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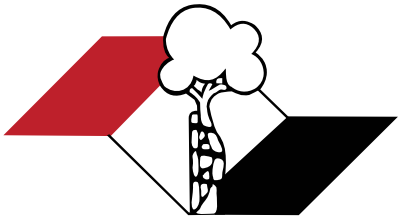

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ACTA ORTOPÉDICA BRASILEIRA

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(Reviewed March 2021)

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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

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

The sending of manuscripts

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Levels of Evidence for Primary Research Question[a]

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

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

[a] A complete assessment of quality of individual studies requires critical appraisal of all aspects of the study design.
[b] A combination of results from two or more prior studies.
[c] Studies provided consistent results.
[d] Study was started before the first patient enrolled.
[e] Patients treated one way (eg, cemented hip arthroplasty) compared with a group of patients treated in another way (eg, uncemented hip arthroplasty) at the same institution.
[f] The study was started after the first patient enrolled.
[g] Patients identified for the study based on their outcome, called "cases" eg, failed total arthroplasty, are compared with patients who did not have outcome, called ''controls'' eg, successful total hip arthroplasty.
[h] Patients treated one way with no comparison group of patients treated in another way.

SUMMARY

VOLUME 29 – Nº 3 – 2021

Original Articles

FOOT AND ANKLE

HIP

KNEE

ORTHOPEDIC TRAUMA

DOI: http://dx.doi.org/10.1590/1413-785220212903117

EDITORIAL

Dear friends and collaborators,

We would like to share more good news on the path towards the improvement and excellence of scientific production published by *Acta Ortopédica Brasileira*.
In 2020 we presented 1.03 in cites per doc by *Scopus-SCImago Journal Rank*.
Another notable result published by SCImago is the increase in the H index; we reached the highest value in Latin America in the area of orthopedics, with *H-19.* This metric is applied to estimate the productivity and impact of scientific journals that are part of the Scopus collection.
We take the opportunity to invite all editors, reviewers and authors to value the production of academic research from master's and doctoral investigations by citing the manuscripts accepted by *Acta Ortopédica Brasileira* in their scientific productions published in other journals in Brazil and worldwide.
As researchers and authors of renowned international journals with high impact factor, we can add to the reference base of our articles the production of our competent colleagues and compatriots, stimulating the deserved recognition of Brazilian journals with increased citation numbers of our research and dissemination of national scientific improvement.

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

<< SUMÁRIO

ORIGINAL ARTICLE
FOOT AND ANKLE
DOI: http://dx.doi.org/10.1590/1413-785220212903236709

FOOT ALIGNMENT IN SYMPTOMATIC NATIONAL FOOTBALL LEAGUE (NFL) ATHLETES: A WEIGHTBEARING CT ANALYSIS

ALINHAMENTO DO PÉ EM ATLETAS SINTOMÁTICOS DA NFL: UMA ANÁLISE DE TOMOGRAFIA COMPUTADORIZADA COM CARGA

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3. Clinique de l'Union, Foot and Ankle Surgery Center, Saint-Jean, France.
4. Universidade de São Paulo, Department of Orthopedics, Foot and Ankle Surgery, São Paulo, SP, Brazil.

ABSTRACT

Objective: Our aim was to describe the foot alignment in National Football League (NFL) players with different symptomatic foot and ankle pathologies using weightbearing cone-beam computed tomography (WBCBCT), comparing them to normally aligned feet as control group. Methods: 41 feet (36 active NFL players) were assessed using WBCBCT and compared to 20 normally aligned controls from a normal population. Measurements included: Foot and Ankle Offset (FAO); Calcaneal Offset (CO); Hindfoot Alignment Angle (HAA); angle between inferior and superior facets of the talus (Inftal-Suptal); angle between inferior facet of the talus and the horizontal/floor (Inftal-Hor); Forefoot Arch Angle (FAA); navicular- and medial cuneiform-to-floor distance. Results: NFL athletes showed a neutrally aligned hindfoot when compared to controls (FAO: 1% vs 0.5%; CO: 2.3 mm vs 0.8 mm; HAA: 2.9° vs 0.8° in two groups, with all $p > 0.05$) and a normal morphology of the subtalar joint (no difference in Inftal-Suptal and Inftal-Hor angles). Conversely, in athletes we found a decreased medial longitudinal arch (FAA: 15° vs 18.3°, $p = 0.03$) with smaller navicular (38.2 mm vs 42.2 mm, $p = 0.03$) and medial cuneiform (27 mm vs 31.3 mm, $p = 0.01$) mean distances to the floor when compared to controls. Conclusion: In our series, NFL players presented a lower medial longitudinal arch than controls but a neutrally aligned hindfoot. WBCBCT may help shed light on anatomical risk factors for injuries in professional players. ***Level of Evidence III, Retrospective comparative study.***

Keywords: Foot. Athletes. Tomography.

RESUMO

Objetivo: Descrever o alinhamento do pé em jogadores da National Football League (NFL) com diferentes patologias sintomáticas do pé e tornozelo usando a tomografia computadorizada de feixe cônico com suporte de peso (weightbearing cone-beam computed tomography – WBCBCT), e comparar as medidas a grupo controle de voluntários com pés de alinhamento normal. Métodos: Quarenta pés (36 jogadores ativos da NFL) foram avaliados usando WBCBCT e comparados com 20 controles da população normal. As medidas incluíram: Offset do pé e tornozelo(FAO); Calcâneo Offset (CO); ângulo de alinhamento do retropé (HAA); ângulo entre as facetas inferior e superior do tálus (Inftal-Suptal); ângulo entre a faceta inferior do tálus e o solo (Inftal-Hor); ângulo do arco do antepé (FAA); distância navicular/solo e cuneiforme medial/solo. Resultados: Atletas da NFL mostraram retropé com alinhamento neutro quando comparados aos controles (FAO: 1% vs. 0,5%; CO:2,3mm vs. 0,8 mm; HAA: 2,9° vs. 0,8°, com todos p > 0,05) e morfologia normal da articulação subtalar (sem diferença nos ângulos Inftal-Suptal e Inftal-Hor). Por outro lado, observamos nos atletas profissionais um arco longitudinal medial diminuído (FAA: 15° vs. 18,3°,p=0,03) com distâncias médias do navicular/solo (38,2 mm vs. 42,2 mm, p = 0,03) e do cuneiforme medial/solo (27 mm vs. 31,3 mm, p = 0,01) menores quando comparados ao grupo controle. Conclusão: Em nossa série, os jogadores da NFL apresentaram um arco longitudinal medial diminuído em relação aos controles, mas um retropé neutro. WBCBCT pode ajudar a esclarecer os fatores de risco anatômicos para lesões em jogadores profissionais de elite. ***Nível de Evidência III, Estudo retrospectivo comparativo.***

Descritores: *Pé. Altletas. Tomografia.*

Citation: Bernasconi A, de Cesar Netto C, Roberts L, Lintz F, Godoy-Santos AL, O'Malley MJ. Foot alignment in symptomatic national football league (NFL) athletes: a weightbearing CT analysis. Acta Ortop Bras. [online]. 2021;29(3):118-123. Available from URL: http://www.scielo.br/aob.

INTRODUCTION

Professional players who sustain lower extremity injuries may experience a significant reduction in playing time, decrease in performance, and in some cases these injuries can be career ending.[1] Common sport movements like jumping, running and lateral cutting movements, together with the risk of collision, are associated with a considerable increase risk of injuries – often

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

The study was conducted at the Department of Orthopedics, Foot and Ankle Surgery, Hospital for Special Surgery.
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involving the ankle and the knee. More specifically, foot and ankle injuries accounted for 27% of total musculoskeletal injuries in competitive professional and collegiate athletes, with 21% of these injuries resulting in missed play time.[2] It has also been estimated that 85% of professional athletes experience at least one ankle sprain during their careers.[3] In light of these numbers, many studies have and are investigating potential risk and prognostic factors for these elite-level athletes.[1,4,5] Regarding foot and ankle pathologies, a varus hindfoot alignment in elite athletes has been reported as a predisposing factor for Jones-type metaphyseal-diaphyseal fractures and refractures of the fifth metatarsal.[6] A possible association between metatarsus adductus and stress fractures of the base of the fourth has also been described.[7] Furthermore, a high-arched or cavus foot and metatarsus adductus have been proposed as risk factors for Lisfranc injuries and stress fractures of the tarsal bones, respectively.[7,8]

Traditionally, the assessment of foot alignment has relied on conventional radiographic views. Evidence has showed how standard radiographs are inherently limited as they only illustrate the anatomy in a two-dimensional (2D) manner and can be flawed by error from patient and x-ray beam positioning, image superposition and potential measurement errors.[9] The introduction and increasing use of weight-bearing cone beam computed tomography (WBCBCT) in clinical practice seems to have addressed many of the issues encountered with standard radiographs, allowing a better three-dimensional (3D) assessment of the foot and ankle.[10,11] WBCBCT obtains images comparable with a traditional CT in quality but does so with the foot in a loaded condition and with a markedly lower radiation dose. Many authors demonstrated the efficacy and reliability of WBCBCT use to measure different foot alignment.[10,11] Recently, De Cesar Netto et al. investigated foot alignment in National Basketball Association (NBA) players on WBCBCT images, documenting a tendency toward varus hindfoot malalignment.[12] However, to the best of our knowledge, no study has reported any investigation on National Football League (NFL) players so far.

In this study, we described the foot morphology (measured on WBCBCT images) in a cohort of NFL players that went to our institution with different foot and ankle pathologies and compared them with normally aligned controls. We also discussed our results considering reference data for the same measures performed on normal feet and flatfeet obtained from the most recently available literature.

MATERIALS AND METHODS

Data collection

The data used for this study was obtained as part of routine clinical care of NFL players with symptomatic foot and ankle pathologies that underwent WBCBCT as part of their clinical assessment, from September 2013 to November 2017. Institutional review board approval was obtained for the review of these data. The images of 41 feet (17 right, 24 left) from 36 NFL players (mean age 24.9 years, range 16-35) were retrospectively reviewed; a cohort of 20 clinically neutrally aligned feet (gathered from bilateral scans on 10 patients from normal population) was selected as control group. All scans were obtained using a PedCAT® unit (CurveBeam®) installed in the outpatient clinic of an orthopedic foot and ankle surgery referral center. The datasets were obtained using the following cone beam scanner settings: voxel size, 0.37 mm; field of view diameter, 350 mm; field of view height, 200 mm; exposure time, 9 seconds, total scan time, 54 seconds. The data sets were extracted from the existing database, containing the 3D image data (Figure 1), as well as demographic characteristics regarding age, side, sex, weight, height and the body mass index (BMI).

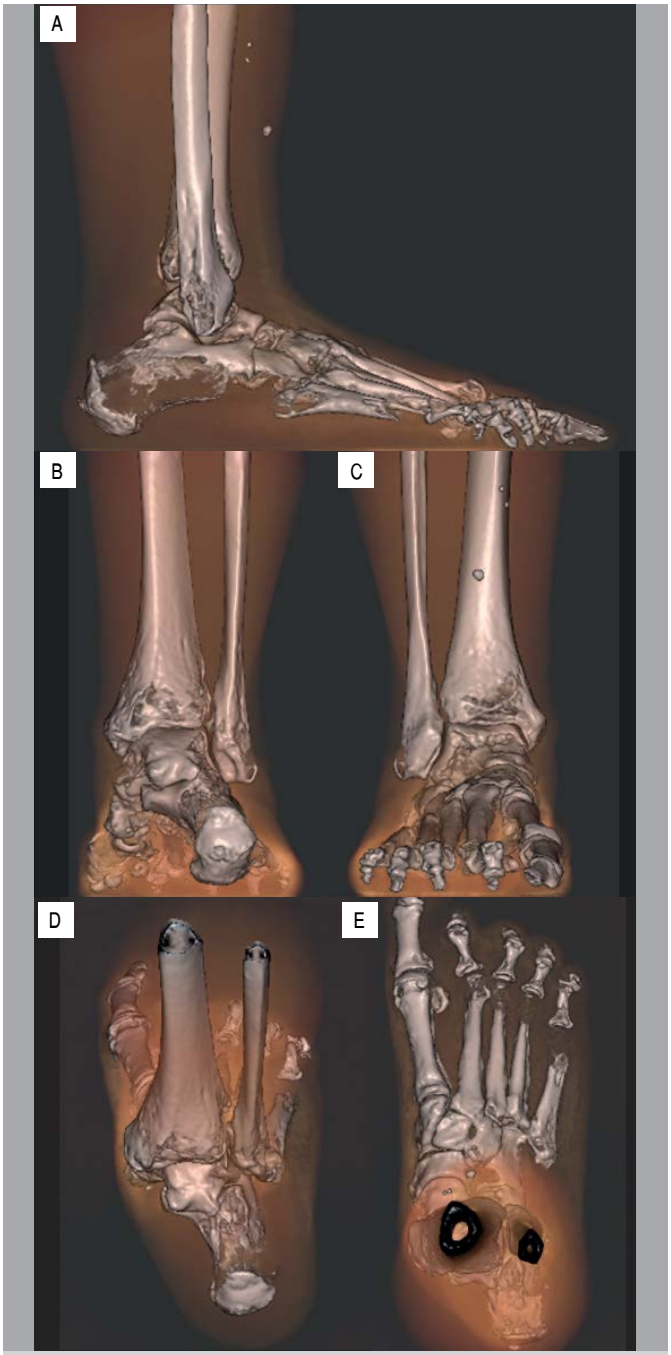

Figure 1. Example of three-dimensional WBCBCT dataset viewed from A) lateral; B) posterior; C) anterior; D) postero-superior; and E) dorsal positions.

Measurements

For this study, both semiautomatic and manual measurements of foot alignment were performed.

Semiautomatic measurements

Datasets were screened using the built-in software TALAS™, CubeView™ (CurveBeam©), and the 3D coordinates of specific anatomical landmarks required for the software to process and calculate FAO were collected, as described by Lintz et al.,[10] that included the most distal and weightbearing vortex of the head of the first metatarsal, head of the fifth metatarsal and calcaneal tuberosity, as long as the most proximal and central aspect of the talar dome (Figure 2).

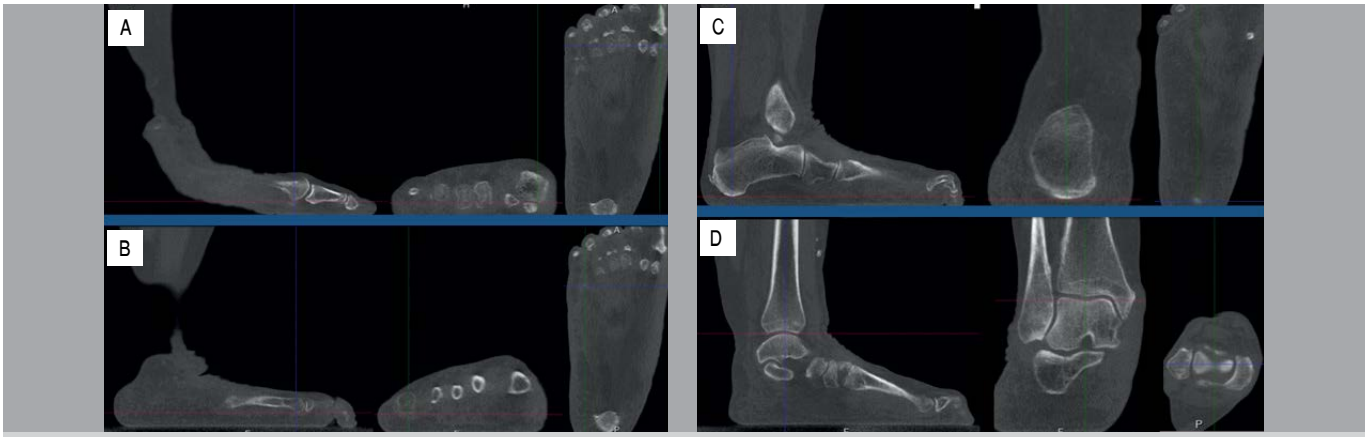

Figure 2. Marking of 3D coordinates of specific anatomical landmarks: A) most distal WB vertex of the head of the first metatarsal; B) most distal WB vertex of the head of the fifth metatarsal; C) most distal WB vertex of the calcaneal tuberosity; D) most proximal and central aspect of the talar dome.

The Foot and Ankle Offset (FAO) was described as a three-dimensional measurement of the torque acting in the ankle joint as result of body weight and ground reaction forces.[10-12] It takes into consideration the relationship between the center of gravity of the foot tripod and the center of the ankle joint, represented by the apex of the talar dome. Negative measurements indicate a varus alignment, where the center of the ankle lies laterally to the bisecting line of the foot tripod. Positive values represent a valgus alignment, with the center of the ankle joint positioned medially to the foot line (Figure 3).

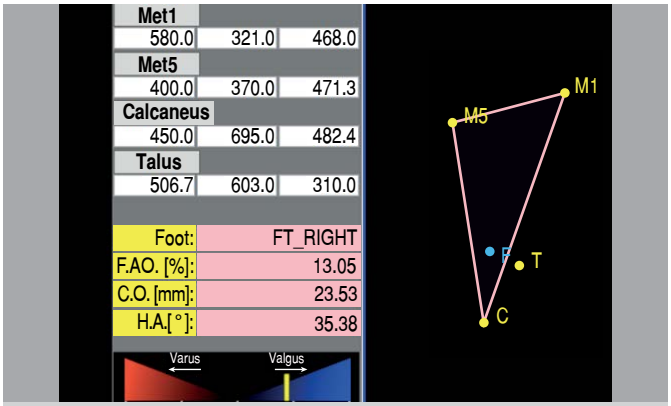

Figure 3. Example of semiautomatic measurement using TALAS™, CubeView™ (CurveBeam©). Three-dimensional coordinates (x, y, z planes) were harvested for the first (met1), fifth (met5), calcaneus and talus. The tripod is represented by the triangle formed by the coordinates of M1 (first metatarsal), M5 (fifth metatarsal) and C (Calcaneus). F represents the ideal position of the center of rotation of the ankle joint, that lies on a bisecting line of the tripod. T represents the positioning of the proximal and central aspect of the talus, center of the ankle joint, in this specific patient. It can be noticed that this point is positioned laterally to the F point, demonstrating an important varus alignment of this hindfoot in this case. F.A.O. is the value for the Foot and Ankle Offset; C.O. represents an estimated value in millimeters that the calcaneus would have to be displaced to correct the alignment of the hindfoot; and H.A. is a two-dimensional representation of the hindfoot alignment angle (reported in the text as HAA).

The mean FAO value in asymptomatic patients with normally aligned foot is described to be at 1.2 – 2.3%,[10,11] and these values were used as a reference for this study. Furthermore, the Calcaneal Offset (CO) and the hindfoot alignment angle (HAA) were recorded. CO represents the distance (in mm) between a theoretically neutral position of the calcaneus and the actual position of the calcaneus. HAA represents an estimation of the coronal angular alignment of the hindfoot and it is measured as the angle formed by three points: apex of the center of the talar dome projected on the floor plane (as the vertex), the ideal position of the calcaneus and the actual position of the calcaneus.

Manual measurements

In the coronal plane, three angles were measured. The first two included the angle between the inferior aspect of the posterior facet of the talus at the subtalar joint and two reference lines: one horizontal line representing the floor (Inftal-Hor) and a tangent line to the superior aspect of the talar dome (Inftal-Suptal). Both angles evaluate the orientation of the subtalar joint. The coronal plane in which the measurements were performed was determined in the sagittal plane at the midpoint of the longitudinal length of the posterior facet of the subtalar joint. For these angles, positive values indicate a valgus alignment and negative values indicate varus alignment.

The third angle measured in the coronal plane was the forefoot arch angle. It measures the transverse arch height of the foot and the relative supination/pronation of the forefoot. Positive values indicate a relatively higher positioning of the medial cuneiform in relation to the fifth metatarsal.

In the sagittal plane, two measurements were recorded, both using the height evaluation of the transverse and longitudinal arches of the foot. The first was the navicular-to-floor distance, measured from the most inferior aspect of the navicular to the floor line. The second was the medial cuneiform-to-floor distance, measured from the most inferior aspect of the medial cuneiform to the floor line.

For all manual measurements, standard values based on the most recent literature were gathered and used in the comparison of normally aligned feet, varus and valgus alignment of the hindfoot and flattening or elevation of the arch of foot.[13]

Statistical analysis and synthesis of results

Data were reported as mean values, percentages, and minimum-maximum values. Normality of data was assessed by the Shapiro-Wilk test. Intergroup differences for demographic characteristics (age, side, height, weight, and BMI) and mean values for measurements were compared with Student's t test (normally distributed variables) or Wilcoxon's rank-sum test (non-normally distributed variables). Fisher's exact test was used for categorical variables. Analysis was performed using STATA statistical software package (version 12.0, StataCorp, College Station, TX, 2011). Statistical significance was set at 0.05 (p-value).

RESULTS

Demographic data of players and controls are outlined in Table 1.

Table 1. Main characteristics of our sample and control group.

	Athletes		Controls		p-value
N (feet)	36 (41)		10 (20)		-
Sex M/F	36/0		8/2		-
Side R/L	17/24		10/10		0.377*
Role	8 Wide receiver 7 Outside linebacker 6 Tackle 5 Running back 3 Defensive end 3 Cornerback	2 Offensive guard 2 Tight end 2 Guard 2 Kicker 1 Quarterback	-	-	-
	Mean	**Min – Max**	**Mean**	**Min-Max**	
Age (y)	24.9	16 – 35	29	19 – 48	0.275**
Height (cm)	188.3	173 – 206	172	155 – 191	< 0.001***
Weight (kg)	109.2	84 – 154	82.7	51 – 138	0.001***
BMI (kg/m^2)	30.6	23 – 39	28.7	20 – 39	0.138***

*: Fisher's exact test; **: Wilcoxon's rank-sum test; ***: Student's t test.

Groups were comparable by age, side and BMI ($p > 0.05$). NFL athletes showed a neutrally aligned hindfoot when compared to controls (FAO mean value at 1% vs 0.5%, CO at 2.3 mm vs 0.8 and HAA at 2.9° vs 0.8° in two groups, with all $p > 0.05$). Inftal-Suptal and Inftal-Hor angles stood at 4.5° vs 5.9° (p 0.32) and 4.6° vs 5.7° (p 0.48) in two groups, suggesting a similar subtalar joint morphology. Conversely, NFL athletes presented a decreased medial longitudinal arch (FAA at 15° vs 18.3°, p 0.03) with smaller navicular (38.2 mm vs 42.2 mm, p 0.03), and medial cuneiform (27 mm vs 31.3 mm, p 0.01) distances to the floor (Table 2).

Table 2. Comparison of values between NFL players and normally aligned controls. Normative data from literature about well-aligned feet and flatfeet have been reported as well. All variables were normally distributed; therefore, Student's t test was applied for comparison.

