia Morphol. 2007;66(2):83-93.
8. Sunderland S, Ray LJ. Metrical and non-metrical features of the muscular branches of the median nerve. J Comp Neurol. 1946;85(2):191-203.
9. Gunther SF, DiPasquale D, Martin R. The internal anatomy of the median nerve in the region of the elbow. J Hand Surg Am. 1992;17(4):648-56.
10. Chantelot C, Feugas C, Guillem P, Chapnikoff D, Rémy F, Fontaine C. Innervation of the medial epicondylar muscles: an anatomic study in 50 cases. Surg Radiol Anat. 1999;21:165-8.
11. Tung TH, Mackinnon SE. Flexor digitorum superficialis nerve transfer to restore pronation: two case reports and anatomic study. J Hand Surg Am. 2001;26(6):1065-72.
12. Dogan NU, Uysal II, Karabulut AK, Fazliogullari Z. The motor branches of median and ulnar nerves that innervate superficial flexor muscles: a study in human fetuses. Surg Radiol Anat. 2010;32(3):225-33.
13. Raouf HA, Kader GA, Jaradat A, Dharap A, Fadel R, Salem AH. Frequency of palmaris longus absence and its association with other anatomical variations in the Egyptian population. Clin Anat. 2013;26(5):572-7.
14. Fuss FK, Wurzl GH. Median nerve entrapment pronator teres syndrome. Surg Radiol Anat. 1990;12(4):267-71.
15. Segal RL. Neuromuscular compartments in the human biceps brachii muscle. Neurosci Lett. 1992;140(1):98-102.
16. Liu J, Pho RW, Pereira BP, Lau HK, Kumar VP. Distribution of primary motor nerve branches and terminal nerve entry points to the forearm muscles. Anat Rec. 1997;248(3):456-63.

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EXTREME LATERAL INTERBODY FUSION IN PACIENTS WITH CHRONIC LOW BACK PAIN

FUSÃO INTERSOMÁTICA POR VIA EXTREMO LATERAL EM PACIENTES COM LOMBALGIA CRÔNICA

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ABSTRACT

Objective: To evaluate the effect of lateral lumbar interbody fusion (LLIF) or oblique interbody fusion (OLIF) on low back pain due to degenerative intervertebral disc disease. Methods: We systematically reviewed articles on surgical treatment of low back pain by LLIF and OLIF, according to the Cochrane Handbook for Systematic Reviews of Interventions. We searched through electronic databases, including Medline via PubMed, Lilacs through the Virtual Health Library (VHL), Cochrane Collaboration/Central and Cohrane/Dare Cochrane Controlled Trials Register, without language or publication date restrictions and with design for prospective cohorts and randomized clinical trials. Results: We have selected and presented three studies. Conclusion: The literature review showed great relevance in the improvement of the new surgical approach (LLIF) in relation to TLIF, but greater content availability in the databases is necessary to reach a satisfactory conclusion regarding the efficiency of the lateral approach and its advantages over other traditional procedures. ***Level of Evidence II, Systematic review of Level II studies.***

Keywords: Low Back Pain. Intervertebral Disc. Arthrodesis

RESUMO

Objetivo: Avaliar o efeito da técnica de fusão intersomática lateral lombar (LLIF) ou da fusão intersomática obliqua (OLIF) na lombalgia em decorrência de doença degenerativa do disco intervertebral. Método: Revisamos estudos de abordagem cirúrgica LLIF e OLIF, de acordo com o Manual Cochrane para Revisões Sistemáticas de Intervenções. A busca foi realizada, por meio de bases de dados eletrônicos, incluindo Medline via PubMed, Lilacs via Biblioteca Virtual em Saúde (BVS), Registro de ensaios Controlados da Colaboração Cochrane/Central e Cohrane/Dare, sem restrições de idiomas ou de data de publicações e com delineamento para coortes prospectivos e ensaios clínicos randomizados. Resultados: Selecionamos e apresentamos três estudos. Conclusão: Houve relevância na melhora da nova abordagem cirúrgica (LLIF) em relação à abordagem tradicional, porém é necessário maior disponibilidade de conteúdo nas bases de dados para que seja obtida conclusão quanto à eficiência da via lateral e seus benefícios em relação às demais abordagens tradicionais. ***Nível de Evidência II, Revisão sistemática de Estudos de Nível II.***