Variable	NFL (n = 41)	Control (n = 20)	NFL vs Control p-value*	NBA (n = 54) from literature	Controls from literature	Flatfoot from literature
	mean (95%CI)	*mean (95%CI)*			*mean (95%CI)*	*mean (95%CI)*
Foot and Ankle Offset *(%)	1 (0.1 to 1.8)	0.5 (-0.9 to 2)	0.604	0.4 (-0.2 to 1.2)	2.3 (-0.6 to 5.2)1.2 (0.7 to 1.7)	11.4 (5.7 to 17.1)
Calcaneal Offset (mm)	2.3 (0.4 to 4.2)	0.8 (-2 to 3.8)	0.4	1.1 (-0.5 to 2.8)	NA	NA
Hindfoot Alignment Angle (degrees)	2.9 (0.2 to 5.6)	1.8 (-2.9 to 6.6)	0.665	1.4 (-0.8 to 3.6)	NA	NA
Inftal-Suptal angle (degrees)*	4.5 (2.1 to 6.9)	5.9 (2.9 to 8.8)	0.322	5.3 (3.5 to 7.1)	10.7 (4.3 to 17.1) 8.6	21.2 (14.5 to 26.9) 19.9
Inftal Hor angle (degrees)*	4.6 (2.9 to 6.2)	5.7 (3.3 to 8.1)	0.487	4 (2.5 to 5.5)	5.7 (-1.0 to 12.4) 4.3	15.9 (10.2 to 21.6) 14.8
Forefoot Arch Angle (degrees)*	15 (13.8 to 16.2)	18.3(16.4 to 20.3)	0.03	15.8 (14.7 to 16.9)	18.61**	8.89** 3.0 (1.4 to 4.6)
Navicular-to-floor distance (mm)*	38.2 (36.3 to 40.1)	42.2 (38.3 to 46.2)	0.03	38.3 (36.1 to 40.4)	NA	19.4** 23 (22 to 25)
Medial Cuneiform-to-floor distance (mm)	27.0 (25.6 to 28.5)	31.3 (29 to 33.6)	0.01	26.7 (25.3 to 28.2)	NA	18 (17 to 19)

*: variables for which more than one reference value was available in literature; **: simulated weight bearing.

DISCUSSION

To the best of our knowledge, this is the first time that reference values for foot morphotypes in professional NFL players are reported in the literature using 3D WBCBCT images. Furthermore, it must be considered that historically, any available foot measurements have always relied on conventional radiographic views. This approach is highly influenced by inherent potential flaws related to the evaluation of a 2D imaging of a 3D structure. Errors in patient positioning, overlap of different structures and operator-related bias can limit the effectiveness of measurements on conventional radiographs.[9] The advent of the WBCBCT allows clinicians to obtain images comparable to a traditional CT but in a physiologically-loaded condition and with a lower radiation dose. Recent studies have also documented how the foot morphotype measurements used in this study (such as the FAO, the CO, the HAA, the Inftal-Suptal angle, the Inftal-Hor angle, the FAA, the navicular-to-floor distance and the medial cuneiform-to-floor distance) provide high intra- and inter-observer reliability.[10,11,14,15]

Our comparative study showed that symptomatic professional male football players within the National Football League have a normally aligned hindfoot with a more pronated forefoot when compared to healthy controls, as demonstrated by significant differences in FAA, navicular-to-floor and medial-cuneiform-to-floor distance. However, although we could not perform a formal statistical analysis including data reported by other authors, values for these measurements from

NFL players were still far higher than historical flatfeet (Table 2). This suggests that, while their medial arch is decreased, it would probably be inappropriate to consider them as 'flatfooted' (Table 2). Secondly, when comparing our results with a previous study on NBA players in which some tendency towards varus high arched morphology was identified, we found very similar values in WBCBCT measurements (Table 2) but surprisingly this led us to a different conclusion. We believe that this discrepancy can be explained by the comparative design of this study that allowed to deem results on the basis of a control group rather than on literature data.

Unfortunately, there are only few other studies within the available literature that assess foot morphotypes in professional athletes specifically. In a study of 151 competitive triathletes, the foot type – as assessed by the Foot Posture Index and Valgus Index – did not appear as a risk factor for acute injuries of the foot and ankle, however the authors found a four-fold increase in risk of overuse injury in athletes with a supinated foot.[16] According to Lopezosa-Reca et al.,[3] who have investigated the Foot Posture Index in 220 basketball players, the foot morphotype varied in players based on their in-game position. Guards usually had a more supinated foot, whereas centers presented a more pronated foot. However, this hypothesis has never been confirmed.

More specifically, only a small number of studies have addressed foot and ankle injuries in professional football players. In most of these, authors have investigated fractures of the fifth metatarsal affecting NFL athletes, documenting treatments, complications and return to play.[4-6] Carreira and Sandilands[6] analyzed risk factors and focused on foot alignment of these players, concluding that a varus alignment was more frequent in athletes who sustained a fracture of the fifth metatarsal. Raikin, Slenker and Ratigan[17] investigated the foot morphotype in 20 patients (13 athletes, 7 nonathletes) presenting Jones fracture and found that the presence of a varus hindfoot alignment, assessed both clinically and radiographically, represented a predisposing factor for Jones-type metaphyseal-diaphyseal fractures and re-fractures of the fifth metatarsal. Karnovsky et al.[5] recently found that NFL players with long, narrow, and straight fifth metatarsals with an adducted forefoot presented the greatest risk for fifth metatarsal fractures. This seems to corroborate the results by Rongstad et al.,[7] who suggested an association between metatarsus adductus and stress fractures of the base of the fourth metatarsal in athletes. Similarly, reports have linked high-arched cavus feet with higher risk of Lisfranc injuries.[8] Another relevant study was a large prospective investigation on 449 military personnel in training, which showed that dynamic pes planus, pes cavus, restricted ankle dorsiflexion, and increased hindfoot inversion were associated with higher risk of lower extremity overuse injuries.[18]

Within the literature there is some evidence suggesting that increased participation in high-impact sports during youth would be associated with increased varus alignment of the knee at the end of growth in males, mainly due to increased frequency of intense running and cutting maneuvers.[19] Furthermore, Norton et al. have reported in a non-athletic population that a compensatory valgus of the hindfoot could be expected in the setting of a varus knee.[20] Whether the converse of this observation is true in professional players of high-impact sports with varus knees has yet to be investigated.

Our study has several limitations. Firstly, we could not perform any meaningful analysis about the role of players or their specific type of injury. This was essentially due to the size of the cohort. While we think that investigating the relationship between any specific injury and various foot morphotypes with WBCBCT measurements would be useful to plan dedicated prevention programs, we also believe that sharing normative data from symptomatic athletes could represent a step forward towards further analysis in specific activities. Secondly, the retrospective design and the small sample size. Thirdly, we have not performed an assessment of intra- or inter-observer agreement in this study. However, this was not among the aims of our study since previous studies have documented excellent reliability on these measures.

CONCLUSION

Professional NFL male football players seem to have a neutrally aligned hindfoot, with an overpronated forefoot (decreased medial longitudinal arch) when compared to controls. In male elite players, structured training programs have already been validated for sports injury prevention. When confirmed by further prospective and controlled investigations, the results of the current study on foot morphology may represent a starting point to guide future preventive action to reduce the rate of foot and ankle injuries in professional football. Further studies are necessary to identify groups of athletes at increased risk as well as the relationship between different foot morphotypes and specific injuries.

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EPIDEMIOLOGY OF HIP PAIN IN BRAZILIAN BODYBUILDERS

EPIDEMIOLOGIA DA DOR NO QUADRIL EM FISICULTURISTAS BRASILEIROS

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ABSTRACT

Objective: To determine the frequency of hip pain in competitive bodybuilders over three different bodybuilding competitions. Methods: This study evaluated bodybuilders recruited from three competitions during the year of 2016. All participants provided their informed consent and the study received IRB approval. Training routine, health condition, level of success on competitions, history of hip pain and physical examination of the hip were evaluated. Results: 113 bodybuilders were evaluated, mean age was 30.5 ± 8.65 years and mean BMI was 25.2 ± 3.65 kg/m^2. Mean values for hip flexion, adduction, abduction, internal rotation, external rotation and distance between the knee and the table (FABER distance) were 116 ± 13, 23 ± 8, 71 ± 12, 40 ± 10, 36 ± 9 and 19 ± 4, respectively. Eight (7%) participants presented hip pain within the week prior to examination and only 2 (1,7%) presented with anterior impingement sign. None of the athletes who reported hip pain interrupted their physical training or performance. Conclusion: Symptomatic athletes continued their training program under the presence of hip pain. The frequency of hip pain among bodybuilders is high and may be underestimated in this study. ***Level of Evidence IV, Case series.***

Keywords: Hip Joint. Arthralgia. Resistance Training. Femoracetabular Impingement.

RESUMO

Objetivo: Determinar a frequência de dor no quadril em atletas fisiculturistas durante três competições de fisiculturismo. Métodos: Este estudo avaliou fisiculturistas recrutados em três competições de fisiculturismo durante o ano de 2016. Termo de consentimento foi obtido de todos os participantes, e também foi obtido a aprovação do CEP. Rotina de treinos, condição de saúde, nível de sucesso nas competições, antecedente de dor no quadril ao exame físico foram avaliados. Resultados: Um total de 113 fisiculturistas foram avaliados, com idade e IMC médio de 30.5 ± 8.65 anos e 25.2 ± 3.65 kg/m2, respectivamente. O valor médio de flexão, adução, abdução, rotação interna, rotação externa do quadril, e distância entre o joelho e a mesa de exame (distância FABERE) foi de 116 ± 13, 23 ± 8, 71 ± 12, 40 ± 10, 36 ± 9 e 19 ± 4, respectivamente. Oito (7%) participantes apresentavam dor no quadril dentro da última semana antes de serem examinados, e apenas dois (1.7%) apresentavam sinal do impacto anterior do quadril à manobra de flexão adução e rotação interna. A dor no quadril não afetou o treinamento físico e a performance dos atletas que reportaram dor no quadril. Conclusão: Atletas sintomáticos continuaram o programa de treinamento mesmo na presença de dor no quadril. A frequência de dor no quadril de atletas fisiculturistas é alta e pode ter sido subestimada neste estudo. ***Nível de Evidência IV, Série de casos.***

Descritores: *Articulação do Quadril. Artralgia. Treinamento de Resistência. Impacto Femoroacetabular.*

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INTRODUCTION

Hip pain is frequently diagnosed in running and football athletes, where athletes are prone to change-of-direction movements and different movement strategies.[1,2] However, studies on hip injuries in other sports activities remain scarce. In strength sports, physical and mental stress associated to weight gain during "off-season" may contribute to an increased risk of injury, particularly on the hip, knees and sacroiliac joints.[3] According to a recent systematic review, up to 31% of all injuries among weightlifters and powerlifters involve the groin or hip joint.[4] Peripheral nerve injuries, especially involving the femoral nerve, are also reported in bodybuilders.[5] Hip injuries are known to be a common cause of pain in high level athletes such as bodybuilders and weightlifters. Bodybuilding culture has grown together with the opening of numerous fitness centers, with the popularity of competitions growing over the last decades. Several championships with different categories take place across Brazil and athletes frequently have to change their exercise regimen. Competitive bodybuilding athletes usually join

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

The study was conducted at Universidade de São Paulo, Faculty of Medicine, Hospital das Clínicas, Institute of Orthopedics and Traumatology.
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qualifying series, and the nutritional and exercise routine can vary significantly between "on-season" and "off-season" cycles.
These athletes frequently lift a large amount of weight from squatting position. The squat using loaded barbells requires appropriate technique and is performed by flexing the hips and knees, keeping the lower limbs parallel until the thighs are parallel to the floor. If not done appropriately according to the specific body type, this intense routine of workouts can severely hurt the athletes' hip due to labral tearing. The frequency of disorders on the hip of bodybuilders is about 5.6% of all injuries, as reported by Siewe et al.[6] Femoroacetabular impingement (FAI) is a severe but treatable injury and is caused by a bony anatomical deformity that causes the hip joint to impinge, which can lead to subchondral or intra-articular damage and pain. This condition may affect some exercises performed by bodybuilders, in particular, squatting.[7] However, a recent study found no differences in squat depth when comparing patients with and without symptomatic FAI.[8]
So far there are no reports about hip pain and FAI in Brazilian bodybuilders, and the risks of hip injuries are unknown. Athletes with symptomatic FAI do not present differences in hip joint range of movement if functional impairments in hip muscle strength and balance of the lower limbs are present.[9] Our goals in this study were to identify the incidence of hip pain and then examine the risk factors for groin/hip injuries among bodybuilders.

MATERIALS AND METHODS

This is cohort study with epidemiological collected data from questionnaires and physical examination of the hip of Brazilian weightlifters. Participants were recruited from two regional and one national bodybuilding competitions. This study obtained approval from the local IRB (n.14969/CAI 56997116.0.0000.0065). Informed consent was obtained from all the participants.
Athletes were included based on their volunteer participation. Individuals from different weight categories were included; they were interviewed and examined one day before the competition. The interviewer was an orthopedic surgeon who also performed the physical examination of the hip. After answering the questionnaire, the participants were physically evaluated at an appropriate and private room.
The questionnaire evaluated frequency, duration, weight lifted on squatting, years of training, the success on competitions (regional, national, international), and past history of hip pain or injury. The physical evaluation consisted of measuring weight, height and range of motion with a goniometer for hip flexion, adduction, abduction, supine and prone internal rotation. In addition, two specific tests for FAI were included: the FADIR test (flexion, adduction and internal rotation of the hip) (Figure 1) and the distance between the lateral genicular line of the knee and the exam table in supine. This distance is called the Flexion Abduction External Rotation (FABER) distance and is frequently used as a clinical parameter for assessing femoracetabular impingement.[1]
Patients who presented pain in the physical evaluation received orientation about their symptoms and possible etiologies of the pain. The medical team also provided a list of referral hospitals and diagnostic procedures.

Statistical Analysis

Continuous variables were expressed as mean and standard deviation, or median and interquartile range when the distribution curve was not normal. The assumption of a normal distribution was assessed by the histogram and the quantile-quantile plots, followed by the Shapiro-Wilk test. Categorical variables were expressed in absolute number and percentage. Comparisons between continuous variables involving a given group were performed by the Student's t test for normal distribution patterns, or by the nonparametric Mann-Whitney's test, otherwise. Comparisons between categorical variables were performed using Fisher's exact test.

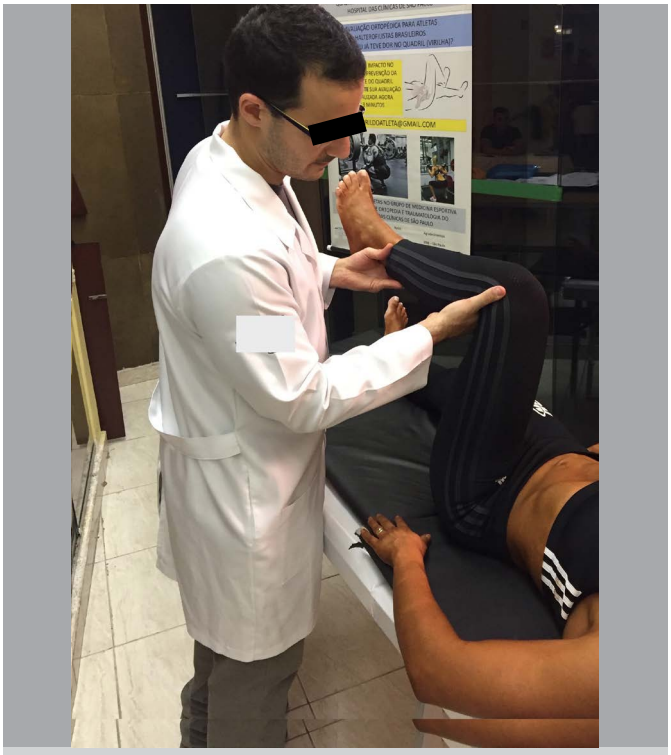

Figure 1. Anterior hip impingement test, athlete in supine position.

RESULTS

Between April 2016 and July 2016, 113 bodybuilders completed the questionnaire and underwent the physical examination of the hip. In total, 113 bodybuilders, 46 (40.7%) female and 67 (59.3%) male athletes, were evaluated. The mean age was 30.5 ± 8.65 years and mean BMI was 25.2 ± 3.65 kg/m^2. Mean hip flexion, adduction, abduction, internal rotation, external rotation and distance between the knee and the table (FABER distance) were 116 ± 13, 23 ± 8, 71 ± 12, 40 ± 10, 36 ± 9 and 19 ± 4, respectively. Eight (7%) participants presented with hip pain within the week prior to examination and 2 (1.7%) presented with anterior impingement sign during physical examination. Hip pain did not affect physical training or athlete's performance in the athletes who reported it. The baseline data according to the presence of hip pain within the week prior to the physical examination is displayed in Tables 1 and 2.

Table 1. Demographics and training regimen according to the presence of hip pain.

	Hip pain (n = 8)	No hip pain (n = 105)	P value
Age (years)	30.8 ± 8.7	30.7 ± 8.7	0.49
Gender (M:F)	3:5	64:41	0.19
BMI (Kg/m^2)	25.2 ± 5.3	25.1 ± 3.4	0.33
Squat weight (Kg)	115.6 ± 74.2	113.5 ± 50.8	0.34
Frequency (weeks)	5.6 ± 0.5	5.6 ± 1.2	0.12
Time of training (minutes)	70.5 ± 34.9	69.7 ± 24.9	0.47
Time training (years)	6.3 ± 7.2	6 ± 5.8	0.68

BMI: body mass index.

Table 2. Range of motion (right hip) according to the presence of hip pain.

	Hip pain (n = 8)	No hip pain (n = 105)	P value
Flexion (°)	116.2 ± 11.4	115.2 ± 9.9	0.01
Adduction (°)	23.6 ± 7.8	23.3 ± 6.3	0.37
Abduction (°)	70.8 ± 8.8	69.9 ± 10.2	0.03
Internal Rotation 0 (°)	37.6 ± 9.4	37.1 ± 9.2	0.30
External Rotation 0 (°)	35.7 ± 6.9	35 ± 9.1	0.70
Internal Rotation 90 (°)	39.2 ± 11	38.4 ± 11.2	0.03
External Rotation 90 (°)	35.8 ± 11.3	35.7 ± 9	0.37
FABER Distance (cm)	18.5 ± 4.8	18.7 ± 4.6	0.63

FABER: flexion abduction external rotation.

DISCUSSION

The frequency of hip pain in competitive bodybuilders was 7% in the present study, which is considerably higher than the 0.6% incidence found in the general population.[10] The mean age of our study population was 30.5 years, being considered a young population of active bodybuilders. Among the patients with hip pain, 2 (25%) were clinically diagnosed with FAI, similar to rates reported from the general population.[10] Siewe et al.[6] found 0.12 injuries per bodybuilder as the incidence in a similar population, and the rate of hip disorders was 5.6%. Our study also found that the presence of hip pain among bodybuilders did not affect the athlete's performance and interruptions of training or competition were low. We believe the rate of hip pain is underestimated in this particular population due to possible fear of the athlete in reporting a physical disability just before the competition. Athletes face stress in the days leading up to a competition, mainly because of the need to keep their weight within the limits of their category.

Hip pain was reported by 8 out of 113 athletes, and only 2 (1.7%) presented positive results in the anterior hip impingement test. The anterior hip impingement sign indicates the presence of an intra-articular injury, which may be present in 5% of the total hip athletic injuries of the hip.[2] Two athletes showed positive signs during physical examination. One female participant had bilateral positive hip impingement test and signs of joint laxity. Patients with soft tissue laxity are sometimes difficult to diagnose.[11] Moreover, this patient was an amateur running athlete before starting her bodybuilder career. Since this study is a cohort epidemiological one, further investigation with previous imaging of the hip was not the focus of our study. The other patient, also a female, had unilateral symptoms and did not mention practicing other sports activities prior to bodybuilding.

Sagittal pelvic mobility allows adequate trunk flexion during squatting.[12] All athletes reported squatting as part of their training routine. Squatting is a risk factor for femoracetabular impingement[13,14] and athletes reported to lift up to 250 kg during squatting. Although the difference between symptomatic and asymptomatic groups was not statistically significant, studies on the relationship between squatting and femoracetabular impingement should be encouraged. Low back pain was described as the most prevalent injury in a population of competitive weightlifters.[15] All three tournaments had categories for athletes with age greater than the average; however, none of the athletes over 35 years old reported hip pain, but many reported low back pain. Regarding the physical examination, most of the athletes in this study have not distinguished between a groin and a lateral pain. The lack of knowledge about femoracetabular impingement can contribute not only to the continuation of training despite the presence of hip pain, but also to a more difficult recognition of the initial symptoms of hip disorders. Regarding the range of motion, statistically significant differences were found for flexion, abduction and external rotation ($p < 0.05$). However, these differences were minimal and probably do not present any clinical relevance. Moreover, these differences may be related to possible variation of the measurements with the goniometer. In addition, some patients were not completely comfortable during hip examination due to the stress faced on the day before the competition. FABER distances were similar between symptomatic and asymptomatic athletes in our study, which may be explaind by the heterogeneity of the studied population. Many athletes reported previous practice of other sports in addition to bodybuilding. Furthermore, many athletes were not completely sure about when they started their bodybuilding training, so recreational weightlifting could have been considered as part of their official preparation for the competition. Another limitation was the smaller group of symptomatic patients and imbalanced comparison groups.

CONCLUSION

Our study found an incidence of hip pain of 7% among competitive bodybuilders. Only 2 (1.7%) patients were clinically symptomatic for femoracetabular impingement. Although the frequency of hip pain among bodybuilders is considered high, it did not alter athlete's performance.

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ONE-YEAR RESULTS OF BRACING FOR PATELLO-FEMORAL OSTEOARTHRITIS. PROSPECTIVE RANDOMIZED STUDY

UM ANO DE USO DE ÓRTESE PARA OSTEOARTRITE FÊMORO-PATELAR. ESTUDO PROSPECTIVO RANDOMIZADO

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ABSTRACT

Objective: To compare the long-term effects of a brace designed to stabilize the patellofemoral (PF) joint in comparison to a standard neoprene sleeve for the knee with patellar hole in patients with patellofemoral osteoarthritis (PFOA). Methods: 38 patients with PFOA and comorbidities received either a functional PF brace (Study Group, SG) or a neoprene sleeve for the knee (Control Group, CG). Both groups received clinical treatment to OA and comorbidities according to a program from the institution. Patients were evaluated with Western Ontario and MacMaster (WOMAC) and Lequesne questionnaires, 30-second chair stand test (30CST), Timed Up and Go (TUG), anthropometric measures and self-reported physical activity in minutes/week at inclusion, one, three and twelve months after placing the brace. X-Rays were taken to measure the angles. Results: At one year there was more abandonment in the CG without differences in weight and body mass index between groups during the study. The SG maintained improvements in Lequesne and WOMAC total and subsets during the year, whereas the CG returned to baseline values for pain, function and total ($p < 0.01$). TUG and 30CST results were always better in the study group without any clinically important improvement in both groups. Conclusion: Long-term use of functional brace added to self-management program improves pain and function in patients with PFOA. ***Level of Evidence II, Lesser quality RCT (eg, < 80% followup, no blinding, or improper randomization).***

Keywords: Osteoarthritis. Orthotic Devices. Patellofemoral Pain Syndrome.

RESUMO

Objetivo: Comparar o efeito a longo prazo de uma órtese destinada a estabilizar a articulação fêmoro-patelar em comparação com uma de neoprene com orifício para patela em pacientes com osteoartrite fêmoro-patelar (OAFP). Métodos: Trinta e oito pacientes com OAFP e comorbidades receberam ou uma órtese funcional fêmoro-patelar (grupo estudo, GE) ou uma joelheira de neoprene com orifício para patela (grupo controle, GC). Os grupos receberam tratamento clínico da osteoartrite e comorbidades conforme programa da instituição. Foram avaliados com os questionários de WOMAC e Lequesne, testes de senta e levanta em 30 segundos (TSL30) e Timed-Up-and-Go (TUG), medidas antropométricas e minutos de atividade física semanal à inclusão, com um, três e doze meses depois da colocação da órtese. Radiografias foram realizadas para mensurar ângulos fêmoro-tibiais. Resultados: Houve mais abandono no GC, sem diferenças de peso, índice de massa corpórea e atividade física entre os grupos durante o estudo. GE manteve melhoras de Lequesne e WOMAC total e subdomínios durante todo o estudo, enquanto o GC piorou progressivamente após o primeiro mês ($p < 0,01$). TUG e TSL30 tiveram melhoras não clinicamente relevantes para ambos os grupos. Conclusão: O uso a longo prazo da órtese funcional adicionado ao tratamento clínico melhora a dor e a função dos pacientes com OAFP. ***Nível de Evidência II, Evidence II,ECRC de menor qualidade (por exemplo, < 80% de acompanhamento, sem mascaramento do código de randomização ou randomização inadequada).***

Descritores: *Osteoartrite. Aparelhos Ortopédicos. Síndrome da Dor Patelofemoral.*

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INTRODUCTION

Osteoarthritis (OA) has the fastest growing prevalence of all musculoskeletal diseases with greatest indirect health costs in terms of years of healthy life lost due to disease and disability adjusted life years.[1] Of the weight-bearing joints, the knee is the most commonly affected by OA.[2] Most intervention studies have focused on the femorotibial (FT) joint, whereas OA of the patellofemoral (PF) joint, either in isolation or combined with FT OA, is reported to be more

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The study was conducted at Universidade de São Paulo, Hospital das Clínicas, Faculty of Medicine, Osteometabolic Diseases Group of the Institute of Orthopedics and Traumatology.
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prevalent.[3] PFOA is a significant source of knee pain and disability,[4] with known abnormal gait patterns such as increased mechanical load (i.e., knee flexion moment, impulse and patellofemoral joint stress) during the second half of the stance phase.[5,6]
Research on PFOA suggests that altered mechanics are indicators of a poor prognosis. Medially directed therapeutic taping and bracing are frequently used to modify the position and kinematics of the patella. Both techniques are hypothesized to produce a medial translation of the patella and increase joint contact forces, thereby reducing joint stress on the lateral compartment.[7]
Treating PFOA with medially directed tape and braces improves pain and bone marrow lesions.[8-12] The use of a brace to stabilize the knee with medial, lateral, superior and inferior compression bands also improved pain not differently from a sleeve with patella hole.[11]
The aim of this study is to verify the long-term effects of these two braces[11] in pain and function of patients with PFOA.

MATERIALS AND METHODS

This is a prospective randomized study approved by the Ethics Committee for Analysis of Research Projects (CAPPesq) (number 15016/16 and Clinical Trials registration number NCT02984254). All patients signed an informed consent form after receiving a detailed explanation.
The diagnosis of PFOA was made using the clinical criteria of the ACR,[13] i.e., presence of symptoms (pain and sensitivity) in the patellofemoral compartment of the knee, associated with signs of OA according to the Kellgren and Lawrence (K&L) classification.[14] Alignment was examined through long leg X-rays, tracing the mechanical axis (from the center of the femoral head to the center of the ankle) and the femorotibial angles. When long leg X-rays were not available, the femoro-tibial angle was measured in anterior-posterior knee X-rays.
The inclusion criteria were:
1) Symptomatic PFOA, absence of patella dislocation;
2) Age ≥ 30 years;
3) Clinical treatment for knee osteoarthritis for more than 6 months.
Non-inclusion criteria included:
4) Patients with involvement of the femoro-tibial compartment of the knee;
5) Patients unable to read or understand the consent form or the Western Ontario McMaster Universities (WOMAC) questionnaire;[15]
6) Patients with grade II or higher obesity.
The exclusion criteria were:
1) Braces used differently from what was requested;
2) Abandonment of the study;
3) Non-adaptation to the brace;
4) Skin and vascular complications due to brace use.
Procedure: at inclusion, the 60 patients were divided into three blocks and allocated to one of the two groups according to the order given by the spreadsheet 6591 created on April 12, 2017, at 8:58:36 in www.randomization.com.
At baseline, all patients arrived early to the hospital where they informed their age, schooling in years and number of minutes per week they exercised (self-reported). Weight and height were measured and patients performed the thirty-second chair-stand test (30CST),[16] Timed Up and Go (TUG)[17] and answered the WOMAC[15] and Lequesne[18] questionnaires. They attended a half-day course on osteoarthritis and its forms of treatment based on a self-management program for patients with knee OA of the institution, and finally had the braces placed in their knees according to randomization. Patients allocated to the study group (SG) used the Free Knee®: patellofemoral functional brace (Figure 1a, Technical characteristics: knee brace made of neoprene with upper, lower, and lateral impact absorption system), whereas the control group (CG) used Neoprene knee brace with a patellar orifice and support (Figure 1b, Technical characteristics: patella-shaped neoprene knee brace with lateral reinforcement).

Figure 1. A) Functional knee brace (Free Knee®, Salvapé, made of neoprene with Velcro and rubber tubes in the upper, lower, and lateral parts of the patella); B) Neoprene knee brace (Knee brace with patellar orifice, Salvapé, neoprene, and Velcro)

Patients were instructed to use the brace for 2 hours on the first day and increase by half an hour per day from the second day, up to a maximum of 12 hours/day. Patients were instructed to sleep without the device and use it when performing physical activities, except for activities performed in water.
Follow-up evaluations were made one, three and 12 months after knee brace placement.
Radiography without the brace (Schuss view and profile and axial views of the patella) to measure the affected joint spaces was performed in all patients. Long leg radiographies were not performed in all patients at inclusion.
Sample calculation: "n" was calculated to obtain a statistical power of 80% and a significance level of 5%. To this end, we considered the standard deviation of the WOMAC variation in the study by Campos et al.,[19] with a similar population of patients with knee OA from the Institute of Orthopedics and Traumatology. The sample size was selected so that it allowed the detection of a 5-point WOMAC variation. Considering eventual dropouts of about 10% of the patients, 26 patients per group was obtained as the recommended sample size.

Statistical analysis

The normal distribution of most of the data was verified by the Shapiro-Wilk test. Age, schooling (in years), physical activity, weight, BMI and the distribution of the femorotibial angle according to knee brace were compared by an independent t-test. Sex according to groups and condition of the knee at X-rays was compared using Pearson's chi-square test.
The scores of the questionnaires and functional tests were compared by an ANOVA test with repetitive measures. The analyses were followed by Bonferroni's multiple comparisons to determine the point at which significant differences between the groups and evaluation periods occurred. The analyses were performed using IBM's SPSS version 24.0. The tests were performed with a 5% significance level.

RESULTS

This study is the long-term follow-up of a study[11] comparing two different PF knee braces. The study commenced with 30 patients in each arm. Three patients (one from the CG and two from the SG) abandoned the study before retrieving the knee brace. One patient in each group missed evaluation at three months, not returning to the study. Thirteen patients from the control group did not attend the one-year evaluation, whereas only one from the study group missed the one-year evaluation. The study ended with 14 in the control group and 24 in the study group.

Table 1 shows descriptive variables regarding knee bracing at baseline. Groups were similar at inclusion for age, schooling, physical activity, weight and BMI. Despite more women than men, gender was equally distributed between the two models of PF bracing (Table 2).

Physical activity and weight improved with a non-significant BMI change in both groups (Table 3).

The SG maintained WOMAC total and subset improvements at one-year, whereas CG returned to baseline values for WOMAC pain, function and total (Table 4). The same pattern was seen with Lequesne's algo-function questionnaires (Table 5). TUG and 30CST results were always better in the SG without any clinically significant improvement in both groups (Table 5).

Table 1. Baseline descriptive variables according to groups.

	CG		SG		t	p	ES
	n	Mean ± SD	n	Mean ± SD			
Age	29	65.31 ± 7.6	28	63.00 ± 7.9	1.12	0.26	0.15
Schooling	29	7.90 ± 4.10	28	8.29 ± 6.4	-0.27	0.78	0.04
PA	29	136.03 ± 157.5	28	74.63 ± 8.3	0.27	0.78	0.04
Weight	29	74.63 ± 8.4	26	73.17 ± 11.1	0.555	0.58	0.07
BMI	29	29.51 ± 3.2	27	27.57 ± 6.4	1.42	0.16	0.19

CG: Control Group; SG: Study Group; PA: Physical Activity; BMI: Body Mass Index; SD: standard deviation; *t*: independent t test; $p < 0.05$; ES: effect size.

Table 2. Absolute and relative gender frequencies according to group.

	CG		SG		x^2	p	Total	
	n	%	n	%			n	%
Female	25	43.9	22	38.6	0.16	0.68	47	82.5
Male	4	7.00	6	10.5			10	17.5

x^2: Pearson's Chi-square; $p < 0.05$.

Table 3. Comparison of the descriptive variables during the study.

		Baseline		1 month	3 months	1 year	p	ES
		n	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD		
PA	CG	14	180.00 ± 165.6	225.36 ± 262.0	182.86 ± 189.8	216.43 ± 176.9	0.50	0.02
	SG	25	131.00 ± 137.4	158.00 ± 156.1	215.80 ± 148.2	201.00 ± 252.6		
Weight	CG	14	75.20 ± 6.9	74.41 ± 7.2	73.27 ± 7.0	73.54 ± 7.2	0.33	0.03
	SG	23	73.22 ± 11.5	72.96 ± 11.6	73.2 ± 12.6	72.51 ± 10.9		
BMI	CG	14	29.68 ± 3.0	29.35 ± 3.1	28.98 ± 2.8	29.44 ± 3.0	0.16	0.04
	SG	23	28.40 ± 3.9	28.25 ± 3.8	28.62 ± 4.4	28.46 ± 4.1		

PA: Physical Activity; BMI: Body Mass Index; CG: Control Group; SG: Study Group; SD: standard deviation; $p < 0.05$; ES: effect size.

Table 4. Comparison of WOMAC total and subsets results.

		Baseline		1 month	3 months	1 year	p^a	p^b	p^c	ES
WOMAC		n	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD				
Pain	CG	14	9.57 ± 3.0	6.79* ± 4.0	7.43 ± 4.8	10.29** ± 4.5	0.03	0.02	0.01	0.02
	SG	24	8.25 ± 4.2	6.79 ± 3.8	6.29 ± 4.3	6.46^{B4} ± 4.2				
Stiffness	CG	14	4.71 ± 1.7	3.00* ± 1.8	3.5 ± 1.9	4.07 ± 2.2	0.01	0.01	0.03	0.11
	SG	24	3.13^{B1} ± 2.4	2.38 ± 1.6	2.75 ± 2.0	2.58 ± 2.3				
Funtion	CG	14	31.79 ± 11.0	24.57 ± 14.3	30.14 ± 16.0	35.5** ± 12.8	0.01	0.01	0.02	0.10
	SG	24	29.88 ± 15.2	24.00 ± 13.6	22.54 ± 14.6	23.75^{B4} ± 15.5				
Total	CG	14	46.07 ± 12.7	35.79 ± 18.1	41.21 ± 21.9	49.86** ± 18.4	0.01	0.01	0.01	0.11
	SG	24	41.25 ± 20.8	33.17 ± 18.1	31.58 ± 19.8	32.79^{B4} ± 21.2				

CG: Control Group; SG: Study Group; SD: standard deviation; *: different from baseline; **: different from 1 month; p^a: p group; p^b: p moment; p^c: p interaction; $p < 0.05$; *ES*: Effect Size. ^{B1}: Different from CG at baseline; ^{B4}: Different from CG at one-year.

Table 5. Comparison of Lequesne, Timed Up and Go (TUG) and 30 seconds chair stand test (30CST) results.

		Baseline		1 month	3 months	1 year	p^a	p^b	p^c	ES
		n	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD				
LEQ	CG	14	12.42 ± 3.3	8.82* ± 4.0	11.07 ± 5.2	11.75 ± 4.3	0.01	0.01	0.03	0.11
	SG	24	10.66 ± 5.1	8.97 ± 3.9	8.89 ± 4.4	8.25^{B4} ± 4.9				
TUG	CG	14	12.11 ± 3.9	11.52 ± 3.0	11.78 ± 2.9	11.85 ± 3.9	0.04	0.06	0.04	0.01
	SG	24	10.16^{B1} ± 2.8	10.47 ± 2.1	10.01 ± 1.8	10.25 ± 3.0				
30CST	CG	14	7.65 ± 3.1	8.29 ± 2.5	8.06 ± 2.9	8.47 ± 2.7	0.38	0.82	0.46	0.02
	SG	24	8.84 ± 2.0	8.88 ± 2.71	9.24 ± 2.9	9.32 ± 3.4				

LEQ: Lequesne; CG: Control Group; SG: Study Group; SD: standard deviation; *: different from baseline; **: different from 1 month; p^a: p group; p^b: p moment; p^c: p interaction; $p < 0.05$; ES: Effect Size. ^{B1}: Different from CG at baseline; ^{B4}: Different from CG at one-year.

Thirty-seven patients had long-leg X-rays. Among them, 61.1% had valgus alignment and 35.2% varus. One patient (3.7%) had one knee varus and one valgus.

DISCUSSION

While symptoms and progression of PFOA is known to be related to poor mechanics,[7] interventions such as patella taping, patella bracing and physical therapy can alleviate joint stress and symptoms for people with this condition.[4] Medially directed PF bracing produces medial translation of the patella, reduces lateral patella tilt and increases joint contact forces, reducing joint stress on the lateral compartment.[20] Treating PFOA by bracing reduces pain, bone marrow lesions and improves function at short term.[8,10,11]

The purpose of this study was to verify the long-term effects (one year) of the usage of two PF braces that had no significant difference in results at short term. Both braces led to reduced medication consumption in the first month and some stopped taking medication based on the results obtained at the third month follow-up.[11] The CG received a standard sleeve with patella hole and the SG used a new model developed to increase joint contact forces while compressing the circumference of the patella (functional brace). At one-year follow-up, six patients abandoned the SG and 16 abandoned the CG. These were significant losses since both groups started with 30 patients. Descriptive variables such as weight, physical activity, body mass index, distribution of gender by type of brace and groups remained constant in both groups despite losses. However, the improvements in the SG were better with time, whereas the return to baseline scores were more evident in the CG for WOMAC total and subsets and Lequesne's algo-functional questionnaires. This result could be explained by a superiority of the functional brace but may be the result of the losses. When estimating the number of participants, 23 patients were estimated to be necessary to show a difference between braces. Crossley et al.[8] also lost a similar number of patients at nine months follow-up but started with a larger number of patients and similar to our SG, maintained the gains at 3 months until the end of the study (nine months).

Functional tests (30CST and TUG) showed no clinically important improvement in both groups. The 30CST tests the PF joint more specifically than the TUG, and as expected of patients with exclusive PFOA, TUG results were close to normal and 30CST were below normal in both groups without relevant improvements provided by either brace. There was an expected greater prevalence of valgus alignment in both groups.

Among the limitations of our study are the lack of control of the number of daily hours of brace usage, lack of measurement of improvement in patellar positioning and patellar tilt to assess whether there is real improvement in patellar alignment with the use of the knee brace. These are all aims for future studies.

CONCLUSION

Long-term use of functional brace added to self-management program improves pain and function in patients with PFOA.

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LEVER SIGN TEST FOR CHRONIC ACL INJURY: A COMPARISON WITH LACHMAN AND ANTERIOR DRAWER TESTS

TESTE DA ALAVANCA PARA LESÃO CRÔNICA DO LCA: COMPARAÇÃO COM OS TESTES DE LACHMAN E GAVETA ANTERIOR

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ABSTRACT

Objective: This study aims to evaluate the sensitivity and specificity of the lever sign test in patients with and without chronic Anterior Cruciate Ligament (ACL) injuries in an outpatient setting and the inter-examiner agreement of surgeons with different levels of experience. Methods: 72 consecutive patients with a history of previous knee sprains were included. The Lachman, anterior drawer, and Lever Sign tests were performed for all subjects in a randomized order by three blinded raters with different levels of experience. Sensitivity, specificity, positive predictive value, negative predictive value, and inter-rater agreement were estimated for all tests. Results: Among the 72 patients, the prevalence of ACL injuries was 54%. The lever test showed sensitivity of 64.1% (95% CI 0.47-0.78) and specificity of 100% (95% CI 0.87-1.00) for the senior examiner. For the less experienced examiner the sensitivity was 51.8% and the specificity was 93.7%. Positive predictive values (PPV) and negative predictive values (NPV) were 100% and 70.2%, respectively. Conclusion: Lever Sign test shows to be a maneuver of easy execution, with 100% specificity and 100% PPV. Moderate agreement between experienced examiners and low agreement among experienced and inexperienced examiners was found. This test may play a role as an auxiliary maneuver. ***Level of Evidence I, Diagnostic Studies – Investigating a Diagnostic Test.***

Keywords: Anterior Cruciate Ligament. Anterior Cruciate Ligament Injuries. Knee Joint. Joint Instability.

RESUMO

Objetivo: O objetivo deste estudo foi avaliar a sensibilidade e a especificidade do teste da alavanca em pacientes ambulatoriais com e sem lesões crônicas do LCA e a concordância entre examinadores com diferentes níveis de experiência. Métodos: Setenta e dois pacientes consecutivos com histórico de entorse de joelho foram incluídos. O teste de lachman, gaveta anterior e teste de alavanca foram realizados para todos os indivíduos em ordem randomizada por 3 examinadores cegados com diferentes níveis de experiência. Sensibilidade, especificidade, valor preditivo positivo, valor preditivo negativo e concordância interavaliadores foram calculados para todos os testes. Resultados: Entre os 72 pacientes, a prevalência de lesões do LCA foi de 54%. O teste da alavanca mostrou sensibilidade de 64,1% (IC95% 0,47-0,78) e especificidade de 100% (IC95% 0,87-1,00) para o examinador sênior. Para o examinador menos experiente, a sensibilidade foi de 51,8% e a especificidade, de 93,7%. Valores preditivos positivos (VPP) e valores preditivos negativos (VPN) foram de 100% e 70,2%, respectivamente. Conclusão: O teste da alavanca mostra ser uma manobra de fácil execução, com 100% de especificidade e 100% de PPV. Foi encontrada concordância moderada entre examinadores experientes e baixa concordância entre examinadores experientes e inexperientes. Este teste pode desempenhar um papel como uma manobra adjuvante. ***Nível de Evidência I, Estudos Diagnósticos – Investigação de um Exame para Diagnóstico.***

Descritores*: Ligamento Cruzado Anterior. Lesões do Ligamento Cruzado Anterior. Articulação do Joelho. Instabilidade Articular.*

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INTRODUCTION

Anterior cruciate ligament (ACL) injuries are the most common ligament injuries of the knee.[1] Diagnosis is made based on history, physical examination and confirmed by magnetic resonance imaging (MRI) and diagnostic arthroscopy.[2]

The most frequently employed physical examination tests are the Lachman, the anterior drawer, and the pivot shift, which have high sensitivity and specificity. Among the three tests, the Lachman test is accepted as the most sensitive (85-96%).[3,4] However, examiner experience, patient's body habitus and the presence of knee effusion and pain[5,6] can impair the execution of the tests.[7] Some series

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The study was conducted at Universidade de São Paulo, Faculty of Medicine, Hospital das Clínicas, Institute of Orthopedics and Traumatology.
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have shown up to 74% of failure in clinical diagnosis of acute ACL injuries among emergency physicians.[8] The significance of the examiner proficiency is further shown by a study in which primary care physicians identified correctly only 62% of chronic ACL injuries, in comparison to 94% for orthopedic surgeons.[5]

In 2016, Lelli et al.[9] described a new maneuver for the diagnosis of ACL injuries, called the *Lever Sign test*. They reported 100% sensitivity and 100% specificity for both acute and chronic injuries, even in patients with large muscle mass and obese. The test does not reproduce the rapid translational movements between the tibia and the femur, so it might induce less pain and resistance by the patient. Also, the objective assessment of the test positivity is reported to be easier than for the traditional tests, especially for inexperienced examiners.[9]

Other authors have investigated the Lever Sign test and found lower sensitivity (38-98%)[10,11] and specificity (72-100%).[10,12] Studies are yet to be able to reproduce the results published by Lelli et al.[9] The fact that no study has specifically evaluated the claim that the test might be easier to perform and therefore more accurate for inexperienced or non-specialist examiners is especially interesting. Moreover, its performance has not been previously tested in chronic injury settings.

This study aims to evaluate the performance of the Lever Sign test for chronic ACL injury and to evaluate inter-rater agreement between two experienced examiners and between an experienced and an inexperienced examiner, in comparison to the Lachman and the Anterior Drawer tests.

MATERIALS AND METHODS

The study was conducted from August 2017 to June 2018 in an orthopedic department of a tertiary hospital after approval by the institutional ethics review board.

In total, 72 consecutive patients were evaluated at the first outpatient visit in the institution. All patients had a history of knee sprain for more than one month and had been referred for evaluation.

Inclusion criteria were age between 18 and 50 years, history of knee sprain for at least 1 month without previous knee surgeries and an available MRI to confirm the diagnosis. ACL injury at MRI was defined as a complete ligament rupture. Patients with other ligament tears, diagnosis of osteoarthritis, and bilateral ACL injuries were excluded.

The Lachman, Anterior Drawer, and Lever Sign tests were performed in all patients by the main examiner, a knee surgery specialist, and these data were used to evaluate the tests performance. Furthermore, to evaluate inter-examiner agreement in different levels of examiner experience, the first 35 patients of the study were also examined by another experienced knee surgeon, and an inexperienced one (a first-year resident of the orthopedic program), with little previous physical examination experience in knee ligament injuries. The inexperienced examiner was instructed on the physical examination tests prior to the beginning of this study.