Descritores: *Dor lombar. Disco Intervertebral. Artrodese*

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INTRODUCTION

Low back pain is a symptom that may be caused by ligament, muscle, nerve and intervertebral disc (ID) changes, besides arising from psychosocial, occupational, obesity and age conditions, with a prevalence of 85% in the population.[1,2] Low back pain shows important correlation with degenerative disc disease (DDD), which consists of a chronic and natural aging process, progressing steadily through the decline in the concentration of proteoglycans in the DI, decreased hydration and loss of gelatinous consistency of the nucleus pulposus, generating changes in the functional properties of the disc, with this process being most commonly found in the lower lumbar regions (L4/L5 and L5/S1).[3,4]

With the evolution of degeneration, other secondary diseases such as herniated disc, intervertebral foramen stenosis (EFI), deformities such as scoliosis, and spondylolisthesis may be associated.[1,5] Radicular symptoms and intermittent claudication in the lower extremities are generally linked to EFI and thus a factor for decreased quality of life, especially in older adults. Due to the difficulty of treatment with conservative management, new surgical methods and approaches were introduced, such as interbody fusion.[6] The pioneering technique is posterior lumbar interbody fusion (PLIF), which mimics the natural repair of degenerative disc disease. This technique led to the introduction of the concept of independent interbody fusion devices.[6,7]

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

The study was conducted at Universidade Anhembi Morumbi.
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From this, other techniques emerged such as transforaminal lumbar interbody fusion (TLIF) and anterior lumbar interbody fusion (ALIF), but these techniques together with PLIF were associated with some post-surgical complications such as: retrograde ejaculation, sympathetic chain injury, vascular complications, colonic obstruction, dural tear, radiculitis, and denervation of the paravertebral musculature.[6] As an alternative to avoid these complications, minimally invasive techniques were developed, with extreme lateral interbody fusion (LLIF) and oblique interbody fusion (OLIF) being implemented.[6,8,9] This study aims to evaluate and establish the possible benefits of minimally invasive methods of lateral or oblique arthrodesis interbody fusion in relation to traditional ones.

MATERIALS AND METHODS

This systematic review was registered in Prospero under CRD protocol 42018106702.

Search strategy

The research used the following databases: Medline via PubMed (1966-2018), Lilacs via Virtual Health Library (VHL) (1982-2018), Cochrane Collaboration/Central and Cohrane/Dare Cochrane Controlled Trials Register, without languages or publication date restrictions and with design for prospective cohorts and randomized clinical trials. When more than one study with the same intervention was described by the same author, only the most current was included. Figure 1 describes the search strategy used on Medline via PubMed, the same used for the other databases with the terms adapted to the base.

((((“Intervertebral disc degeneration” [mh] OR “Disc Degeneration” [mh] OR “Degenerative disc disease” [tw] OR spondylolisthesis [tw] OR Degenerative disease [tw] OR degenerative scoliosis [tw] OR adult degenerative scoliosis [tw] OR adult scoliosis [tw] OR spinal stenosis [tw] OR lumbar spinal stenosis [tw] OR Zygapophyseal Joint [mh] OR Back Pain [mh] OR low back pain [mh] OR low back pain [tw] OR facet joint* [tw] OR lumbar pain [tw] OR Intervertebral disk degeneration [mh] OR Lumbago [tw] OR sciatic neuropathy [mh] OR Spondylolisthesis [mh] OR Spondylolysis [mh] OR spinal stenosis [mh] OR neurogenic claudication [tw] OR Intermittent Claudication [mh] OR Spondylodiscitis [tw] OR hernia* [tw] OR prolapse* [tw] OR extru* [tw]) AND (transpsoas [tw] OR interbody fusion [tw] OR LLIF [tw] OR XLIF [tw] OR lateral interbody [tw] OR OLIF [tw] OR oblique lumbar interbody fusion [tw] OR fusion [tw] OR extreme lateral interbody fusion [tw] OR oblique lateral fusion [tw] OR DLIF [tw] OR direct lateral interbody fusion [tw] OR posterolateral fusion [tw] OR in situ fusion [tw] OR interbody fusion [tw])) AND (((meta-analysis [pt] OR Systematic Reviews [tw] OR randomized controlled trial [pt] OR controlled clinical trial [pt] OR randomized controlled trials [mh] OR random allocation [mh] OR double-blind method [mh] OR single-blind method [mh] OR clinical trial [pt] OR clinical trials [mh])))

Figure 1. Medline search strategy via Pubmed.