All examiners were blind to the diagnosis and other information about the patient or the results of the physical examination by the other examiners. The examined limb, defined as the limb of the patient's complaint, was indicated by the researcher responsible for compiling the data. This last researcher was also blinded for the MRI and clinical results. Because the physical examination tests are clinically performed in a comparative way, the evaluation of the contralateral side was allowed, but only the index side data was considered for analysis.

The tests were performed in the office, without anesthesia, and recorded as positive or negative after a bilateral comparative evaluation of each test. The order of the tests was randomized, using a previously generated list, which was concealed from the examiner until the test in order to avoid performance bias by the previous test result.

The Lever Sign test was performed as it was originally described.[9] The patient was lying in the supine position with knees in extension on a rigid surface, the examiner stands beside the patient and places the closed fist under the proximal third of the posterior leg, generating a small knee flexion. With the other hand, it exerts a moderate force from anterior to posterior on the distal third of the patient's thigh. The test is considered positive when passive elevation of the heel does not occur in relation to the plane of the examination table. The heel rise makes the test negative and therefore the ACL is considered intact (Figure 1).

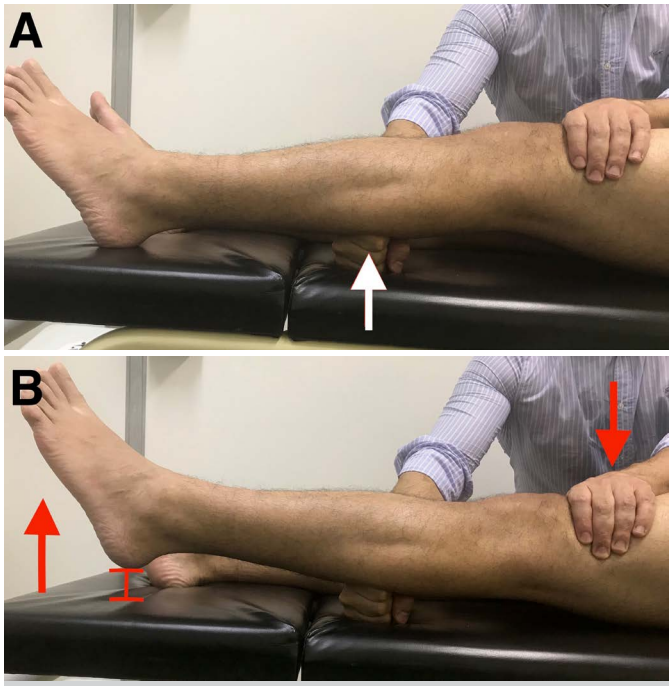

Figure 1. A: Closed fist is placed under the proximal third of the posterior leg in the resting position; B: A negative test is demonstrated.

Data analysis

For the Lachman, Anterior Drawer, and Lever Sign tests, the values of sensitivity, specificity, positive and negative predictive values were obtained for the main examiner and the resident examiner, with 95% confidence intervals (95% CI), using MRI as the gold standard diagnosis.

The inter-examiner agreement between the main examiner and the second experienced surgeon and between the main examiner and the orthopedic resident were evaluated with Cohen's Kappa coefficient. The agreement was interpreted according to McHugh:[13] none (0-.20), minimal (.21-.39), weak (.40-.59), moderate (.60-.79), strong (80-.90), almost perfect (>.9).

For quantitatively comparing the discriminative ability of the tests, ROC (Receiver Operating Characteristic) curves were produced from the results obtained by the principal examiner.[14,15] The use of ROC curves for binary diagnostic tests has been previously described.[16] The areas under the curve obtained were compared between the diagnostic tests.

The sample size was defined based on the recommendations of Bujang and Adnan,[17] considering an expected prevalence of 50% of ACL injuries among patients with history of knee sprains,[18] expected sensitivity for the Lachman test of 90%, and 80% power to demonstrate a 20% difference of the sensitivity of the tests. The calculated minimum sample was 62 participants, so we chose to enroll 72 patients for safety.

Values of $p < 0.05$ and differences beyond 95% CI were considered statistically significant. Statistical software SPSS 22 (IBM Corp., NY, USA) and VassarStats (Richard Lowry, Vassar College, NY, USA) were used.

RESULTS

In total, 72 patients were included in the study, 49 men and 23 women, with a mean age of 33.2 ± 8.6 years. The prevalence of ACL injuries was 54% among all knee sprains, of which 39 had ACL rupture and 33 had no injury.

For the main examiner, the Lever Sign test sensitivity was 64.1% (95% CI 47-78%), specificity was 100% (95% CI 87-100%), positive predictive value (PPV) was 100% (95% CI 0.83-1.00), negative predictive value (NPV) was 70.2% (95% CI 0.55-0.82) and accuracy was 80.5%.

The Lachman and Anterior Drawer test for the main examiner were, respectively, 94.8% (95% CI 81-99%) and 82.0% (95% CI 65-91%) sensitivity, 100.0% (95% CI 87-100%) and 84.8% (95% CI 67-94%) specificity, 100% (95% CI 88-100%) and 86.4% (95% CI 70-94%) PPV, 94.2% (95% CI 79-99%) and 80.0% (95% CI 62-90%) NPV, and 97.2% and 32.3% accuracy. Therefore, the Lachman test had a superior specificity to the Lever Sign test beyond the 95% CI (Table 1).

Table 1. Tests performance for the main examiner. 95% confidence intervals in parentheses.

Test	Sensitivity	Specificity	VPP	VPN
Lever Sign	64.1% (47-78%)*	100% (87-100%)	100% (83-100%)	70.2% (54-82%)
Lachman	94.8% (81-99%)	100% (87-100%)	100% (88-100%)	94.2% (79-99%)
Anterior drawer	82.0% (65-91%)*	84.85% (67-94%)	86.4% (70-94%)	80% (62-90%)

*: statistically significant.

For the inexperienced examiner, the Lever Sign test percentages were 51.8% (95% CI 32-70%) sensitivity, 93.7% (95% CI 67-99%) specificity, 93.3% (95% CI 66-99%) PPV, 53.5% (95% CI 34-71%) NPV and 67.4% accuracy.

The Lachman and Anterior Drawer test for the inexperienced examiner presented, respectively, 66.6% (95% CI 46-82%) and 62.9% (95% CI 42-79%) sensitivity, 93.7% (95% CI 67-99%) and 93.7% (95% CI 67-99%) specificity, 94.7% (95% CI 71-99%) and 94.4% (95% CI 70-99%) PPV, 62.5% (95% CI 40-80%) and 60.0% (95% CI 38-78%) NPV, and 76.4% and 74.4% accuracy.

The inter-examiner agreement by the Kappa coefficient between the main examiner and the second experienced examiner was 0.60 (moderate) for the Lever Sign ($p = 0.001$), 0.92 (almost perfect) for the Lachman test ($p < 0.001$), and 0.60 (moderate) for the Anterior Drawer test ($p = 0.001$) (Table 2).

Table 2. Inter-rater agreement by the Kappa coefficient.

	Kappa coefficient			
Test	Main examiner vs experienced examiner	*p*	Main examiner vs inexperienced examiner	*p*
Lever Sign	0.60 (0.32-0.88)	0.001	0.35 (0.05-0.66)	0.034
Lachman	0.92 (0.78-1.00)	< 0.001	0.42 (0.14-0.71)	0.009
Anterior drawer	0.60 (0.31-0.88)	0.001	0.34 (0.02-0.66)	0.052

Values in parentheses are 95% CI.

Between the main examiner and the inexperienced examiner, inter-examiner agreement by the Kappa coefficient was 0.35 (minimum) for the Lever Sign test ($p = 0.034$), 0.42 (weak) for the Lachman test ($p = 0.009$), and 0.34 (minimum) for the anterior drawer test ($p = 0.052$) (Table 2).

The ROC curve was 0.974 in area under the curve (AUC) for the Lachman test, 0.834 for the anterior drawer test and 0.821 for the Lever Sign test (Figure 2 and Table 3). The Lachman test AUC was higher than the anterior drawer and Lever Sign tests ($p = 0.008$ and 0.004, respectively).

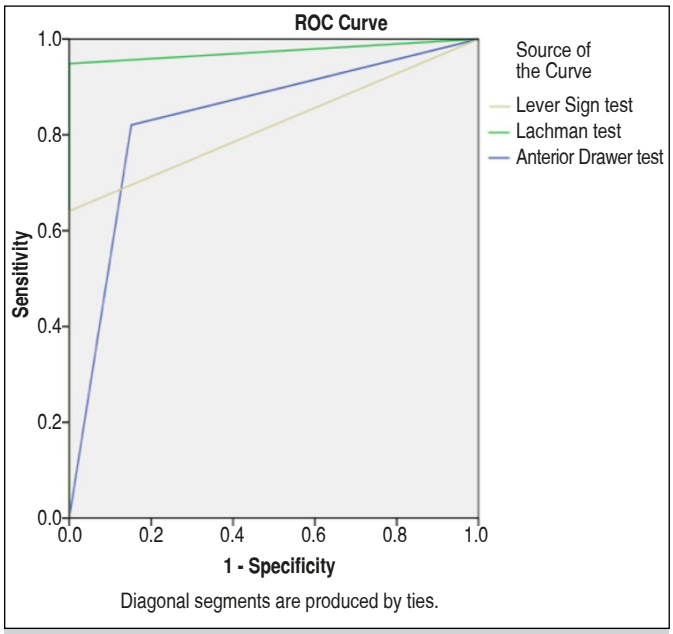

Figure 2. Receiver Operating Characteristic (ROC) curves of test maneuvers.

Table 3. Area under the curve (AUC) for Receiver Operating Characteristic (ROC) curves.

Diagnostic test	AUC
Lever Sign	0.821 ♦ †
Anterior Drawer	0.834 * ♦
Lachman	0.974 * †

*: $p = 0.008$; †: $p = 0.004$; ♦: $p = 0.85$ (not significant).

DISCUSSION

The main finding of this study is that the Lever Sign test is a maneuver with 100% specificity and 100% PPV despite not having a high sensitivity. It was less sensitive and less accurate than the Lachman test and presented moderate agreement among experienced examiners and a low agreement between an inexperienced and the experienced examiners.

Currently, physical examination tests are not always able to confirm ACL insufficiency, therefore there is great interest in the test described by Lelli et al.,[9] which was reported to achieve 100% sensitivity and specificity in their study.

Unfortunately, the test showed to have much higher accuracy in experienced examiners and should not be extrapolated as the gold standard for ACL injury to all emergency physicians or orthopedic surgeons who do not have a knee surgery or sports medicine background, as it was initially speculated. Our results were discordant with those reported by Jarbo et al.,[19] who found similar

accuracy between undergraduate and senior staff, 84% and 88%, respectively. In our study, the accuracy was proportional to the evaluator's experience, with 81.4% for the experience evaluator and 67.4% for the orthopedic resident.

Despite the high sensitivity of MRI for the ACL rupture diagnosis,[20] it is often not readily available in the clinical or emergency scenario and physical examination is extremely valuable for the diagnosis of ligament injuries of the knee.

Regarding the original article of the maneuver, it should be mentioned that the author created the test and all studied patients already had the presumed diagnosis of the injury. The examiner was also not blinded. This may constitute a significant observer bias for the study.

Our study found a 64.10% combined sensitivity and 100% specificity, which is closer to the results obtained in recent studies.[10-12,19-22] The main characteristic common to all studies to date that studied this maneuver is the high specificity despite a moderate sensitivity. In this context, this maneuver of easy execution becomes desirable when used in association with other propaedeutic exams, since a positive result is highly suggestive of an ACL injury. The maneuver must be performed on a rigid surface because when a softer and padded surface is used, we observed that the wrist under the leg sinks into the patient's bed and can change the test result. This influence of surface type on the positivity of the test has not been investigated and future studies may define the real importance of this factor.

Recently, other authors have investigated this maneuver and found divergent results of sensitivity and specificity: Jarbo et al.[19] 63% and 90%, Lichtenberg et al.[12] 39% and 100%, Mulligan et al.[10] 38% and 72%, Massey et al.[21] 83% and 80%, Deveci et al.[11] 94-98% and Chong et al.[22] 82-88% and 100%, respectively.

Physical examination maneuvers are known to be insufficient in the diagnosis of ACL injuries depending on the examiner's experience[5,23] and for acute scenarios, in which knee effusion and muscle spasms lead to lowed sensitivity values.[4] Thus, our study included only chronic lesions and evaluators with different experience levels were tested. The prevalence of ACL injury in our study was 54%, which is similar to the results found in the literature.[24] In the present study, the examiners had not had contact with the Lever Sign maneuver prior to the assessments and all of them started the learning curve concomitantly.

It is noteworthy that the mechanism by which the Lever Sign test works is not well understood from a biomechanical point of view. The theory that the force directed at the thigh from anterior to posterior position would be transmitted by the ACL and would act as a Lever Sign for the tibia, surpassing the force of gravity and generating the heel elevation from the bed plane was not biomechanically validated.

It is important to note that the Lever Sign test does not contemplate the ACL rotational restriction component and the possible involvement of knee anterolateral structures, which may decrease the accuracy for patients who present greater rotational instability than anterior translation. This occurs in patients with a more significant pivot shift than the Lachman and anterior drawer tests, as it has already been demonstrated in cases of partial injuries of the posterolateral ACL band.[25] Thus, the Lever Sign test has a qualitative character and does not allow the quantification of translational or rotational instability. In this study, the behavior of the different functional bands in the ACL partial ruptures was not separately studied since all patients presented complete ligament rupture.

The force to be applied to the thigh is also not well established and since it is not theoretically a comparative test to the contralateral limb, its positivity is based only on the heel elevation at the examination table and it is not known if the use of a greater force could elevate the limb even in the absence of ACL injury. We thus believe that the maneuver should be performed in a comparative bilateral way in order to establish a minimum adequate force to acquire the elevation of the non-affected limb and to define the response pattern for that individual. However, in our study this concern was not verified, and the test presented excellent specificity. In the present study the applied force was not measured or standardized, but the same examiner applied similar force intensity and did it comparatively bilaterally, as is usually done in the outpatient physical examination for the Lachman and anterior drawer tests.

This study presents some limitations, such as the fact that the evaluations were performed only with non-anesthetized patients. It is known that the values of sensitivity, specificity and accuracy increase with the anesthetized patient,[6] but the purpose of the study was to evaluate the diagnosis in the clinical context of the office or emergency room with an awake patient. It is also noteworthy that the gold standard to determine the injury positivity was magnetic resonance imaging evaluated by experienced musculoskeletal radiologists, which, although present high sensitivity and specificity values and 93.5% accuracy, can be cited as a possible limitation.[2]

Another limitation is that the first 30 patients were evaluated sequentially by the 3 examiners, for 9 total maneuvers performed on each patient, which may increase discomfort and promote some degree of muscle spasm, altering the results.

Thus, the Lever Sign tests proved to be an easy maneuver with moderate agreement between experienced examiners and low agreement among experienced and inexperienced examiner. This test has a role as an adjuvant maneuver, but not isolated for the diagnosis of ACL ruptures.

CONCLUSION

Lever Sign test was shown to be a maneuver of easy execution, with 100% specificity and 100% positive predictive value. Moderate agreement between experienced examiners and low agreement between experienced and inexperienced examiners was found. This test may play a role as an adjuvant maneuver.

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EVALUATION OF POST-SURGICAL MANAGEMENT OF FRAGILITY FRACTURES

AVALIAÇÃO DA CONDUTA PÓS CIRÚRGICA NAS FRATURAS POR FRAGILIDADE ÓSSEA

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ABSTRACT

Objective: To evaluate the conduct of Brazilian orthopedists regarding preventive treatment after fragility fracture surgery. Methods: A questionnaire was applied to Brazilian orthopedists. Statistical analyses were performed using the SPSS 16.0 program. Results: 257 participants were analyzed. Most participants, 90.7% (n = 233), reported that they cared for patients with fractures and 62.3% (n = 160) treated them. The most indicated treatments were vitamin D (22.6%; n = 134) and calcium supplementation (21.4%; n = 127). According to the experience of the physicians – experienced (n = 184) and residents (n = 73) – fragility fractures were more common in the routine of residents (98.6%; n = 72) than experienced physicians (87.5%; n = 161), p = 0.0115. While treatment conduction was more reported by experienced physicians (63.6%; n = 117) than residents (58.9%; n = 43), p = 0.004. More experienced orthopedists (21.4%; n = 97) indicated treatment with bisphosphates than residents (14.2%; n = 20), p = 0.0266. Conclusion: Although most professionals prescribe treatment after fragility fracture surgery, about 40% of professionals still do not treat it, with differences in relation to experience. In this sense, we reinforce the importance of secondary prevention in the management of fragility fractures. ***Level of Evidence II, Prospective comparative study.***

Keywords: Femoral Fractures. Osteoporosis. Orthopedics. Vitamin D.

RESUMO

Objetivo: Avaliar a conduta adotada por ortopedistas brasileiros em relação ao tratamento adjuvante após a cirurgia de fraturas de fragilidade. Métodos: Foi aplicado um questionário aos ortopedistas brasileiros. A estatística foi realizada no programa SPSS 16.0. Resultados: Foram analisados 257 participantes. A maioria dos participantes 90,7% (n = 233) relataram atender os pacientes com fraturas e 62,3% (n = 160) relataram tratar. Os tratamentos mais indicados foram a suplementação de vitamina D (22,6%; n = 134) e de cálcio (21,4%; n = 127). De acordo com a comparação médicos experientes (n = 184) versus médicos residentes (n = 73), a rotina de fraturas de fragilidade foi mais observada por médicos residentes (98,6%; n = 72) que por médicos experientes (87,5%; n = 161), p = 0,0115. Enquanto a conduta de tratamento foi mais relatada por médicos experientes (63,6%; n = 117) versus médicos residentes (58,9%; n = 43), p = 0,004. A maior proporção de médicos experientes (21,4%; n = 97) indicaram o tratamento com bifosfatos versus médicos residentes (14,2%; n = 20), p = 0,0266. Conclusão: Apesar da maioria dos profissionais prescreverem um tratamento após a cirurgia de fraturas de fragilidade, cerca de 40% dos profissionais ainda não tratam, sendo observadas diferenças em relação à experiência. Neste contexto, reforçamos a importância da prevenção secundária na conduta de fraturas de fragilidade. ***Nível de Evidência II, Estudo prospectivo comparativo.***

Descritores: *Fraturas do Fêmur. Osteoporose. Ortopedia. Vitamina D.*

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INTRODUCTION

Osteoporosis is a multifactorial disease that usually affects individuals over the age of 50 and it is the main cause of fragility fractures. Osteoporosis epidemiology is significant because it affects more than 200 million older adults worldwide; fracture of the hip being the most frequent. In the United States more than 53 million people have osteoporosis or are in the risk group for the development of this disease.[1,2]

The prevalence of all types of fragility fracture in Brazil is high, ranging from 11% to 23.8%. According to national studies, osteoporosis and fragility fractures are considered a public health problem, since the prevalence of fragility fractures is high; they are associated with patient mortality, physical disability and recurrent fractures.[3] The existence of a previous history of fragility fracture is an important risk indicator for future fractures. These individuals present a much higher risk of having another fracture in the future,[4,5] and the risk is

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

The study was conducted at Universidade Federal de São Paulo, Paulista School of Medicine, Department of Orthopedics and Traumatology.
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even higher during the first year after the fracture.[4] Thus, patients with previous fractures are an obvious opportunity for preventive interventions.

Practical and low-cost methods for screening at risk populations can quantify the problem and allow the planning of early interventions, which may prevent or delay the occurrence of primary and recurrent fragility fractures.[6] Primary prevention depends mainly on the health professional, because patients' perception of fracture risks is considered low.[7] Thus, orthopedists have the opportunity to prevent new injuries.

Although fragility fractures have epidemiological relevance in orthopedics and geriatrics, there is no standardized and uniform clinical approach for their treatment. In this sense, the aim of this study was to evaluate the conduct of Brazilian orthopedists in relation to treatment after fragility fractures surgery.

MATERIALS AND METHODS

Study

This is a prospective, cross-sectional and observational study, conducted at the Department of Orthopedics and Traumatology of the *Hospital São Paulo da Universidade Federal de São Paulo – UNIFESP* (EPM), São Paulo, Brazil. It was performed from June to August 2020. The study was submitted and approved by the Research Ethics Committee of UNIFESP/EPM (11957619000005505). The questionnaires were applied via the Google Forms platform.

Inclusion and exclusion criteria

Inclusion factors were Brazilian orthopedists and residents in orthopedics and traumatology, men or women that agreed to answer the questionnaire and signed the free and informed consent form. As requested by the ethics committee, the form was sent to participants via Google Forms. The exclusion criteria were participants of other nationalities, non-participating physicians and incomplete questionnaires.

QUESTIONNAIRE APPLICATION

During the study period, a letter inviting individuals to answer an exclusively digital questionnaire was sent to the Regional Societies of Orthopedics and Medical Residency Services of this specialty. Individuals were invited to answer a questionnaire with six questions, which addressed independent and dependent variables (Figure 1), about the conduct of Brazilian orthopedists in relation to preventive treatment after fragility fracture surgery.

Universidade Federal de São Paulo – EPM

Departamento de Ortopedia e Traumatologia – Grupo do Trauma Ortopédico

Evaluation of post-surgical conduct of fragility fractures

The goal of this questionnaire is to evaluate the approach and treatment of osteoporosis/osteopenia in fragility fracture patients.

1) In what Brazilian state do you practice medicine? _____

2) You are:
☐ Resident in Orthopedics and Traumatology (skip to question 4)
☐ Orthopedist

3) Do you have a specialty?
☐ No
☐ Yes. Which one?

4) Are proximal humerus, distal radio and/or proximal femur fractures part of your work routine?
☐ Yes
☐ No (end of the questionnaire)"

5) In these patients with boné fragility, does your conduct involve osteoporosis/osteopenia treatment?
☐ Yes
☐ No (end of the questionnaire)
☐ I refer the patient to a specialist. Which one?_____(end of the questionnaire)

6) What options do you recommend for treatment? Choose between the options bellow.
☐ Calcium supplementation
☐ Vitamin D supplementation
☐ Bisphophonates
☐ Hormonal therapy"
☐ Muscle strengthening exercise
☐ Others: _____

Figure 1. Supplementary material.

Statistical analysis

To obtain a sample with statistical power, sample calculation was performed considering a 95% confidence level and 5% sampling error; the sample number of 243 participants was obtained. Descriptive analysis was expressed as frequency and proportion. To test homogeneity between proportions, the chi-square test or Fisher's exact test were used. The results were analyzed with the SPSS 16.0 software (Chicago, USA) and GraphPad Prism 5.0 (Software Inc., USA), considering a 5% significance level ($p < 0.05$) as statistically significant.