Selection criteria and study eligibility

We selected studies with patients older than 18 years, with degenerative disc disease, without other diseases described. The variables considered were related to measures of disability and low back pain, measured by the Oswestry’s disability index (ODI) and the visual analog scale (VAS), respectively, in addition to blood loss greater than 100 mL and surgical time.

Data extraction

The data were extracted independently by two authors (AN and RD). A third author (DM) was consulted to control differences. The primary outcomes analyzed were: low back pain, using the VAS scale; lumbar disability, through the ODI scale; and consolidation of arthrodesis using imaging. Secondary outcomes were surgical time, blood loss, hospital stay and clinical complications.

Statistical analysis and synthesis of results

We performed a descriptive analysis of the results to characterize the variables and experiments. The results are presented in tabular form, considering the measures of means, standard deviation and proportion according to the nature of the variable. Heterogeneity was evaluated using the I^2 and chi-square method.

Aiming to summarize the results of the study for the variables considered, the meta-analysis methodology was used, combining the results of the experiments so that average and proportion estimates are more reliable to reality. The meta-analysis combines the results of the studies, both for mean and proportion, from weighted average, such that the weights assigned to each study are calculated by means of the inverse variance method, considering the approaches of fixed and random effects, the latter being best suited in case of heterogeneity between the experiments, as it considers a random effect associated with each study, being therefore more comprehensive and preferable.

To perform the analyses, the *meta* and *Metafor* packages of the statistical environment R were used and the significance levels set at 5% in all cases.

Risk of bias

Bibliographic research articles were critically reviewed by two authors regarding their suitability for inclusion in the study, according to the Cochrane Collaboration critical review list.[10] All data from this study were extracted from articles, with conclusions drawn based on the data presented. The Cochrane Risk of Bias Tool was used to critically assess the risk of bias.[11]

RESULTS

Carried out on August 19th of 2008, the search strategies resulted in 1,265 articles found, complemented by active search, totaling 1,319 articles. After applying the selection and eligibility criteria, the review included three articles (Figure 2).

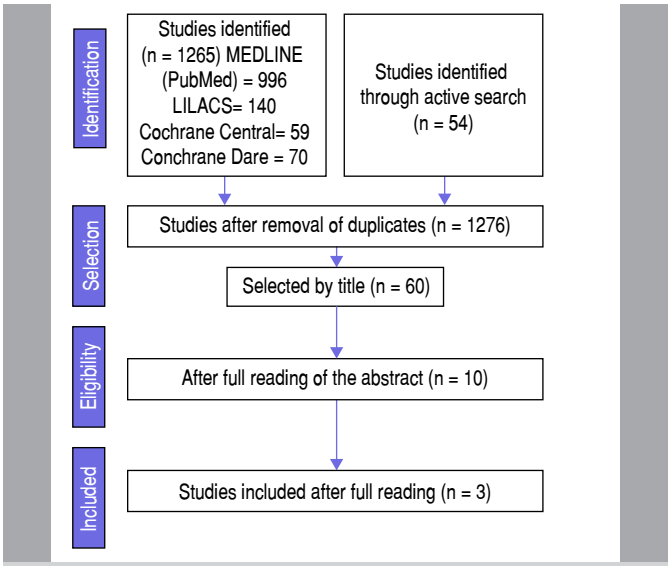

Figure 2. Article selection flowchart.

The studies are represented by numbers, as shown in Table 1, with studies 1 and 2 being prospective cohorts and 3 a randomized clinical trial. In all studies, patients presented different degrees of low back pain, with impaired quality of life and underwent the analyzed methods of interbody fusion. For results analysis, we grouped the studies of similar methodology (cohorts) into meta-analysis[12,13] and

evaluated the randomized clinical trial[14] separately. This evaluated the risk of bias showed in Figure 3.