RESULTS

Sample characterization

The study population consisted of 257 interviewed participants. Most of the participants were from the Southeast region (60.7%; n = 156) and had already finished residency (Experienced physicians: 71.6%; n = 184) Among the subspecialties, half of the professionals (50.6%) had no specialty (20.2%; n = 52). Among the reported subspecialties, the most common were knee (14.4%; n = 37), orthopedic trauma (11.7%; n = 30) and hip (8.2%, n = 21) (Table 1).

Table 1. Description of the sample of Brazilian orthopedists.

Variable	N	%
Region		
Midwest	12	4.7%
Northeast	30	11.7%
North	13	5.1%
Southeast	156	60,7%
South	46	17.9%
Professionals		
Experienced physician	184	71.6%
Resident physician	73	28.4%
Subspecialty		
None	52	20.2%
Undefined	78	30.4%
Surgery (spine)	6	2.3%
Surgery (hand)	8	3.1%
Orthopedic trauma	30	11.7%
Shoulder/elbow	9	3.5%
Hip	21	8.2%
Knee	37	14.4%
Foot/ankle	11	4.3%
Sports Orthopedics	2	0.8%
Bone tumor	3	1.2%

Legend: 257 orthopedists were interviewed.

Regarding the routine and treatment of fragility fractures, more than 90% (n = 233) of the interviewed professionals routinely deal with proximal humerus, distal radio and/or proximal femur fractures. Among the approaches adopted in patients with bone fragility, the majority (62.3%, n = 160) of the responders reported using the treatment of osteoporosis/osteopenia, while approximately 28% reported not applying any treatment nor referring the patient to a specialist (Table 2).

Table 2. The routine and conduction of fragility fracture treatment of Brazilian orthopedists.

Variable	N	%
Routine with fractures		
Yes	233	90.7%
No	24	9.3%
Conducts treatment		
Yes	160	62.3%
No	42	16.3%
Refers to specialist	30	11.7%
Undefined	25	9.7%
Referred Specialist		
Undefined/ does not refer	228	88.7%
Endocrinologist	2	0.8%
Orthomolecular/Osteometabolic	7	2.7%
Geriatric Specialist	5	1.9%
Obstetrician and Gynecologists	3	1.2%
Other	12	4.7%

257 orthopedists were interviewed. *Fractures of the proximal humerus, distal radius and/or proximal femur were considered routine fragility fractures.

Treatments used by the interviewed orthopedists

The professionals mainly used treatment with vitamin D supplementation (22.6%; n = 134), followed by calcium supplementation (21.4%; n = 127) and bisphosphonates (19.7%; n = 117). The most unusual treatment was hormone therapy (1.7%; n = 10) (Table 3).

Table 3. Treatments used by the interviewed Brazilian orthopedists.

Treatment	N	%
Vitamin D Supplementation	134	22.6%
Calcium Supplementation	127	21.4%
Bisphosphonates	117	19.7%
Muscle strengthening exercise	100	16.8%
Undefined	93	15.7%
Other	13	2.2%
Hormone therapy	10	1.7%

We interviewed 257 orthopedists.

Fragility fracture treatment according to orthopedist's experience

When separating the interviewees according to their professional experience – experienced physicians (n = 184, 71.6%) and resident physicians (n = 73, 28.4%) – no statistically significant difference was found between Southeast and Other regions ($p > 0.05$). In relation to subspecialties, this association was statistically significant and, as expected, most experienced physicians (67.9%) had some defined subspecialty and almost all resident physicians (97.3%) declared no subspecialty (Table 4).

Table 4. Description of the sample according to experience.

Variable	Experienced Physician (n=184)		Resident Physician (n=73)		p
	N	%	N	%	
Region					
Southeast	107	58.2%	49	67.1%	0.2355
Others	77	41.8%	24	32.9%	
Subspecialty					
None	52	28.3%	0	0.0%	<0.0001*
Undefined	7	3.8%	71	97.3%	
Surgery	14	7.6%	0	0.0%	
Orthopedic trauma	30	16.3%	0	0.0%	
Shoulder/elbow	9	4.9%	0	0.0%	
Hip	19	10.3%	2	2.7%	
Knee	37	20.1%	0	0.0%	
Foot/ankle	11	6.0%	0	0.0%	
Sports Orthopedics	2	1.1%	0	0.0%	
Bone tumor	3	1.6%	0	0.0%	

257 orthopedists were interviewed. [a]Chi-square association test was performed considering as subspecialty groups: "Undefined," "None" and "Some," the latter being the sum of all defined subspecialties.

Regarding the routine and treatment of fragility fractures, we observed that even though most professionals reported that they attend to fragility fractures cases in their routine, this was more frequent in resident physicians' reports (n = 72, 98.6%) (p = 0.01). However, experienced physicians conducted treatment more often (63.6%; n = 117) than residents (58.9%; n = 43) – p = 0.004. No significant differences were observed regarding referral to other specialists (p > 0.05) (Table 5).

Table 5. Brazilian orthopedists' routine and treatment conduct of fragility fractures.

Variable	Experienced Physician (n = 184)		Resident Physician (n = 73)		p
	N	%	N	%	
Fragility fracture in the routine					
Yes	161	87.5%	72	98.6%	0.0115
No	23	12.5%	1	1.4%	
Conducts treatment					
Yes	117	63.6%	43	58.9%	0.004[b]
No	20	10.9%	22	30.1%	
Refers to specialist	23	12.5%	7	9.6%	
Undefined	24	13.0%	1	1.4%	
Referred Specialist					
Undefined/does not refer to specialist	160	87.0%	68	93.2%	0.2314[c]
Endocrinologist	1	0.5%	1	1.4%	
Orthomolecular/ Osteometabolic	7	3.8%	0	0.0%	
Geriatric Specialist	3	1.6%	2	2.7%	
Obstetrician and Gynecologists	3	1.6%	0	0.0%	
Other	10	5.4%	2	2.7%	

257 orthopedists were interviewed. [a]Chi-square association test was performed considering as conduct groups: "Yes," "No" and "Refers to specialist"; the undefined cases were disregarded in the Chi-square Association Test, considering the following groups: "Undefined/does not refer to specialist" and "Some," the latter being the sum of all defined specialties.

Among the treatment options chosen by the professionals, we found a significant difference regarding the fragility fracture treatment with bisphosphonates according to the experience. More experienced physicians reported using this type of treatment more often than residents (21.4% *versus* 14.2%, p< 0.05) (Table 6).

Table 6. Fragility fracture treatment, according to the experience of Brazilian orthopedists.

Treatment	Physician Experienced		Resident Physician		p
	n	%	n	%	
Bisphosphonates	97	21.4%	20	14.2%	0.0266*
Vitamin D Supplementation	98	21.6%	36	25.5%	0.8389
Calcium Supplementation	95	21.0%	32	22.7%	0.5879
Muscle strengthening exercise	81	17.9%	19	13.5%	0.0911
Undefined	64	14.1%	29	20.6%	0.7099
Other	11	2.4%	2	1.4%	0.5256
Hormone therapy	7	1.5%	3	2.1%	NS

257 orthopedists were interviewed. [a]Chi-square association test was performed considering as conduct groups: "Yes," "No."

DISCUSSION

Fragility fractures are associated with morbidity, reduced life expectancy, pain, functional disability, decreased self-esteem, reduced quality of life and increased risk of recurrent fractures. Fragility fractures have epidemiological relevenance in orthopedics, mainly in the older adults group of the population.[8] However, there is still no standardized and uniform clinical approach for the management and treatment of fragility fractures, which shows the importance of this study on the conduct of Brazilian physicians regarding preventive treatment after fracture surgery.

This study analyzed the clinical conduct and treatment management of 257 orthopedists. More than 90% (n = 233) of the interviewed professionals routinely deal with proximal humerus, distal radio and/or proximal femur fragility fractures. Most orthopedists reported treating fragility fractures with medications used for osteoporosis and not referring patients to other specialists.

The frequency of fractures observed in this study, according to the affected anatomical region, is consistent with the epidemiology: other studies have also reported higher frequency of fragility fractures in the proximal humerus, radio and femur.[2,9,10] In Brazil, femoral fractures stand out due to their impact on the health of older adults, mortality and morbidity rates. Studies report that patients with femoral fracture have a 15 to 20% reduction in life expectancy, with mortality rates ranging between 15 and 50% in the first year after the fracture.[9,10]

Regardless of the initial fracture location, the history of a previous fracture confers a higher risk of subsequent fractures, which justifies preventive treatment. Systematic reviews on the prevention of secondary fractures demonstrate that the treatment of primary fractures reduces relative and absolute risk of new fractures.[11,12]

Regarding the conduct of the responders, we can observe that the main type of treatment was vitamin D supplementation, followed by Calcium and Bisphosphonate supplementation.

Vitamin D is a factor associated with the genesis of bone deterioration. A study involving fragility fractures reported high rates of vitamin D deficiency in patients with peripheral fractures and vertebral fractures.[13] Despite the clear connection between low-energy fractures and vitamin D deficiency, the literature is not in complete agreement with the preventive effect of this treatment. According

to Chapuy et al.,[13] the administration of tricalcium phosphate associated with cholecalciferol in women (mean age of 84 years) for 18 months decreased the rate of hip fractures in 29% and non-vertebral fractures in 24%, with preventive effect during 3 years of treatment. However, other studies have shown that vitamin D administration is unlikely to avoid fragility fractures. When administered with calcium supplements, it reduces the risk of hip fractures, especially in institutionalized patients.[14,15]

In order to identify whether the conduct of the professionals differed according to experience, the responders were stratified among experienced physicians (n = 184, 71.6%) and resident physicians (n = 73, 28.4%). Among the treatment options chosen by the professionals, we noticed a significant difference in the treatment of fragility fractures with bisphosphonates, according to their experience. More experienced physicians reported using this type of treatment more often than residents (21.4% versus 14.2%, $p < 0.05$) (Table 6). Several treatment options with bisphosphonates are available, the most widely used of the biphosphonate group are alendronate, risedronate and etidronate, which can be used as initial treatments.[11,16]

The conduct of experienced orthopedists is consistent with meta-analysis studies that evaluated the treatment with alendronate and etidronate to reduce the occurrence of fragility fractures, presenting evidence classified as "gold" and "silver" level, respectively.[11,16] Regarding the administration of alendronate, we observed a reduction in relative (RR) and absolute (RA) risk of vertebral fractures (45% RR, 6% RA), non-vertebral (23% RR, 2% RA), hip (53% RR; 1% RA) and wrist (50% RR; 2% RA).[11]

Despite the efficacy of already established drugs, such as bisphosphonates, side effects and loss of potency due to recurrent use of the same drug may limit the long-term use of a single drug. Therefore, treatment continuation and patient follow-up are essential. In addition, sequential and combinatorial use of current medications can provide an alternative approach, which motivates the continued update of fragility fracture treatments.[17]

Resident physicians have vitamin D supplementation as their preferred therapeutic treatment. This calcium and/or vitamin D based treatment may be indicated in cases of deficiency of these substances, or in patients with a high risk of fractures and/or undergoing osteoporosis treatment. In patients with postmenopausal osteoporosis, it is necessary to dose the amount of 25 hydroxyvitamin D before starting drug treatment. However, the use of calcium and vitamin D does not seem to be effective in fracture prevention.

Hormone therapy was the less used treatment, regardless of the experience of the prescribing physician. In the review study, Levin et al.[18] suggests that low-dose transdermal hormone therapy has important characteristics such as cost, safety and efficacy for primary prevention and treatment of osteoporosis and fragility fractures, especially for menopausal women. Thus, hormone therapy could be applied in menopausal women to reduce risks of osteoporosis fractures.

In this study, 62.3% (n = 163) of the responders conduct the treatment of fragility fractures, which corroborates data from the literature. However, we can observe that approximately 40% of the responders do not treat fragility fractures, which reflects a worrying situation. Iolascon et al.[19] emphasize that patients who have already suffered a fragility fracture are generally not adequately investigated and are almost never treated with osteoporosis medications.[19]

Many referral services for the prevention of recurrence fractures are increasing in the world due to good results. Naranjo et al.[20] propose the establishment of a framework of good practices and performance indicators to implement and monitor the coordination of fracture services and primary care in clinical practice, demonstrating the need for treatment of secondary fractures.

The occurrence of previous fractures and risk factors for osteoporosis are already indicative of the need for specialized follow-up and appropriate treatment. In this sense, we reinforce the need for preventive treatment of primary and secondary fragility fractures.

CONCLUSION

Although most professionals have reported that they prescribe preventive treatment after fragility fracture surgeries, about 40% of professionals still do not treat this condition. In addition, we observed a difference in the indicated treatment according to the experience of the physician. Despite the non-standardization of clinical management of fragility fractures in Brazil, we reinforce the importance of primary and secondary fractures prevention, which is supported by the literature and can have a positive impact on patient mobility and mortality.

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LOCALIZED PECTUS EXCAVATUM TREATED WITH BRACE AND EXERCISE: LONG TERM RESULTS OF A BRAZILIAN TECHNIQUE

TRATAMENTO DO PECTUS EXCAVATUM LOCALIZADO COM ÓRTESE E EXERCÍCIOS: RESULTADOS DE LONGO PRAZO DE UMA TÉCNICA BRASILEIRA

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ABSTRACT

Objective: Pectus excavatum is a deformity that affects aesthetics and causes emotional disorders. Surgical correction is well established, but conservative treatment is less common. We investigated the long-term results of using a brace and performing specific physical exercises to treat localized pectus excavatum, a type of deformity in which the depressed area is restricted to the midline region along the nipple line. Methods: We selected 115 patients (mean age 12.8 years), with a minimum follow-up of 36 months, who were evaluated more than one year after the end of treatment and skeletal maturity. Results were correlated with deformity flexibility, severity, regular use of the device, and performance of specific exercises. The chi-square (χ^2) and the Cochran-Mantel-Haenszel tests were used for statistical analysis. Results: Treatment was successful in 58% of patients, however, when exercises were performed and the brace was used regularly by patients with flexible deformities, the rate increased to 83% ($p = 0.005$). Severity and adherence to treatment greatly impacted successful treatment ($p = 0.009$ and < 0.001, respectively). Conclusion: The proposed treatment method was effective for correction or partial correction of the deformity in motivated patients followed up until skeletal maturity, especially when started early in milder and more flexible deformities. ***Level of Evidence V, Expert opinion.***

Keywords: Pectus Carinatum. Funnel Chest. Orthotic Devices. Exercise Therapy. Conservative Treatment.

RESUMO

Objetivo: O pectus excavatum é uma deformidade importante por comprometer a estética e causar distúrbios emocionais. A sua correção cirúrgica é bem estabelecida, mas o tratamento conservador é menos familiar. Investigamos os resultados de longo prazo do tratamento do pectus excavatum localizado (deformidade restrita a linha média e na linha mamilar) com uso de órtese e exercícios físicos específicos. Métodos: Selecionamos 115 pacientes (média de 12,8 anos) com seguimento mínimo de 36 meses, sendo avaliados mais de um ano após o término do tratamento e maturidade esquelética. Os resultados foram relacionados estatisticamente (qui-quadrado e Cochran-Mantel-Haenszel) com a flexibilidade da deformidade, a gravidade, o uso regular da órtese e a realização de exercícios específicos. Resultados: O tratamento foi bem-sucedido em 58% dos pacientes, mas quando o uso da órtese e os exercícios foram regulares em pacientes com deformidades flexíveis, essa taxa aumentou para 83% ($p = 0,005$). A gravidade e a adesão ao tratamento tiveram grande impacto no sucesso do tratamento ($p = 0,009$ e $<0,001$, respectivamente). Conclusão: O método de tratamento proposto foi eficaz para correção total ou parcial da deformidade em pacientes motivados acompanhados até a maturidade esquelética, principalmente quando a terapêutica foi iniciada precocemente em deformidades mais leves e flexíveis. ***Nível de Evidência V, Opinião do especialista.***

Descritores*: Pectus Carinatum. Tórax em Funil. Aparelhos Ortopédicos. Terapia por Exercício. Tratamento Conservador.*

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INTRODUCTION

Pectus excavatum (PE) and pectus carinatum (PC) account for 90% of all anterior chest wall deformities, with one case per 100-300 live births.[1] Both conditions can be treated with a brace that applies gradual compressive force on the anterior chest wall and via specific physical exercises. This type of treatment is more accepted for carinatum deformities.[2,3] However, conservative treatment of PE in which a brace applies compressive force below the depressed

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

The study was conducted at the Centro Clínico Orthopectus.
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area along with specific exercises, is less common.[4,5] Previous reports have shown that flexibility and application of a standard treatment protocol are important factors to achieve good results.[3,6,7] There are no publications on PE treatment with braces and exercises apart from those by Haje et al.,[4-8] which describe short term results. Most of the musculoskeletal system deformities (like clubfoot, teeth deformities, scoliosis, pectus, etc.) can relapse after a short period or during growth when treated by conservative or surgical methods.[9-12] This study aimed to evaluate the long-term results after skeletal maturity of conservative treatment of localized PE, using a dynamic chest reshaping method that consists of the use of a custom-made bespoke brace[5] and specific exercises.

MATERIALS AND METHODS

The evaluation protocol was approved by the Institutional Ethics Committee (58417516.3.0000.5553). Written consent was obtained from all patients. In total, 6072 medical records of individuals suffering from pectus carinatum and pectus excavatum deformities were considered to select patients. All patients were treated according to a pre-established protocol, from 1977 to 2017, by the same group of physicians. All patients were supervised by one of the authors. The study only evaluated the treatment of localized PE patients with a depressed area restricted to the midline region along the nipple line.[7,8] Patients with the broad type of PE, in which the depression was located above and below the nipple line, were excluded, whether the nipple area was affected or not,[7,8] and their treatment results will be shown in another study.

Deformity severity was classified subjectively, based on aesthetics, by the first or second authors as mild, moderate, or severe, as shown in Figure 1. Flexibility was assessed by the first or second author, by manually compressing the lower rib cage and using the Valsalva maneuver, associated with upper limb adduction against resistance. Younger patients who were unable to execute the Valsalva maneuver were asked to blow a balloon, while a manual compression of the flaring ribs was performed. Each deformity was classified as "flexible" when it was completely reversed by maneuvers; "rigid" or "poorly flexible" when no or little reduction of the deformity occurred, respectively; or "moderately flexible" in intermediate situations.[5] For result analyses, the "flexible" and "moderately flexible" deformities were grouped, as the "rigid" and "poorly flexible" pectus.

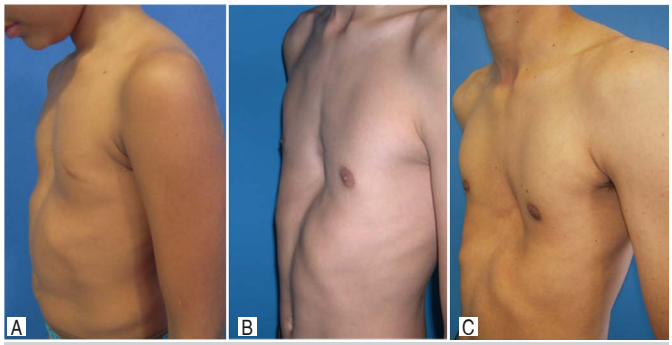

Figure 1. Classification of localized pectus excavatum severity according to esthetic compromise: A: mild; B: moderate; and C: severe.

The treatment indication criteria were patients between 2 and 19 years of age, with localized PE, and motivation to adhere to the treatment protocol by the patients and/or family members. Most deformities were moderate or severe, but some adolescent patients with mild deformities were also treated when it was important for the patient or the family. If the depression component of the localized pectus excavatum started worsening before puberty, treatment would begin in this age group. Adolescent patients with postural problems (like postural kyphosis) were encouraged to start treatment. Despite severity, treatment was indicated to all patients whose conditions were associated with mild scoliosis (less than 20° Cobb angle, measured in standing position). The treatment comprised of wearing a brace developed by Haje and Bowen[5] and specific exercises to strengthen trunk muscles. Figure 2 shows the patient selection flowchart. Only patients with follow-up periods longer than 36 months and at least one-year after they stopped growing were included (n = 115). Patients with iatrogenic deformities, associated with scoliosis greater than 20° or patients treated with a vacuum bell were excluded. Patients with deformities that did not bother them or cases where treatment was rejected by the family were also not included. The comparison group was composed of patients who remained untreated, although treatment was indicated, and who subsequently returned for a new evaluation.

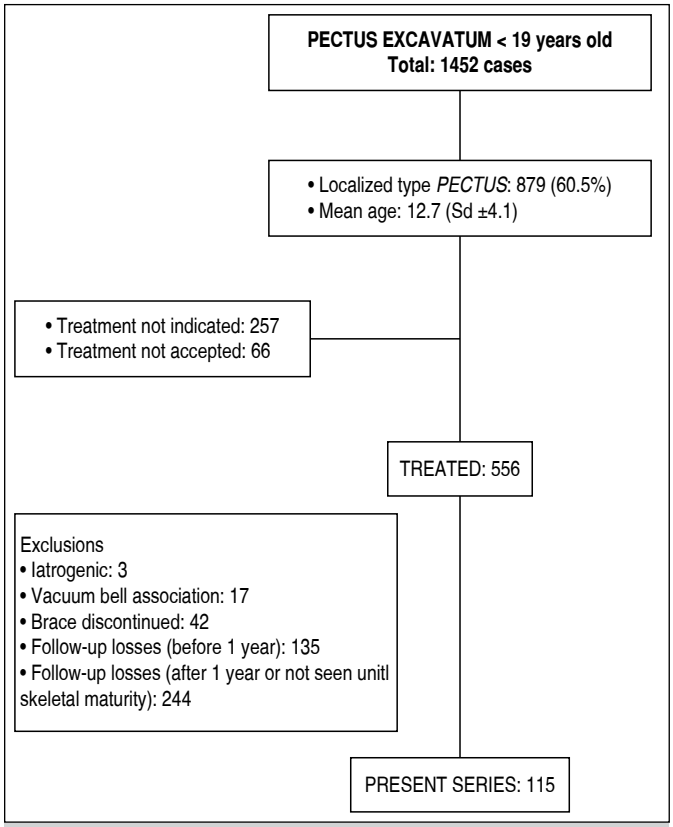

Figure 2. Flowchart of the treatment and monitoring until skeletal maturity of patients with localized pectus excavatum.

All patients were treated with the device shown in Figure 3. They were instructed to wear the brace until maximum correction for 23 hours a day, with a minimum of 18 hours. It could be removed for aquatic activities and contact sports. The patients themselves controlled the compression force at a comfortable level. This adjustment was discontinued only when the costal arch flare had disappeared. It was recommended that the specific exercises to strengthen the anterior chest wall muscles were performed while wearing the device, at least five times a week, maintaining maximum inspiration during concentric contraction. These exercises were initially taught by a physical therapist and adapted according to the patient's age and acceptance. The main exercises for older children and adolescents were the following: abduction and simultaneous counter-resistant extension of the upper limbs, trunk extension in the prone position, push-ups, sit-ups, crucifix, and blowing a balloon for 10 minutes.