Table 2 shows the descriptive measures considering the variable related to the VAS pain scale score. First, it is noted that the three studies vary in number of individuals effectively analyzed, with study 1 having approximately twice as many patients as study 3. It is also seen that the initial means are close between studies, varying between 7.2 and 7.8, while study 3 presented the biggest difference, with a mean of 5.4. We also observed that the standard deviation of the difference in study 1 is the highest in relation to the others (3.1), while study 3 has no information on this statistic.

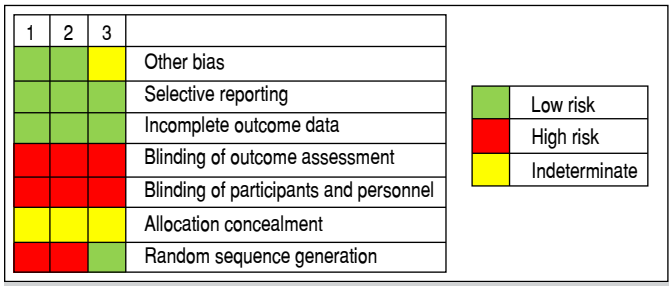

Figure 3. Risk of study bias.

Table 1. Information on the studies considered in the analysis.

Number	Author	Year	Country	Study design	Patients in the intervention group (N)	Patients in the control group (N)	Clinical outcomes evaluated
1	Phillips et al.[12]	2013	USA	Prospective cohort	-LLIF (20) -LLIF + anterolateral fixation (7) -LLIF + posterior fixation (80)	(0)	-VAS, ODI -Surgical time -Blood loss -Loss of strength -Neuropathy -Reoperation
2	Marchi et al.[13]	2012	Brazil	Prospective cohort	-LLIF (52)	(0)	-VAS, ODI -Surgical time -Blood loss -Olisthesis -Increased disc height -Total lordosis -Segmental lordosis -Bone healing
3	Sembrano et al.[14]	2016	USA	Randomized Clinical Trial	LLIF (29)	TLIF (26)	-VAS, ODI -Surgical time -Blood loss -Loss of strength -Post-operative fracture -Neuropathy

Table 2. Descriptive measures of the VAS scale scores according to the study.

Study	N	Initial mean	Final mean	Mean difference	SD
1	82	7.20	3.8	3.40	3.1
2	52	7.80	3.1	4.70	2.18
3	42	7.3	1.9	5.40	-

SD: Standard deviation of the difference.

Table 3 shows the descriptive measures related to the ODI scale score according to each study included in the review. It this respect, study 2 had the highest initial mean measure (66.00), in addition to the highest mean difference (36.00), while the lowest mean difference found was relative to study 1 (21.50). The standard deviations of the differences were close between the studies, however, study 3 provided no information on the difference deviation.

Table 3. Descriptive measures of the ODI scale scores according to the study.

Study	N	Initial mean	Final mean	Mean difference	SD
1	82	48.50	27.00	21.50	20.00
2	52	66.00	30.00	36.00	16.80
3	42	43.00	20.00	23.00	-

SD: Standard deviation of the difference.

Regarding surgical time, Table 4 shows that studies 1 and 3 presented the highest mean measures (177.90 and 171 minutes, respectively), while study 2 had the lowest mean time (73.20 minutes). There are also differences between the standard deviations of the studies, being the highest relative to study 1 (60.59) and the lowest to study 2 (31.40).

Table 4. Descriptive measures of mean surgical time in minutes according to the study.

Study	N	Mean	SD
1	82	177.90	60.59
2	52	73.20	31.40
3	42	171.00	-

SD: Standard deviation.

Similarly to previous cases, we see that study 3 provides no information regarding the standard deviation for this variable.

Regarding blood loss, in study 1, the LLIF procedure, 62.5% of patients had an estimated blood loss of 100 mL or less, and in only 9 patients (8.4%) bleeding reached 300 mL. In study 2, the mean blood loss was < 50 mL. In study 3, blood loss was significantly lower in LLIF than in the TLIF group, with 79% versus 27% of cases, respectively, resulting in < 100 mL of blood loss, $p < 0.001$.

For the meta-analysis results referring to the VAS and ODI variables, we considered the mean difference (final – initial) as an

effect measure, evaluated for a group (lateral), whereas for surgical time and blood loss, means and proportions were considered as measures of effect, respectively.