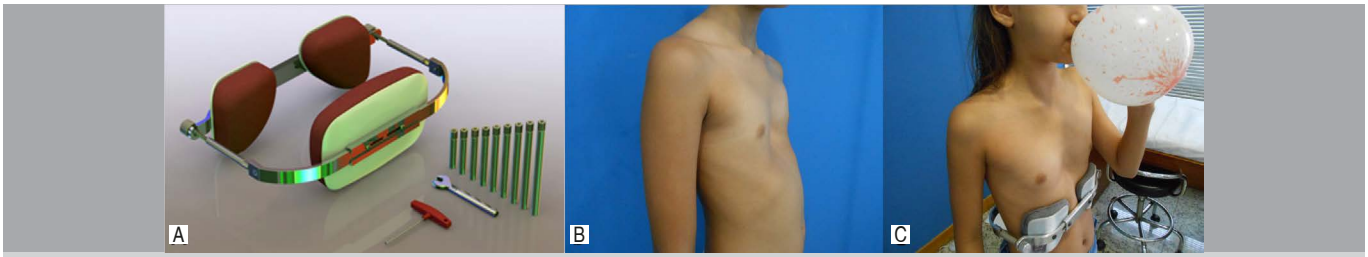

Figure 3. Illustration of the dynamic chest compression brace used for the treatment of all localized pectus excavatum cases. The brace is made up of two anterior padded plates resting on the lower costal margins and another padded plate on the dorsal region. A: compression between the anterior and posterior plates is controlled by the patient and it is applied by lateral screw threaded rods; B: in the picture, the patient with a moderate deformity performs an exercise to increase intrathoracic pressure by inflating a balloon; C: the pectus was classified as moderately "flexible".

After correction, patients were gradually weaned off the brace after completing at least 24 months of treatment. Treatment was discontinued after skeletal maturity, and additional follow-up was extended for at least another 12 months. Treatment adherence was classified as inadequate when the brace was not worn for the prescribed time or when the physical exercises were not performed regularly. Patients who stopped using the device before discharge were excluded, but those who discontinued the exercises before the recommended period were maintained in the final analysis, being classified as "irregular exercise adherence". Patients who used the brace for fewer hours than the indicated were classified as "irregular adhesion to the brace". Figure 3 shows the Dynamic Chest Compression Brace 2 (DCC 2) used for all patients, manufactured after receiving patient measurements and specifications from the doctor.

Results were considered "poor" when the deformity was aggravated or not corrected; "average" when it was under-corrected; and "good" when it was significantly improved (determined by one of the first two authors). Patient satisfaction with the treatment was defined as "satisfied" or "not satisfied". Successful treatments were defined as a "good" result and a "satisfied" patient. Photos of all patients were taken before and after treatment, and the clinical pictures were used for evaluation.

The Statistical Package for the Social Sciences (SPSS) software v. 22.0 (IBM, USA) was used for statistical analysis. The level of significance was set at $p < 0.05$. The chi-square (χ^2) test was used to verify associations between categorical variables. The Cochran-Mantel-Haenszel test was used to verify if the odds ratio between two variables remained the same for the categories of a third variable.

RESULTS

The mean age at the beginning of treatment was 12.8 years (SD = 4.0; median 13.7 years, variation 5.4 to 17.2; 24% were less than 10 years old, n = 28). Figure 4 shows age histogram of treated patients, with a mean follow-up duration of 23.9 months (S.D = 7.6; median 24.7) after the end of the treatment. Of the treated patients, 85 (74%) were male and 30 (26%) were female.

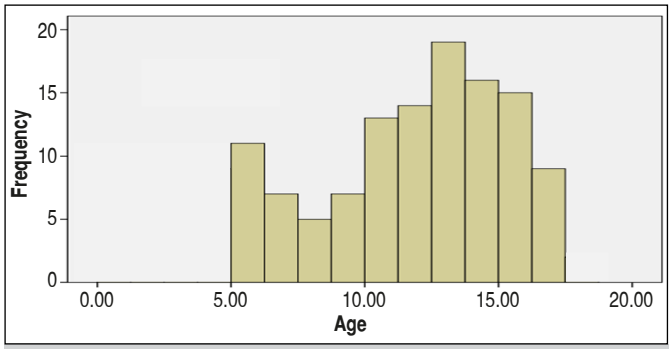

Figure 4. Age histogram of treated patients.

Thirty-four patients (30%) showed mild deformity, 67 (58%) showed moderate deformity, and 14 (12%) showed severe deformity. The deformity was very flexible or moderately flexible in 64 patients (56%) and rigid or poorly flexible in 51 patients (44%). The results were considered good in 66 patients (58%), average in 36 (31%), and poor in 13 (11%). Patients were satisfied with their treatment in all cases with good results, in 25%(n = 9) of average outcomes, and in none with poor results.

Good results were obtained in 57% (n = 20) of patients with mild deformities, 61% (n = 41) with moderate deformities, and 36% (n = 5) with severe deformities. In terms of flexibility, the results were good in 55% (n = 35) of patients with flexible or moderately flexible deformities and in 61% (n = 31) of patients with rigid or poorly flexible deformities (Figure 5).

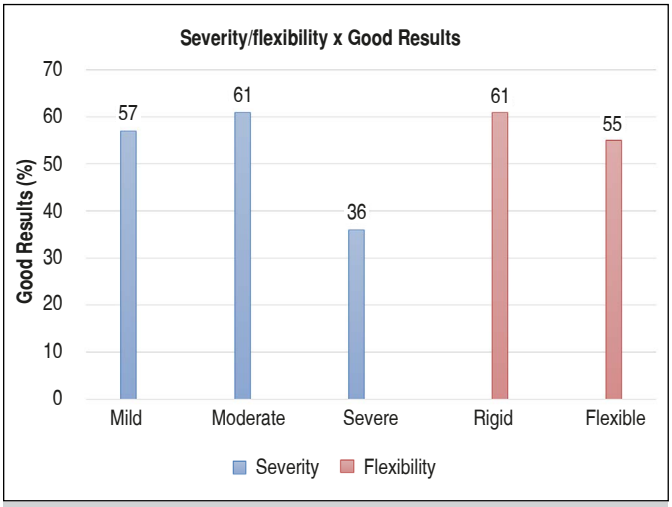

Figure 5. Results according to severity and flexibility.

Brace use was regular in 63% (n = 72) and irregular in 37% (n = 43). The specific exercises were regular in 49% (n = 57) and irregular in 51% (n = 58).

When flexibility was analyzed alone, no statistical difference between the results (p = 0.27) was observed, but when analyzed together with the regular use of braces, a significantly positive response to treatment was observed, with 83% of patients showing good results (p = 0.005). On the other hand, when the use of the brace was irregular, even with regular exercise performance, only 38% of the results were good (p = 0.167). In patients with regular orthosis use and exercise performance, good results were observed in 62% of patients (p < 0.001) (Figure 6). Table 1 shows the comparisons made. Figures 7 illustrates the final treatment results.

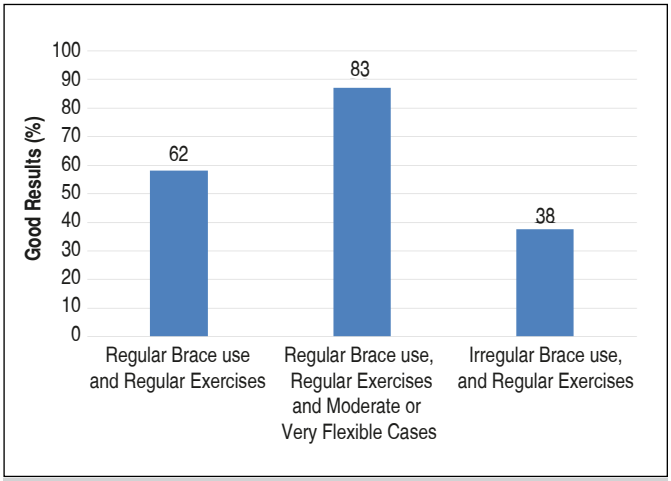

Figure 6. Results according to treatment regularity (brace use and specific exercises) associated or not with chest flexibility.

Table 1. Comparisons and interpretation of results.

Comparison	χ^2 value / p / odds ratio and 95%CI	Association between variables
Good results vs. pectus severity	17.09 / p = 0.009 / 3.8 (1.2–15.4)	negative
Good results vs. pectus flexibility	3.95 / p = 0.27/ 0.90 (0.38–2.13)	no correlation
Good results vs. regular brace use, and flexibility	23.84 / p = 0.005 / 6.45 (1.85–9.45)	positive
Good results vs. regular brace use	15.39 / p < 0.001 / 8.67 (2.74–27.4)	positive
Good results vs. regular physical exercises	7.40 / p = 0.007 / 4.05 (1.45–11.34)	positive
Good results vs. regular brace use and regular physical exercises	14.90 / p < 0.001 / 14.17 (3.23–62.11)	positive
Good results vs. irregular brace use and regular physical exercises	5.09 / p = 0.167/ 0.91 (0.27–1.28)	no correlation

Complications were not significant, but skin rashes, superficial skin injuries, and transient hyperpigmentation appeared in pressure areas (Figure 7B) in approximately 5% of the patients. In 15% of patients, discomfort or transient pain was experienced in the areas supported by braces. This was resolved by partially releasing the pressure. These complications did not cause discontinuance of device use. In three patients, there was mild overcorrection, which was managed by reducing the device use time or starting a second brace to treat the iatrogenic pectus carinatum (n = 2) (Figure 8). There were no relapses for those who completed follow-up.

The main reasons of the 66 patients who did not accept treatment were the following: surgery was selected as the primary treatment; psychological issues; or socioeconomic conditions. Twenty-eight returned in a mean follow-up of 18 months. The deformity had worsened in 20 patients (an example is in Figure 9), while it remained stable in eight. Among those who had worsened deformities, all showed moderate or accentuated deformities, which were very or moderately flexible in 11 (55%) and rigid in 9 (45%) in the last evaluation (at approximately 14.6 years of age).

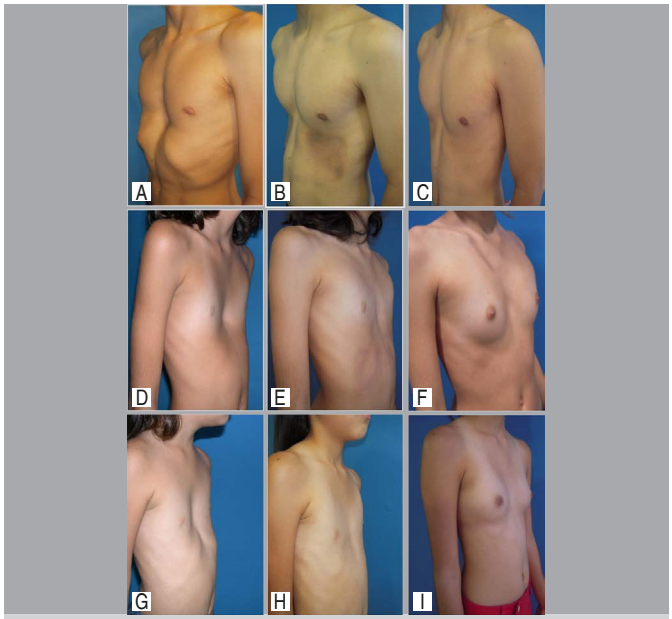

Figure 7. Localized pectus excavatum patients treated with braces and exercises with good final long-term results. A: 13-year-old male patient, showing moderate severity and flexibility of the deformity at the beginning of treatment; B: with transient hyperpigmentation in pressure areas and overcorrection of flaring ribs; and C: final result at the age of 17; D: 10-year-old female patient with good adherence to treatment; E: Correction was achieved after 12 months of treatment; F: Final correction at 15 years and 5 months of age; G: 5-year-old female patient before treatment; H: Complete correction showed when she was 8 years old; and I: 12 years old.

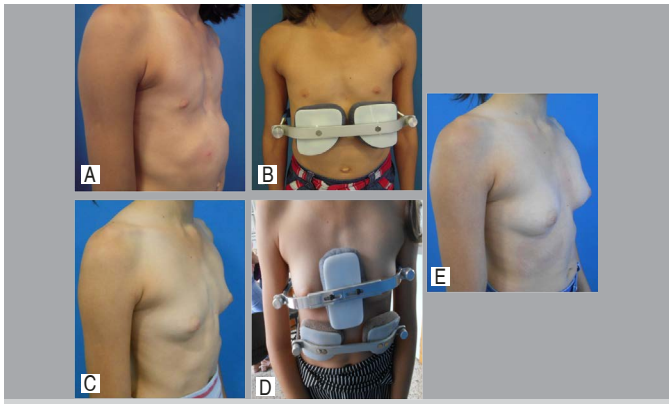

Figure 8. A: 9-year-old female patient with mild localized pectus excavatum and good adherence to the DCC 2 device and exercises; B: first treatment day with the DCC 2 device; C: overcorrection started after 2 years of follow-up and became more evident after 3 years of follow-up, when she demonstrated aesthetic complaints; D: a second DCC 1 device was associated to treat the mild reactive pectus carinatum; E: a good result was observed when she was 14 years old and discharged from using the brace.

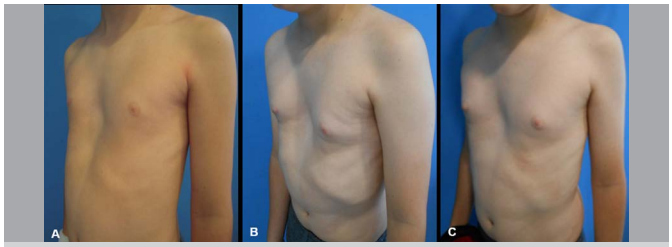

Figure 9. A: 8-year-old male patient with a moderate deformity whose family refused the indicated treatment; B: two years later, the deformity had worsened, and treatment was initiated; C: after nine months, there was an improvement with regular treatment.

DISCUSSION

Our method of treating localized PE using a brace and exercises was effective for the correction or partial correction of the deformity in motivated patients. It had no recurrence after finishing treatment in patients who continued treatment until skeletal maturity. Moreover, it was a low-risk treatment and that offers the possibility of discontinuance in the event of intolerance.

In terms of treatment, surgical correction of the pectus is quite effective.[10] However, with surgery, complications may be devastating and may occur even when patients are in the hands of experienced surgeons.[13] Other less invasive options include procedures that fill the cavity with substances, such as silicone.[14]

There are reports on the use of a device called a vacuum bell (Eckart Klobe, Germany) that applies negative pressure to the depressed area of the PE, resulting in complete improvement in 15 to 31% of patients.[15,16] The method does not reposition the ribs efficiently or correct asymmetrical pectus. When vacuum bell was combined with a braces, additional corrective improvements were observed.[4,17]

The non-invasive alternative treatment for pectus using an orthotic device and thoracic muscle exercises was initially developed by Haje and Raymundo[3] to treat pectus carinatum, and, later, a new device to treat PE was created.[5] In carinatum patients, the principle of correction is quite intuitive, as it applies pressure to the deformity apex. However, in excavatum patients, the action on the sternum and the chondrosternal joints results from the pressure applied to the anterior costal arches at a distance. Furthermore, we believe that this pressure results in a mechanical effect that acts from the mediastinum to the surface, promoting regional thoracic expansion, changing the forces that act on several growth plates, which contributes to reshaping (Wolff's law). These ideas are supported by Wong and Carter, who reported that mechanical forces on the sternum can influence skeletal morphogenesis.[18] Another mechanism that may play a role is the diaphragm, whereby the lowering of the last ribs starts to affect the chest expansion mechanism more efficiently. The secondary actions of the brace may contribute to improved posture. The performance of specific and repetitive exercises, with the patient maintaining inspiration at its maximum volume during muscle contraction, works actively to correct the depressed area. Data from the literature[5,10] show that pectus deformity is progressive. The patients in this study who initially refused treatment and subsequently returned reinforce this idea. Nuss et al.[10] do not recommend surgery in very young patients due to the risk of relapse. In our experience, the conservative method can be used at very early ages, but it should be maintained until skeletal maturity to avoid relapses.

Previous studies reporting results on brace treatment for pectus excavatum or pectus carinatum had short follow-ups, and we believe that Moon et al.[19] overstated when they claimed that their study reported long-term results, as their follow-up period lasted only 13 months. The need for a long treatment period may lead to treatment discontinuation and can ultimately be regarded as a shortcoming of the non-surgical methods of PE treatment.

One limitation of this study is that subjective criteria were used to evaluate the initial flexibility and severity. This is common in publications because imaging methods mentioned in the literature pose limitations. There is no previous description of an objective flexibility measurement for pectus excavatum. Using a CT before and after treatment implies radiation concerns, it does not alter the pectus treatment methodology when using braces and exercises, and there is no correlation between CT indexes and clinical aspect. More recently, an imaging evaluation technique using a structured-light 3D scanner has been introduced to perform more accurate evaluations;[20] this technique was not available when our patients were treated, and nowadays it is still expensive for our center. Also, we believe that it is enough to compare results using photos taken in the same position before and after treatment.

Our results clearly show an association between brace -use and physical exercise and positive results. This information is important to consider when advising families. Treatment regularity was quite important, since most patients who completed the protocol showed good results. Furthermore, when flexibility was analyzed together with regular treatment, our results improved. Haje et al.[4] described flexibility as a key prognostic factor in the treatment of pectus deformities using braces and specific exercises.

The most frequent complication in this study was skin irritation. Wearing a t-shirt under the brace and adequate body hygiene,[4,5] device pressure, size of the anterior and posterior padded plates, and brace width are crucial to minimize discomfort and skin problems. The overcorrection reported in our study, and in previous studies,[4,6] certifies the effectiveness of the treatment method for correction of the chest depressed area.

One expected result was that more severe deformities were related to worse results, which corroborates the idea that early treatment is crucial when using braces and specific exercises.

CONCLUSION

The non-invasive method for correcting PE resulted in positive outcomes in the patients that were adherent to the treatment protocol and continued the treatment until skeletal maturity, especially in flexible and mild deformities.

AUTHORS' CONTRIBUTIONS: Each author contributed individually and significantly to the development of this article. DPH: conceived and planned the activities that led to the study, participated in the review process, performed the treatment together with Sydney Haje from 1999 to July 22nd, 2011, and by himself since this last date, interpreted the results of the study and approved the final version; SAH (*in memorian*): performed the treatment from 1988 to July 22nd, 2011 (3 days before he passed away); JBV: manuscript preparation, participated in the review process and approved the final version; ACOS: data collection and approved the final version; LFBL: data collection and approved the final version; WH data collection and approved the final version.

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CLINICAL RESULT OF PATIENTS WITH DISTAL BICEPS TENDON RUPTURE WITH ENDOBUTTON

RESULTADO CLÍNICO DE PACIENTES COM RUPTURA DO TENDÃO DISTAL DO BICEPS COM ENDOBUTTON

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ABSTRACT

Objective: To evaluate the results obtained in the repair of distal biceps injury using the single-incision approach with endobutton use; complications; and ability to return to sport. Methods: 14 athletes with rupture of the distal tendon of the biceps brachii submitted to surgical repair using a single route with endobutton were evaluated. The parameters analyzed were: Mayo Elbow Performance Score (MEPS), flexion-extension range of motion and pronation-supination, and the ability to return to sports practice. Results: Most injuries were related to weightlifting (57.1%), vaquejada (35.7%) and judo (7.2%). All operated patients returned to sports activities, maintaining the elbow range of motion. Two cases faced complications due to neuropraxia (one case affecting the posterior interosseous nerve and the other the radial sensitive nerve). However, there was spontaneous resolution in 10 weeks of follow-up. One case – due to the late presentation and presence of fibrotic adhesions – evolved with a deficit of the lateral cutaneous nerve of the forearm and later with osteolysis and heterotopic ossification. Conclusion: Repair of the distal tendon of the biceps by the one-way technique is a safe method, with a low complication rate and a short rehabilitation period. ***Level of Evidence III, Retrospective comparative study.***

Keywords: Athletes. Elbow. Sports. Rupture.

RESUMO

Objetivo: Avaliar os resultados obtidos nos reparos da lesão de bíceps distal pela técnica de via única com uso de endobutton; bem como avaliar as complicações e a capacidade de retorno ao esporte. Métodos: Avaliou-se catorze atletas com ruptura do tendão distal do bíceps braquial submetidos à técnica de reparo cirúrgico por via única com uso de endobutton. Os parâmetros analisados foram: escore MEPS (Mayo Elbow Performance Score), arco de movimento de flexão-extensão e pronação-supinação. Além da capacidade de retorno ao esporte. Resultados: A maioria das lesões foi relacionada à musculação (57,1%); em seguida vaquejada (35,7%) e judô (7,2%). Todos os pacientes operados retornaram às atividades esportivas, mantendo o arco de movimento do cotovelo. Em dois casos houve complicações devido à neuropraxia (um caso acometendo o nervo interósseo posterior e outro o nervo sensitivo radial). Entretanto, houve resolução espontânea em dez semanas de acompanhamento. Um caso, por conta da apresentação tardia e presença de aderências fibróticas, evoluiu com déficit do nervo cutâneo lateral do antebraço e posteriormente com osteólise e ossificação heterotópica, tendo que ser reabordado cirurgicamente. Conclusão: Reparo do tendão distal do bíceps pela técnica de via única é um método seguro, com baixa taxa de complicação e curto período de reabilitação. ***Nível de Evidência III, Estudo retrospectivo comparativo.***

Descritores: *Atletas. Cotovelo. Esportes. Ruptura.*

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INTRODUCTION

Distal biceps tendon injuries are uncommon, corresponding to only 3% of biceps injuries, whereas the involvement of the proximal portion of long head occurs in approximately 96% of the cases.[1] Tendon injuries in athletes are often related to the erroneous application of technical movements, uninterrupted training and high training loads, causing the inflammation and weakening of these structures.[2]

Rupture of the distal biceps tendon occurs during weightlifting, with the elbow flexed at 90° or in the unexpected eccentric contraction phase; the primary observed symptoms in these cases are pain, edema, ecchymosis, and deformity, with a palpable defect in the antecubital region.[3] Two independent risk factors were identified and related to the increase in distal biceps injury: smoking and use of steroids, both factors are believed to weaken the tendon, especially at the tendon-bone interface.[4,5]

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

The study was conducted at Instituto Doutor José Frota.
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Treatment depends on the patient's demand, age, and the aesthetic repercussions that the injury may represent to the individual, which can be repaired surgically or not. The option for non-surgical treatment can lead to a decrease in the supination strength of the forearm of up to 40%, which, with sustained contraction in this position, can reach up to 79% loss of resistance.[6] This functional limitation may cause some degree of fatigue or restriction to certain repetitive activities, thus reinforcing the importance of repairing these injuries, especially in athletes due to their high functional demand. Several repair techniques be used for the surgical treatment of these injuries, such as the fixation of anchors, interference screws, transosseous points, and using the endobutton. Depending on the surgeon's experience and the fixation method used, the approach can be a single anterior or double incision, both described in the literature as ensuring satisfactory results.[7-9]

The endobutton technique is one of the most biomechanically stable fixation methods available, with low complication rates and good functional results.[10]

This study demonstrates the clinical outcomes of the treatment of distal biceps brachii tendon injury in athletes treated surgically with the endobutton using the single-incision anterior approach, according to the technique described by Bain et al.[7]

MATERIALS AND METHODS

This was a retrospective study of a case series conducted with the analysis of medical records of athletes with distal biceps brachii tendon injuries caused by sports activities undergoing single-incision technical repair using the endobutton.