We observed that the fixed and random effects models (Figure 4) were slightly different for this case, with the average difference estimates equal to 4.13 and 4.06, with 95% confidence intervals for this measure of (3.69; 4.57) and (2.79; 5.33), respectively. Thus, the results allow us to conclude that the average difference between moments is statistically significant, i.e., there was a greater reduction of 2 points in the VAS, which is established as clinically significant from the intervention.[15] In addition, there is evidence of statistically significant heterogeneity ($I^2 = 88\%$, $p < 0.001$).

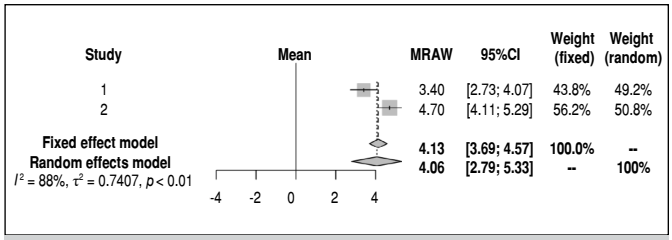

Figure 4. Meta-analysis results for the mean difference (before - after) of the VAS scale scores.

Figure 5 represents the meta-analysis results for the difference in scores on the ODI scale, considering the initial mean measure minus the final of studies 1 and 2, as study 3 presented insufficient information for this type of analysis.

The fixed and random effects models showed different results in this case, with the average difference estimates equal to 28.36 and 28.73 associated with 95% confidence intervals of (25.22; 31.50) and (14.52; 42.94) for the fixed and random effect model, respectively. There was a significant reduction in the ODI score from the intervention, which is established as clinically significant from 4.45 points.[16] Additionally, we found statistical evidence of heterogeneity ($I^2 = 95\%$, $p < 0.001$).

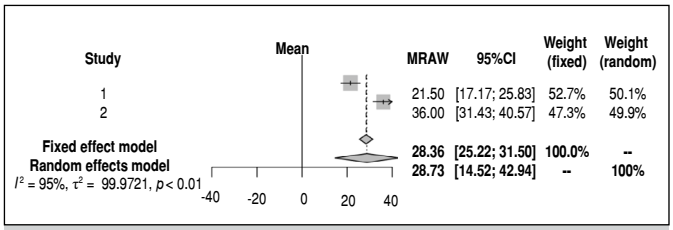

Figure 5. Meta-analysis results for the mean difference (before - after) of the ODI scale scores.

Figure 6 shows meta-analysis results for surgical time, also disregarding study 3 due to lack of information on the variability of this measure. There is a considerable difference in the results according to the approach used. The average time estimated by the fixed effects model is 104.35 min (95%CI 97.20; 111.50), while by the random effects model, due to the greater balance in weights, is 125.43 min and the confidence interval is broader (22.82; 228.03). In addition, we found great heterogeneity among the studies, being statistically significant ($I^2 = 99\%$, $p < 0.001$).

Considering the proportion of cases with blood loss greater than 100 mL, we see from the results shown in Figure 7 that there was a difference between the results of the models again, with the random effects model showing milder weightings, which resulted in a lower estimated proportion of 20% (: 7%; 46%), while the fixed effects model attributed greater weight to studies with different proportions other than 0, leading to the estimated proportion of 31% and 95% confidence interval associated equal to (24%; 40%). Finally, there is evidence of significant heterogeneity ($I^2 = 82\%$, $p < 0.001$).

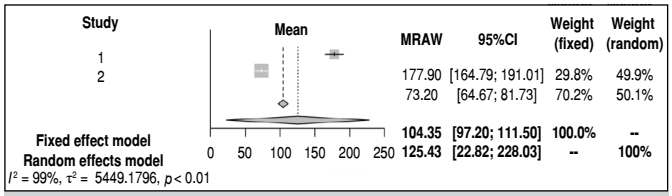

Figure 6. Meta-analysis results for mean surgical time.

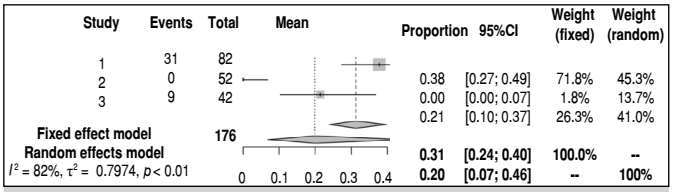

Figure 7. Meta-analysis results for the proportion of cases with blood loss greater than 100 mL.