Patients with a clinical history compatible with distal biceps brachii tendon injury, positive hook test, or inverted Popeye sign, that underwent surgery using the single-incision anterior approach with endobutton use, and that were followed postoperatively for 24 weeks were included in the study. The exclusion criteria were: cases of injury unrelated to sports activities, patients who underwent surgery using a technique other than the single-incision anterior approach with endobutton, cases that did not complete the minimum postoperative follow-up period established in this study (24 weeks), and patients who did not accept to participate in the survey.

This study analyzed the medical records of 24 male patients, ranging from November 2013 to April 2017, with complete rupture of the distal biceps brachii tendon, who were operated by two surgeons with experience in Shoulder and Elbow Surgery at a tertiary hospital specialized in trauma.

The following clinical parameters were evaluated in this study: patient identification by numerical designation, age, activity that caused the trauma, functional results of the dynamic range of motion (DROM) of flexion-extension and active and passive pronosupination, clinical complications (vascular or neurological injury), radiographic complications (loss of fixation), and the Mayo Elbow Performance Score (MEPS)[11] (Table 1).

The rehabilitation protocol employed included physical therapy in the immediate postoperative period with free passive flexion, passive extension limited to 30°, and free pronosupination until the third week. Between three and six weeks, free extension was added to the previous exercises, while free pronosupination was maintained. After six weeks, active flexion-extension with progressive loads was authorized.

This study was previously authorized by the Research Ethics Committee of the hospital where the study was carried out, under Protocol Number 74419417.2.0000.5047.

Surgical technique

Under anesthetic sedation and regional brachial plexus block, the patient was placed in horizontal supine position with the affected elbow on an armrest.

Access was carried out through a single 2-centimeter (cm) transverse incision, slightly distal to the region of the cubital fold, according to Henry's approach for the proximal third of the forearm, followed by subcutaneous dissection, identification, and protection of the lateral cutaneous nerve. Next, the distal tendon of the ruptured biceps brachii was identified and repaired using Krakow stitches 1.0 cm distally from the tendon, and another 3.0 cm with Bunnel stitches, using non-absorbable co-braided polyethylene threads (Force Fiber®, San Jose, California, USA), with later regularization and cruentation of the proximal stump and fixation to the endobutton (Implanet®, Bordeaux, France) – Figure 1A. Similar to Henry's approach, deep dissection was performed, identifying the radial bicipital tubercle. With the forearm in total supination, we perpendicularly drilled at the most anatomical point of the tendon around the radius tuberosity in its anterior cortex (cis) with a 7.0 millimeter (mm)-thick drill to fit the tendon. A new perforation with a 4.5 mm drill was conducted in order to perforate the posterior cortex (trans) for the passage of the endobutton. Two threads were inserted through the holes at the endobutton ends. With the aid of a threaded Steinmann pin, the two wires were passed through the orifice of the bicipital tubercle, extending beyond the skin on the posterior facet of the forearm (Figure 1B).

The elbow was flexed at approximately 90° when one of the wires was pulled, allowing the endobutton to pass through the bone perforation. When the endobutton passed the trans cortex, the other wire was pulled to secure it. At this moment, a radiological control was carried out to check the positioning of the material. After checking, surgical plane occlusal, bandaging, and temporary immobilization of the flexed elbow were conducted for initial postoperative comfort (Figures 1C and 1D).

Table 1. Functional results of the operated patients.

PATIENT	AGE (years)	TRAUMA ACTIVITY	FUNCTIONAL RESULTS AT 24 WEEKS		MEPS
			FLEXION-EXTENSION	PRONOSUPINATION	
# 1	31	*Vaquejada*	140/0	80/80°	100
# 2	21	Weightlifting	140/0°	80/80°	100
# 3	28	Judo	140/0°	80/80°	100
# 4	31	Weightlifting	140/0°	80/70°	100
# 5	61	Weightlifting	140/0°	80/80°	100
# 6	39	Weightlifting	140/0°	80/80°	100
# 7	26	Weightlifting	140/0°	80/80°	100
# 8	38	*Vaquejada*	140/0°	80/80°	100
# 9	61	Weightlifting	140/0°	60/60°	100
# 10	34	*Vaquejada*	140/0°	80/80°	100
# 11	29	Weightlifting	140/0°	75°/85°	100
# 12	49	*Vaquejada*	140/0°	75/85°	100
# 13	23	*Vaquejada*	140/0°	75°/85°	100
# 14	38	Weightlifting	140/0°	75°/85°	100

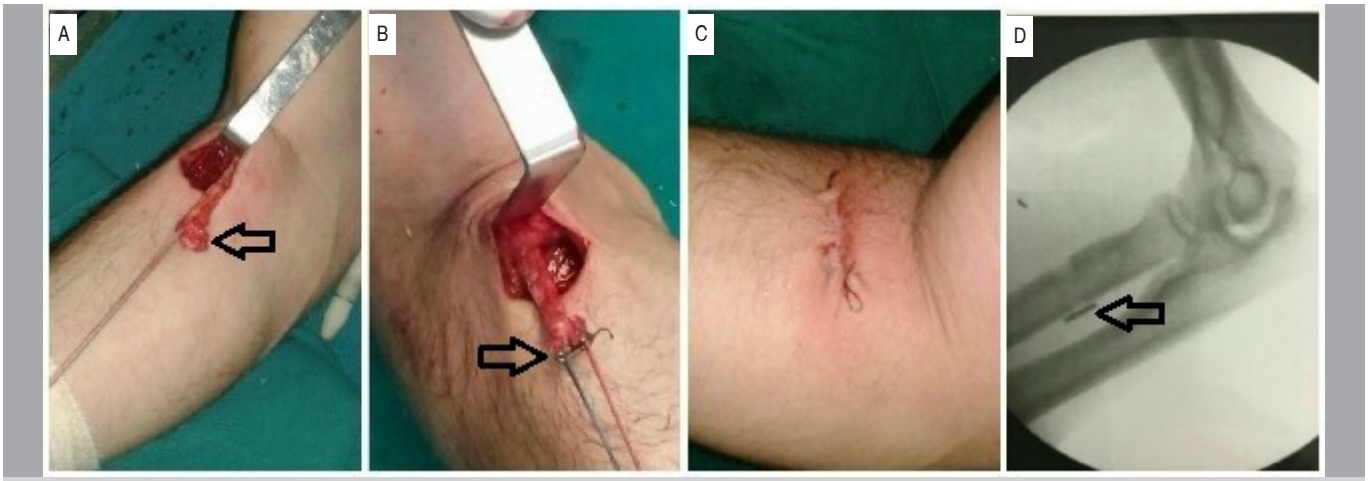

Figure 1. Intraoperative sequencing of reconstruction of the distal tendon of biceps branchii with the one-way technique using endobutton. Repair of the ruptured distal biceps tendon. A: anterior incision and preparation of the tendon; B: fixation of the endobutton; C: visual aspect at the end of the surgery; D: demonstration of the endobutton positioning.

RESULTS

The medical records of 24 patients were evaluated in this study. Ten patients were excluded from the sample because they did not meet the inclusion criteria, resulting in 14 elbows of the individuals who took part in the survey. The epidemiological profile of the participants in this assessment consisted of male patients (100%), with 35.6 years as the mean age (range 21-61 years), who sustained rupture of the distal biceps brachii tendon of the dominant limb in 100% of the cases. In the analysis, we observed that most participants (57.1%) sustained injury during weightlifting, 35.7% during the practice of *vaquejadas* (a typical sport in the Northeastern Brazil), and only one case (patient identified as number 3) was injured while practicing judo.

Regarding the follow-up of the monitored patients, the absence of pain was reported between 3 and 10 weeks, and full-load activities were authorized on average at 24 weeks. The 14 patients that underwent surgery achieved a functional range of motion, returning to their sports activities at the end of treatment, and the MEPS score was excellent in all cases. A complication rate of 21.4% (3 cases out of 14) was observed, two of which were neurological injuries (patient 11 exhibited an injury to the posterior interosseous nerve and patient 14, an injury to the lateral antebrachial cutaneous nerve with osteolysis of the endobutton passage tunnel and formation of heterotopic ossification in the tendon repair zone – Figure 2) and one (patient 4) that evolved with biceps muscle rupture.

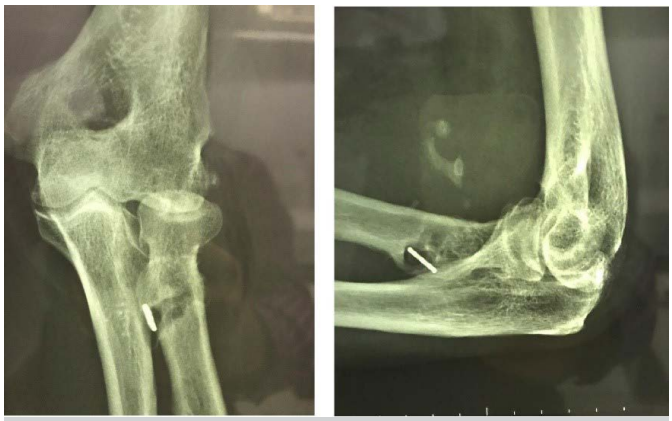

Figure 2. Osteolysis of the endobutton tunnel, with formation of heterotopic ossification in the tendon repair zone.

DISCUSSION

Distal biceps tendon ruptures are uncommon and have an incidence rate of 1.2 cases per 100,000 people per year. These injuries mostly affect men aged 30-50 years.[5] In this study, corroborating these data, the mean age of the analyzed patients, all of which were male, was 36.3 years (range 21-61 years). Ford et al.[12] evaluated 970 cases of distal biceps tendon repair and obtained an average age of 49 years. Similarly, the most patients analyzed were male (97.6%).

Regarding dominance, in 100% of the cases, the rupture of the distal biceps tendon occurred in the dominant limb. Such finding corroborates data in the literature that show the involvement of the dominant limb in most cases (81.8%).[8] Perhaps, the fact that we evaluated only athletes in this study – whose injuries occurred during sports activities – explains why the injury affected the dominant limb in all cases.

Considering the return to sports, all patients went back to their activities at the same level as before the injury within the follow-up period, an average of 24 weeks. Maciel et al.,[8] reported a similar result regarding the return to activities after three months, a shorter period than in our study, using a single-incision anterior approach and anchor fixation, with a complication rate of 27.2%. The complication rate observed herein was 21.4%, corroborating data from the literature that show a similar percentage (26.4%).[13]

According to Bain et al.,[7] pronosupination is the leading movement that can change after the surgical treatment of these injuries. The patients reached an average of 80/81° with endobutton use, using the single-incision anterior approach. In our case series, 80% of the patients obtained normal DROMs, similar to the preoperative state. The remaining 20%, despite not achieving normal DROMs (> 80/80°), obtained functional results with more than 100° of DROM. Garcia et al.[14] reported an average loss of pronation of 14.4° when using the double-incision technique with transosseous suture, it was necessary to reoperate a patient for presenting a loss above 90°, thus rendering the DROM non-functional. Meanwhile, Prabhu et al.,[13] obtained a result similar to that found in our study, with pronation and supination of 75° and 80°, respectively, in patients operated using the single-incision anterior approach and associated fixation of the bicortical endobutton with an interference screw.

Surgical reoperation was required in one patient due to the need for procedure review (7% of the operated cases), more than a year after the initial surgery.

In the study by Matzon et al.,[15] the authors found that 2.4% of the operated cases presented complications that required new surgery

due to tendon rupture or deep infection. Meanwhile, Samuel E. Ford et al.[12] observed a reoperation rate of 4.5%. Notably, both studies evaluated a much larger number of cases (212 and 970 cases, respectively), providing more statistical significance to these indexes. Specifically, considering the complications found in this study, patient number 11 sustained an injury to the posterior interosseous nerve; he exhibited significant muscle mass, leading us to believe that the injury was caused by excessive traction to promote adequate surgical exposure. Burchette et al.[16] reported that maintaining sufficient and safe exposure during the repair of the distal biceps using the single-incision technique is challenging, especially in muscular individuals, as was the case of this patient. The consequent loss of the visual field can compromise the safety and efficiency of the technique, which may result in such complications. Maciel et al.[8] also showed a case with posterior interosseous nerve injury, which, as in our patient, recovered spontaneously after approximately 10 weeks of follow-up.

Regarding the case of patient number 14, who practices weightlifting, since he presented his injury 34 days later, it led to technical difficulties in the procedure due, primarily, to fibrotic adhesions. The patient evolved with a deficit of the lateral cutaneous nerve of the forearm, osteolysis of the endobutton tunnel, and formation of heterotopic ossification in the tendon repair zone. Initially, he had no symptoms of pain and returned to sports normally within four months after surgery. After approximately one year, the patient began to experience pain in movements with intense load, requiring a new surgical approach (Figure 2).

Patient number 4, during an inadvertent eccentric contraction movement on the third postoperative day, underwent muscle fraying above the tendon suture zone, in the region of the tendon muscle, without compromising tendon fixation to the bone, later confirmed by ultrasound; this event was related to the patient's non-adherence to postoperative care through immobilization (sling). In this case, management was conservative with medication, guidance, monitoring, and adequate immobilization. There was no functional impairment, but esthetic deformity occurred.

The limitations encountered in this study include the limited number of analyzed cases (14 patients), the absence of a comparative group to better validate the reported data, and the limited postoperative follow-up period (24 weeks), as well as the lack of dynamometric strength tests for evaluation and comparison between the pre and postoperative levels of the patients in this study. The patient follow-ups will be maintained, and new surveys will be conducted with strength tests, as well as evaluations and comparisons with results obtained from other surgical techniques.

CONCLUSION

The repair of acute distal biceps injury in athletes using the single-incision anterior approach with endobutton fixation proved to be an adequate therapeutic option, with an index of complications within that reported in the researched literature for other techniques and rendered excellent clinical results.

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TOMOGRAPHIC ANALYSIS OF C7, T1 AND T2 VERTEBRAE ANATOMY IN CHILDREN

ESTUDO TOMOGRÁFICO DAS VÉRTEBRAS C7, T1 E T2 EM CRIANÇAS

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ABSTRACT

Objective: To evaluate and compare anatomical measurements of C7, T1 and T2 vertebrae in children from 3 to 12 years of age to provide useful epidemiological data for determining the safe anatomical margin for transpedicular and translaminar fixation with screws in this population. Methods: This observational retrospective cross-sectional study evaluated 76 computed tomography scans obtained over 6 months, analyzing the following parameters: the angle of attack, length, thickness and diameter of the pedicle; and the angle of attack, length and thickness of the lamina. Results: The lamina length and thickness, as well as pedicle length varied in size according to age. Although the angle of attack was similar across different ages, age-dependent variation occurred in the T1 vertebra. Conclusion: Screws with a 3.5 mm diameter are safe to use in the C7 and T2 pedicles, while the T1 pedicle allows the introduction of larger screws ranging from 3.5-4.5 mm in diameter. In the lamina, 3.5 mm screws are safe for use only in children older than 7 years. However, each case should be analyzed individually, with the present study not aiming to replace the preoperative use of CT. **Level of Evidence III, Retrospective comparative study.**

Keywords: Tomography, X-Ray Computed. Cervical Vertebrae. Retrospective Studies.

RESUMO

Objetivo: Avaliar e comparar as medidas anatômicas das vértebras C7, T1 e T2 em crianças de 3 a 12 anos de modo a determinar margens seguras para fixação transpedicular e translaminar com parafusos nessa população. Métodos: Estudo transversal retrospectivo observacional. Um total de 76 tomografias computadorizadas foram analisadas em um período de 6 meses. Os seguintes parâmetros foram analisados: ângulo de ataque, comprimento, espessura e diâmetro do pedículo, comprimento e espessura da lâmina. Resultados: O comprimento e espessura da lâmina bem como o comprimento do pedículo aumenta em tamanho conforme a idade. Enquanto o ângulo de ataque permanece estável conforme variação de idade; variação dependente da idade ocorre somente na vértebra T1. Conclusão: Parafusos com diâmetro de 3.5mm podem ser inseridos de maneira segura nos pedículos de C7 e T2. Já no pedículo de T1 pode-se inserir parafusos com medidas de 3.5 a 4.5mm de diâmetro de maneira segura. Na lâmina, parafusos de 3.5mm podem ser usados de maneira segura somente em crianças maiores de 7 anos. No entanto, cada caso deve ser analisado de maneira individualizada, e o presente estudo não objetivo substituir o uso de tomografia computadorizada no pré-operatório. ***Nível de Evidência III, Estudo Comparativo Retrospectivo.***

Descritores: *Tomografia Computadorizada por Raios X. Vértebras Cervicais. Estudos Retrospectivos.*

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INTRODUCTION

Having anatomical structures of unique importance, the cervicothoracic region presents a shift from the more mobile vertebral segments of the cervical spine to the more rigid segments or the thoracic spine; thus, during surgical treatments performed in this region, it is important to use implants that provide adequate mechanical support, rigidity, stability, and secure fixation. As spinal disorders often occur in this region, including fractures, tumors and deformities, having a detailed knowledge of vertebral morphology becomes essential for any surgical approach using pedicular or translaminar screws at the C7, T1 or T2 level.

As reported by previous studies,[1-3] even within a population comprising individuals with similar ages but different ethnicities, the anatomical dimensions of the vertebral body, spinal canal and transverse diameter of the pedicle can vary. For this reason, tomographic analysis is of great assistance during preoperative planning, helping minimize surgical complications, such as incorrectly positioned implants, violation of the vertebral cortex or neurovascularlesions.[4]

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

The study was conducted at Faculty of Medicine, Hospital das Clínicas, Institute of Orthopedics and Traumatology.
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Since surgical transpedicular fixation in pediatric patients, in whom structures have smaller sizes, entails technical difficulties,[5] it is necessary and useful to evaluate the angle of attack, length and thickness of cervicothoracic junction vertebrae structures. Also relevant is to correlate anatomic measurements with commercially available pedicular and translaminar implants and their screws due to the high prevalence of use, the association with fixation rigidity and the higher rates of arthrodesis consolidation[5-7] of the screws themselves.

Based on the above, the present study used computed tomography (CT) to evaluate the pedicle and lamina anatomy of the C7, T1 and T2 vertebrae in children from 3 to 12 years of age. The aim was to provide a published record of epidemiological data obtained in this pediatric population, which can be useful for determining the safety margins of transpedicular and translaminar fixation in cases that may require implants.

MATERIALS AND METHODS

The study evaluated 76 computed tomography (CT) scans, routinely performed for polytrauma cases during the 6-month period from July 2018 to December 2018, following the institutional protocol. To increase data veracity,[8] two researchers conducted the analysis of this continuously selected sample simultaneously. Morphometric analysis was performed using the iSite PACS Philips Healthcare Informatics® program.

The selected cases were separated in two groups according to the patients' age, with cutoff age based on the fusion period of the primary ossification centers of C7, T1 and T2 vertebrae, complete at 8 years old.[9] *Group 1* included patients from 3 to 7 years of age, and *Group 2* patients from 8 to 12 years of age. Each group was then subdivided into 2 subgroups according to gender: Female and Male. Ethnicity and race were not investigated due to extensive miscegenation in the studied population.

Exclusion criteria included patients with cervical or thoracic vertebrae fracture, a diagnosis of cervical or thoracic spinal deformity or malformation, poor quality imaging tests, infections, tumors, or previous surgery in the cervical or thoracic spine.

Pedicle measurements were obtained as follows:[10]

1) Angle of attack: measured on axial CT as the angle between a line parallel to the spinous process and a line parallel to the long axis of the pedicle (Figure 1).
2) Pedicle diameter: measured on coronal CT as the distance between the medial and lateral cortices of the pedicle in the isthmus (Figure 2).
3) Length: measured on axial CT as the distance between the posterior cortex of the pedicle and the posterior longitudinal ligament along the axis of the pedicle (Figure 3).
4) Thickness: measured on axial CT as the distance between the lateral and medial cortices of the pedicle in the isthmus (Figure 3).

Lamina measurements were obtained as follows:[11]

1) Angle of attack: measured on axial CT between a line parallel to the laminar cortex and a line parallel to the longitudinal axis of the spinous process (Figure 4).
2) Length: measured on axial CT as the distance between the posterior and anterior limit of the lamina (Figure 5).
3) Thickness: measured on axial CT as the distance between the medial and lateral cortex of the lamina in a thin slice (Figure 5).

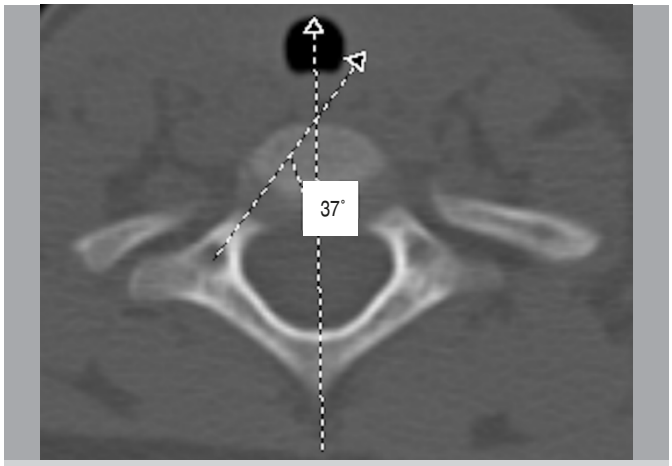

Figure 1. Angle of attack measurement.

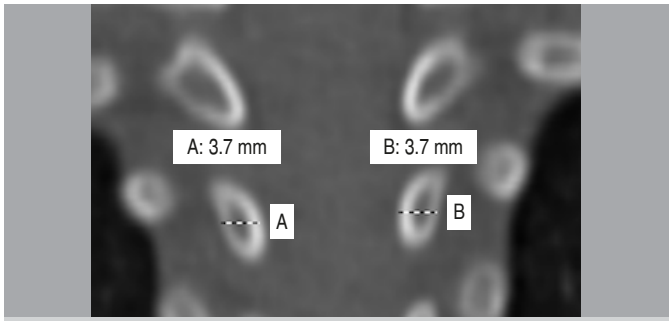

Figure 2. Pedicle diameter measurement.