As for the evaluation of arthrodesis consolidation, it was infeasible to perform meta-analysis of these data due to the difference in follow-up time for each study and the conditions selected for the outcome, thus we performed an independent analysis. Study 1 showed that 58% of the patients who underwent the procedure presented complete fusion after 12 months of follow-up, 39% partial and 3% observed no consolidation. In study 2, we observed that 86.5% of the patients presented total consolidation. All patients in study 3 showed, by magnetic resonance imaging, complete fusion at 12 months for the LLIF approach and 74% for TLIF, being selected for this analysis only patients with low range of motion impairment.

We assessed the length of hospital stay for surgical approaches in articles 1 and 3, with the first being 3.8 days on average and the last 2 days.

Regarding clinical complications, we observed in study 1 that 34% of patients had some degree of postoperative muscle weakness, of which 81% showed weakness in hip flexion, and five patients presented weakness after 25 months. During the 24-month follow-up, 13 patients needed a new surgical approach. In study 2, 10 patients presented weakness in the psoas and five patients had numbness in the anterior region of the thigh, with both conditions resolving within 6 weeks in all cases.

Study 3 observed postoperative hip flexion weakness in 31% of patients with LLIF, all of which resolved within six months of the postoperative period. The study also recorded a femoral neuropathy, with distal weakness of 4/5, in the LLIF group, with complete resolution within six months. We found no loss of postoperative hip strength or distal weakness in the TLIF cohort.

DISCUSSION

In this study, we assessed two prospective cohort studies and a randomized clinical trial evaluating lateral interbody fusion, totaling 188 patients. The results show that in relation to the primary outcomes (Oswestry's disability index and low back pain by VAS) the LLIF approach presents improvement in both parameters when compared with the moment prior the intervention; showing a difference in VAS of 4.13 for the fixed analysis and 4.06 for the randomized analysis; ODI showed a difference of 28.36 and 28.73, respectively.

For better data analysis, we compared the results with the TLIF approach presented in study number 3. This shows an average improvement of 3.6 in VAS, thus being lower than LLIF (3.92; 3.85), which shows greater efficiency of the second method. For the ODI scale, TLIF presents a difference of 25 points, being similar to LLIF (25.91; 24.32) and thus being unable to establish which method is the most efficient; blood loss greater than 100 mL, in the TLIF group, occurred in 73% of the procedures, this value being very low when compared with LLIF (30%).

Regarding the time of arthrodesis consolidation, it was impossible to establish which method has the best result, due to the difference in analysis between the studies, but when performing individual analysis of study 3, we verify a 28% difference in patients who obtained complete fusion in 12 months. It should also be noted that the method used to assess arthrodesis in this study was magnetic resonance, knowing that this method is less than ideal for assessing bone healing.

The length of hospital stay, evidenced in only 2 studies, one of which was the randomized clinical trial, shows similarity between the approaches (LLIF and TLIF), where both had two days of hospitalization. The short surgical time and bleeding presented in study 2 are noteworthy—these data raise the hypothesis of the difference in the learning curve between services, in relation to the applied technique.

The main limitation of the present study is not to have found randomized clinical trials that could be compared among themselves in the literature, performing analysis among the best quality studies available. As another limitation, we noticed that study 1 evaluated three different types of intervention, which were analyzed collectively in this review, reducing the number of participants from 107 to 82 for the 24-month follow-up. In addition, in study 2, we did not identify the number of patients who underwent the LLIF and TLIF procedures with a 24-month follow-up separately, thus considering the total value. As an attempt at a solution, we made communication through an e-mail address, but obtained no response in time.

Regarding the costs of the procedures, the absence of cost data in the three selected studies prevented assessing this variable to know which one is more advantageous. Although techniques with anterolateral approach are considered less invasive, the studies showed a high rate of complications, which were transient, generally associated with the multi-level approach in more complex cases, with removal of the psoas muscle, showing muscle damage or neuropraxia of neural roots of the lumbar plexus and pseudarthrosis.

CONCLUSION

In view of what was discussed by the analyzed studies, the LLIF surgical approach presents an improvement in relation to TLIF, but the authors considered the number of studies, with only one randomized clinical trial, insufficient to establish the most efficient surgical methodology. Thus, greater availability of studies discussing the themes described in this review is needed.

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REFERENCES

1. Kim SM, Lee SH, Lee BR, Hwang JW. Analysis of the correlation among age, disc morphology, positive discography and prognosis in patients with chronic low back pain. Ann Rehabil Med. 2015;39(3):340-6.
2. 2. Haefeli M, Kalberer F, Saegesser D, Nerlich AG, Boos N, Paesold G. The course of macroscopic degeneration in the human lumbar intervertebral disc. Spine. 2006;31(14):1522-31.
3. Silva MR, Domingues CJ, Pinto RP, Neves N, Matos RM, Tulha JM, et al. New perspectives on degenerative disease treatment. Acta Reumatol Port. 2009;34(2B):327-35.
4. Noshchenko A, Hoffecker L, Lindley EM, Burger EL, Cain CM, Patel VV. Long-term treatment effects of lumbar arthrodeses in degenerative disk disease. J Spinal Disord Tech. 2015;28(9):E493-521.
5. Kalichman L, Kim DH, Li L, Guermazi A, Berkin V, Hunter DJ. Spondylolysis and spondylolisthesis: prevalence and association with low back pain in the adult community-based population. Spine. 2009;34(2):199-205.
6. Costa F, Sassi M, Ortolina A, Cardia A, Assietti R, Zerbi A, et al. Stand-alone cage for posterior lumbar interbody fusion in the treatment of high-degree degenerative disc disease: design of a new device for an "old" technique. A prospective study on a series of 116 patients. Eur Spine J. 2011;20(S1):46-56.
7. Cloward RB. The treatment of ruptured lumbar intervertebral discs by vertebral body fusion. J Neurosurg. 1953;10(2):154-68.
8. Patel VC, Park DK, Herkowitz HN. Lateral transpsoas fusion: indications and outcomes. Sci World J. 2012;2012:893608.
9. Xu DS, Walker CT, Godzik J, Turner JD, Smith W, Uribe JS. Minimally invasive anterior, lateral, and oblique lumbar interbody fusion: a literature review. Ann Transl Med. 2018;6(6):104.
10. Higgins JP, Thompson SG. Quantifying heterogeneity in a meta-analysis. Stat Med. 2002;21(11):1539-58.
11. Higgins JPT, Altman DG, Sterne JAC. Chapter 8: Assessing risk of bias in included studies. In: Higgins JPT, Churchill R, Chandler J, Cumpston MS, editors. Cochrane Handbook for Systematic Reviews of Interventions version 5.2.0 [Internet]. Cochrane; 2017 [updated 2017 June; accessed on 2020 Aug 20]. [about 73 p]. Available from: https://handbook-5-1.cochrane.org/chapter_8/8_assessing_risk_of_bias_in_included_studies.htm
12. Phillips FM, Isaacs RE, Rodgers WB, Khajavi K, Tohmeh AG, Deviren V, et al. Adult degenerative scoliosis treated with XLIF: clinical and radiographical results of a prospective multicenter study with 24-month follow-up. Spine. 2013;38(21):1853-61.
13. Marchi L, Abdala N, Oliveira L, Amaral R, Coutinho E, Pimenta L. Stand-alone lateral interbody fusion for the treatment of low-grade degenerative spondylolisthesis. Sci World J. 2012;2012:456346.
14. Sembrano JN, Tohmeh A, Isaacs R, SOLAS Degenerative Study Group. Two-year comparative outcomes of MIS lateral and MIS transforaminal interbody fusion in the treatment of degenerative spondylolisthesis: Part I: clinical findings. Spine. 2016;41(Suppl 8):S123-32.
15. Coelho RA, Siqueira FB, Ferreira PH, Ferreira ML. Responsiveness of the Brazilian-Portuguese version of the oswestry disability index in subjects with low back pain. Eur Spine J. 2008;17(8):1101-6.
16. Carvalho DS, Kowacs PA. Avaliação da intensidade da dor. Migrâneas Cefaleias. 2006;9(4):164-8.

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