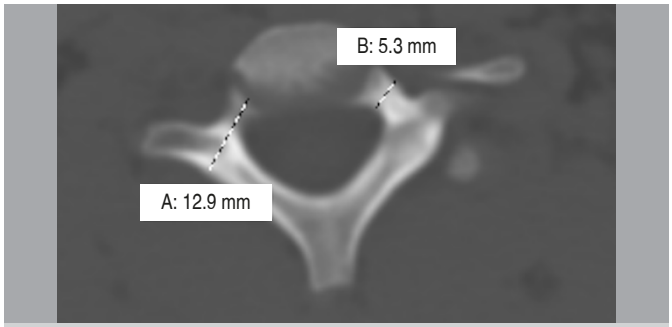

Figure 3. Measurements of a) pedicle length and b) pedicle thickness.

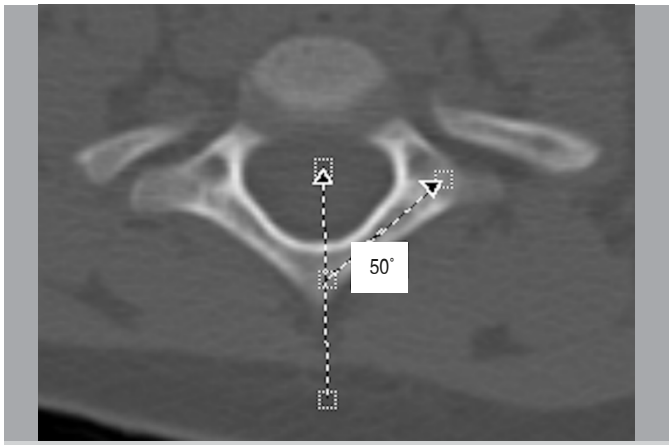

Figure 4. Angle of attack measurement.

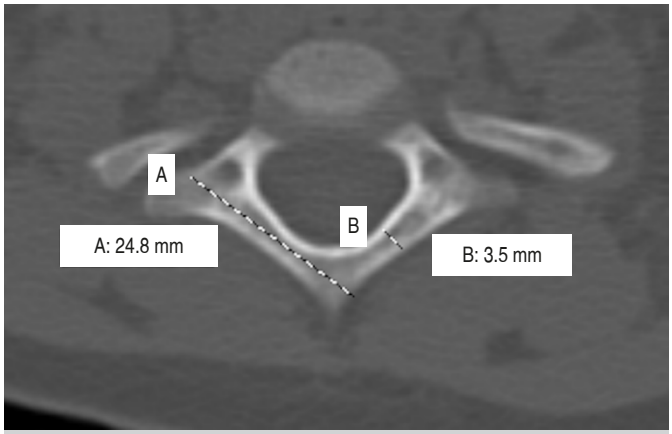

Figure 5. Measures of a) lamina length and b) lamina thickness.

Each vertebra measurement is described by age and gender using means ± standard deviations; estimated ranges are shown with 95% normal distributions.[12] All measures were compared among groups using variance analysis with 2 factors (gender and age) followed by multiple Bonferroni[13] corrections when significant.
The point numbers are described in quadrants and compared among these using generalized estimation equations, with an interchangeable correlation matrix between sides and quadrants, a Poisson marginal distribution and identity bond function[14] followed by multiple Bonferroni[13] comparisons, to determine in which quadrants the differences occurred. All analyses were performed using IBM-SPSS for Windows version 20.0 software; data tabulation used the Microsoft Excel 2003 software. The tests adopted a 5% significance level.

RESULTS

After applying the exclusion and inclusion criteria, the study sample comprised 76 patients with cervicothoracic junction CT scans. Group 1 (patients from 3 to 7 years of age) included 46 individuals; Group 2 (patients from 8 to 12 years of age) included 30 individuals. The children's mean age was 7.1 years old (SD = 3.2 years), with most being between 3 and 7 years old (60.5%) and male (68.4%) (Table 1).

Table 1. Characteristics of the children evaluated.

Variable	Description (n = 76)
Age (years), mean ± SD	7.1 ± 3.2
Age group, n (%)	
3 to 7 years	46 (60.5)
8 to 12 years	30 (39.5)
Gender, n (%)	
Female	24 (31.6)
Male	52 (68.4)

C7 vertebra

Lamina length in C7 was statistically higher only in children from 8 to 12 years of age, regardless of gender ($p < 0.05$) (Table 2).

T1 vertebra

The angle of attack and pedicle length were significantly higher in Group 2 than in Group 1, regardless of gender ($p = 0.006$ and $p = 0.008$, respectively). The lamina length was also significantly higher in older children, regardless of gender ($p < 0.001$) (Table 3).

Table 2. Description and comparison of C7 vertebra measurements by age group and gender.

Variable	3 to 7 years of age		8 to 12 years of age		p Age group	p Gender	p Interaction
	Female (n = 15)	Male (n = 31)	Female (n = 9)	Male (n = 21)			
Pedicle							
Angle of attack					0.188	0.072	0.526
mean ± SD	33.4 ± 5.3	35.2 ± 5.5	34.4 ± 6.1	38.2 ± 7			
NR (95%)	(23 - 43.8)	(24.5 - 45.9)	(22.5 - 46.4)	(24.5 - 51.8)			
Length					0.432	0.202	0.226
mean ± SD	13.1 ± 1.5	13.1 ± 1.4	12.4 ± 1.1	13.3 ± 1.3			
NR (95%)	(10.2 - 15.9)	(10.4 - 15.8)	(10.2 - 14.6)	(10.7 - 15.8)			
Thickness					0.222	0.256	0.611
mean ± SD	3.2 ± 0.7	3.4 ± 0.8	3.4 ± 0.5	3.7 ± 1			
NR (95%)	(1.9 - 4.6)	(1.7 - 5)	(2.5 - 4.3)	(1.8 - 5.6)			
Diameter*					0.883	0.458	0.186
mean ± SD	3.3 ± 0.6	3.2 ± 0.8	3 ± 0.6	3.5 ± 1			
NR (95%)	(2.1 - 4.5)	(1.6 - 4.9)	(1.8 - 4.2)	(1.6 - 5.4)			
Lamina							
Angle of attack					0.658	0.690	0.337
mean ± SD	48.4 ± 3	47.8 ± 3.4	47 ± 3.6	48.4 ± 5.2			
NR (95%)	(42.6 - 54.2)	(41.2 - 54.4)	(39.9 - 54.1)	(38.2 - 58.5)			
Length					0.010	0.346	0.981
mean ± SD	28.1 ± 2.4	28.8 ± 2.5	30 ± 3.2	30.7 ± 3.2			
NR (95%)	(23.4 - 32.8)	(23.8 - 33.7)	(23.8 - 36.2)	(24.3 - 37)			
Thickness					0.269	0.910	0.332
mean ± SD	2.2 ± 0.6	2.3 ± 1	2.6 ± 0.6	2.4 ± 0.6			
NR (95%)	(1 - 3.3)	(0.5 - 4.2)	(1.4 - 3.8)	(1.2 - 3.6)			

ANOVA with two factors; NR: normal range; * two cases were not evaluated for this parameter

Table 3. Description and comparison of T1 vertebra measurements by age group and gender.

Variable	3 to 7 years of age		8 to 12 years of age		p Age group	p Gender	p Interaction
	Female (n = 15)	Male (n = 31)	Female (n = 9)	Male (n = 21)			
Pedicle							
Angle of attack					0.006	0.794	0.974
mean ± SD	30.6 ± 5.5	30 ± 7.1	35.8 ± 8.1	35.4 ± 8.6			
NR (95%)	(19.8 - 41.3)	(16.2 - 43.9)	(20 - 51.7)	(18.6 - 52.2)			
Length					0.008	0.531	0.100
mean ± SD	13.7 ± 1.3	14.2 ± 1.6	15.8 ± 1.6	14.7 ± 2.6			
NR (95%)	(11.1 - 16.3)	(11 - 17.4)	(12.6 - 19)	(9.7 - 19.7)			
Thickness					0.290	0.617	0.607
mean ± SD	3.4 ± 0.8	3.7 ± 1	3.8 ± 0.9	3.8 ± 0.8			
NR (95%)	(1.9 - 5)	(1.6 - 5.7)	(2.1 - 5.5)	(2.2 - 5.4)			
Diameter*					0.267	0.448	0.436
mean ± SD	3.7 ± 1	3.7 ± 0.8	4.2 ± 1	3.8 ± 0.9			
NR (95%)	(1.8 - 5.6)	(2.1 - 5.4)	(2.1 - 6.2)	(2 - 5.7)			
Lamina							
Angle of attack					0.909	0.881	0.255
mean ± SD	48 ± 3.3	46.6 ± 4.1	46.9 ± 3.1	47.9 ± 4.9			
NR (95%)	(41.5 - 54.5)	(38.5 - 54.7)	(40.9 - 52.9)	(38.4 - 57.5)			
Length					<0.001	0.948	0.273
mean ± SD	25.8 ± 2.4	26.7 ± 2.9	29.7 ± 3.4	28.9 ± 3.5			
NR (95%)	(21.1 - 30.6)	(21.1 - 32.3)	(23 - 36.3)	(22 - 35.7)			
Thickness					0.064	0.539	0.978
mean ± SD	2.8 ± 0.6	2.9 ± 0.8	3.1 ± 0.7	3.3 ± 0.9			
NR (95%)	(1.6 - 3.9)	(1.3 - 4.5)	(1.8 - 4.5)	(1.6 - 5)			

ANOVA with two factors; NR: normal range; * two cases were not evaluated for this parameter

T2 vertebra

Lamina length and thickness were significantly higher in children from 8 to 12 years of age than in children from 3 to 7 years of age, regardless of gender ($p < 0.001$ and $p = 0.003$, respectively) (Table 4).

T2 mean pedicle length was significantly higher in 8-12 years old female children than in 3-7 years old female children ($p = 0.012$) and 3-7 years old male children ($p = 0.046$) (Table 5).

Table 4. Description and comparison of T2 vertebra measurements by age group and gender.

Variable	3 to 7 years of age		8 to 12 years of age		p Age group	p Gender	p Interaction
	Female (n = 15)	Male (n = 31)	Female (n = 9)	Male (n = 21)			
Pedicle							
Angle of attack					0.054	0.842	0.851
mean ± SD	20.9 ± 4.7	20.9 ± 5.6	23.8 ± 3.9	23.3 ± 5.8			
NR (95%)	(11.8 - 30.1)	(10 - 31.8)	(16.3 - 31.4)	(11.8 - 34.8)			
Length					0.003	0.309	0.028
mean ± SD	13.9 ± 1.6	14.5 ± 1.6	16.3 ± 1.5	14.8 ± 2.1			
NR (95%)	(10.7 - 17.2)	(11.4 - 17.6)	(13.3 - 19.3)	(10.8 - 18.9)			
Thickness					0.321	0.239	0.679
mean ± SD	3 ± 0.7	3.1 ± 0.9	3.1 ± 0.5	3.4 ± 0.8			
NR (95%)	(1.6 - 4.3)	(1.3 - 5)	(2.1 - 4)	(1.8 - 5)			
Diameter*					0.113	0.544	0.825
mean ± SD	3.2 ± 0.8	3.4 ± 0.9	3.7 ± 1.3	3.8 ± 1.2			
NR (95%)	(1.6 - 4.8)	(1.7 - 5.1)	(1.1 - 6.3)	(1.4 - 6.2)			
Lamina							
Angle of attack					0.319	0.648	0.972
mean ± SD	50 ± 3.1	49.5 ± 4.5	48.9 ± 4.2	48.5 ± 4.2			
NR (95%)	(44 - 56.1)	(40.8 - 58.3)	(40.7 - 57.1)	(40.2 - 56.8)			
Length					<0.001	0.571	0.652
mean ± SD	21.9 ± 1.6	22.5 ± 2	24.3 ± 2.2	24.3 ± 2.9			
NR (95%)	(18.8 - 25)	(18.6 - 26.4)	(19.9 - 28.6)	(18.6 - 30.1)			
Thickness					0.003	0.574	0.468
mean ± SD	2.5 ± 0.6	2.8 ± 0.8	3.2 ± 0.8	3.2 ± 0.7			
NR (95%)	(1.3 - 3.7)	(1.2 - 4.4)	(1.7 - 4.8)	(1.7 - 4.7)			

ANOVA with two factors; NR: normal range; * two cases were not evaluated for this parameter

Table 5. Comparison of T2 pedicle length by age group and gender.

Comparison		Mean difference	Standard error	p	CI (95%)	
				Inferior	Superior	
Female from 3 to 7 years	Male from 3 to 7 years	-0.54	0.55	>0.999	-2.02	0.94
Female from 3 to 7 years	Female from 8 to 12 years	-2.34	0.73	0.012	-4.32	-0.35
Female from 3 to 7 years	Male from 8 to 12 years	-0.90	0.59	0.776	-2.49	0.69
Male from 3 to 7 years	Female from 8 to 12 years	-1.80	0.66	0.046	-3.59	-0.02
Male from 3 to 7 years	Male from 8 to 12 years	-0.36	0.49	>0.999	-1.69	0.97
Female from 8 to 12 years	Male from 8 to 12 years	1.44	0.69	0.246	-0.44	3.31

Multiple Bonferroni comparisons.

DISCUSSION

Performing transpedicular and translaminar fixation on the cervicothoracic junction using screws is becoming a more widespread practice. Hence, why having a detailed knowledge of vertebral morphology becomes essential to select the correct surgical approach for using pedicular or laminar screws in any type of disorder at the C7, T1 or T2 level. Discrepancies between the actual thickness of the pedicle or lamina and the diameters of commercially available screws can lead to fractures on the walls of these structures and implant failure,[15] or even compromise the safety of the procedure, causing neurological risk. Our study is pioneering in presenting a combined evaluation of the pedicle and lamina anatomies at the cervicothoracic junction in children. To our knowledge, this is the first simultaneous analysis in the scientific literature that describes the pediatric C7, T1 and T2 pedicles and laminae and their correlations with the use of commercially available screws.

After analyzing the collected data, we observed that the length of T1 and T2 pedicles differed significantly depending on age, similar to results found by a previous study.[8] In our study, the T2 pedicle was longer in female patients. This result is consistent with Kretzer et al.,[16] who showed that pedicle length depended on the patient's gender ($p < 0.001$); but differs from the findings of Chen et al.,[17] who reported that pedicle length was higher in male patients than in female patients. Such discrepancy may be due to differences peculiar to the ethnicity and age of each analyzed population, as Chen et al.'s[17] study focused on adults instead of children.

Regarding the C7 vertebra, our results show an age-dependent difference in lamina length, similar to the findings by Kanna et al.[18] Onibokun et al.,[19] in turn, found no difference in pedicle length according to age.

Compared to the study by Marchese et al.,[11] which found significant differences in the length and width of the T1 lamina according to age, our results show that while the T1 lamina length was significantly higher in older children regardless of gender ($p < 0.001$), there was no such difference in lamina thickness. As for the T2 vertebra, we found significant differences in lamina length and thickness between age groups, similar to the findings of Molina et al.[5]

Our data allow us to affirm that screws with a 3.5 mm diameter can be safely applied in C7 and T2 pedicles, while T1 supports larger pedicle screws ranging from 3.5 to 4.5 mm in diameter. These findings are similar to those of Rekate et al.,[20] who concluded that pedicle fixation could be safely applied in children over 4 years old. Our results also resemble those by Ranade et al.;[21] the authors showed that the pedicles of patients younger than 8 years old can safely receive 3.5-5.5 mm screws. Hassan et al.,[22] however, observed that applying fixation with pedicular screws of diameter greater than 3.0 mm was unsafe in children and adolescents younger than 18 years old. These divergent findings may be due to the smaller stature of Asian patients.[8]

Regarding translaminar fixation, we conclude that it is possible to safely use 3.5 mm screws only in children older than 7 years old, finding similar to that of a previous study.[5] Our results clash, however, with those presented by Kretzer et al.,[23] who found no size-related limitations for introducing translaminar screws. Since the study published by Kretzer et al.[23] included patients aged 41.7 +/- 19.6 years, the age difference between samples could explain this divergence.

Our findings suggest that it is crucial to analyze the vertebral anatomy based on computed tomography during the surgical planning of pathologies that affect a child's spine. But this is a retrospective study of a sample composed mainly of male children under 8 years of age (hence, prior to the complete ossification of the vertebrae); thus, future studies are needed to confirm the data obtained here and to eventually collect additional information on cervicothoracic junction fixation in the pediatric population.

CONCLUSION

Our results allow us to conclude that lamina length and thickness, as well as pedicle length increase with age. We found a significant age-dependent variation in the angle of attack when considering only the T1 pedicle. Based on the morphologies of the studied vertebrae, screws with 3.5 mm diameter are safe to use in the C7 and T2 pedicles, while the T1 pedicle allows for screws up to 4.5 mm in diameter. As for translaminar fixation, the present study conclude that it is only safe to use screws thicker than 3.5 mm in children older than 7 years old. However, we must analyze each case individually, with the present study not aiming to replace the preoperative use of CT.

AUTHORS' CONTRIBUTIONS: Each author contributed individually and significantly to the development of this article. GEDC: literature review and project design, data collection and analysis, manuscript writing; MGF: literature review and project design, data collection and analysis, manuscript writing; MCMTJ: literature review and project design, data collection and analysis, manuscript writing; RMM: final review of the literature and project, data analysis and manuscript review; AFC: final review of the literature and project, data analysis and manuscript review; OBL: study design, data analysis and final review of the manuscript.

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TRANSLATION AND TRANSCULTURAL ADAPTATION OF THE INJURY REPORT FORM FOR RUGBY UNION

TRADUÇÃO E ADAPTAÇÃO TRANSCULTURAL DO INJURY REPORT FORM FOR RUGBY UNION

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ABSTRACT

Objective: To translate into Brazilian Portuguese and conduct the cross-cultural adaptation of the "Injury Report Form for Rugby Union" questionnaire. Methods: This is a cross-sectional study, level of evidence II, with following the steps: translation; synthesis; back-translation; review by a committee of experts and pre-final version; pre-test to verify comprehension; elaboration of the final version of the instrument and clinical application. Results: The two versions resulting from the translation and adaptation process did not show great differences. The pre-final version was filled by 23 male rugby players; three questions were not understood by 40%, 27% and 82.5% of the players, respectively, which required a new meeting with a multidisciplinary committee of experts. The modifications were made, requiring then a new application. The new version was filled by 25 male rugby players, aged 29.44 ± 5.90 years; of which 56% had complete higher education; finalizing the process of cross-cultural adaptation. Conclusion: The questionnaire "Formulário para Notificação/Avaliação de Lesão em Jogadores de Rugby" was translated and transculturally adapted into Brazilian Portuguese. ***Level of Evidence II, Diagnostic Studies – Investigating a Diagnostic Test.***

Keywords: Physical Therapy Specialty. Athletic Injuries. Football. Validation Studies. Surveys and Questionnaires.

RESUMO

Objetivo: Traduzir para o português brasileiro e realizar adaptação transcultural do questionário "Injury Report Form for Rugby Union". Métodos: Estudo transversal, nível de evidência II, etapas seguidas: tradução; síntese; retrotradução; revisão pelo comitê de especialistas e versão pré-final; pré-teste para verificar a compreensão; elaboração da versão final do instrumento e aplicação clínica. Resultados: No processo de tradução e adaptação as duas versões não apresentaram grandes diferenças entre si. A versão pré-final foi preenchida por 23 jogadores de rugby do sexo masculino, três questões não foram compreendidas por 40%, 27% e 82,5% dos jogadores, respectivamente, convocando-se nova reunião com o comitê multidisciplinar de especialistas. As modificações foram realizadas, sendo necessária nova aplicação. A nova versão foi preenchida por 25 jogadores de rugby do sexo masculino, com idade entre 29,44± 5,90 anos; sendo que 56% possuíam nível de escolaridade superior completo; finalizando o processo de adaptação transcultural. Conclusão: O questionário "Formulário para Notificação/Avaliação de Lesão em Jogadores de Rugby" foi traduzido e adaptado transculturalmente para o português brasileiro. ***Nível de Evidência II, Estudos diagnósticos – Investigação de um exame para diagnóstico.***

Descritores: *Fisioterapia. Traumatismos em Atletas. Futebol Americano. Estudo de Validação. Inquéritos e Questionários.*

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INTRODUCTION

Rugby has a high incidence of injuries, especially in amateur teams since players often lack adequate physical preparation for the practice of the sport.[1] Rugby injuries are mostly musculoskeletal, reaching 626 injuries for every 1000 hours of play, 36.5% of these injuries occur on the lower limbs and 24.6% on the upper limbs and trunk.[2] Still, it has been reported that women suffer concussions at a 0.55 per 1000 hours of sport practice rate, whereas men suffer 4.73 concussions for every 1000 hours of play.[3]

The use of instruments translated and cross-culturally adapted into Brazilian Portuguese to assess injuries in rugby players is not found in the literature.[2,4-8] In the international literature, the following methods have been reported as the most used to assess injuries in rugby players: "Injury Report Form for Rugby Union"; "Orchard Sports Injury Classification System", "Standard injury report form (2002-2003 to 2012-2013)" and "an electronic player medical records system (Rugby Squad Medical, The Sports Office; 2013-2014 to 2014-2015)".[9]

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

The study was conducted at Curitiba Rugby Clube.
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Fuller et. al.[10] prepared, from a meeting with several sports specialists, a form, the Injury Report Form for Rugby Union, in English, to standardize the notification of injuries resulting from the practice of rugby. Although some studies analyzed the injuries related to rugby practice, a validated questionnaire was not used.[4-8,11,12] The methodology described in the international consensus of definitions and procedures for the registration of injuries resulting from the practice of rugby, which includes the Injury Report Form for Rugby Union, was applied during the 2007 Rugby World Cup, a championship with the participation of 626 athletes, showing that it is suitable for assessing incidence, severity, nature and causes of injuries both in training and competitions.[13] The form has already been translated and cross-culturally adapted to European Portuguese, by Gomes and Neves,[14] proving its clinical applicability in Portuguese-speaking countries.

In Brazil, some studies were conducted with Brazilian players, but the methods used were semi-structured questionnaires without previous validation,[2,5] making it difficult for other researchers to reproduce them. Although the Injury Report Form for Rugby Union has already been translated and adapted into European Portuguese, we know the cultural differences between countries and the need for its cross-cultural adaptation into Brazilian Portuguese as well. Therefore, our study aims at translating the Injury Report Form for Rugby Union into Brazilian Portuguese and to cross-culturally adapt it for use in Brazilian rugby players.

MATERIALS AND METHODS

This is a cross-sectional observational analytical study of translation and cross-cultural adaptation of the Injury Report Form for Rugby Union questionnaire was carried out. Approval was given by the Research Ethics Committee of the Health Sciences Sector, CAAE: 71333317.5.0000.0102.

Translation and cross-cultural adaptation

To translate the form, authorization was obtained from the author Colin W. Fuller for the translation and validation of the Injury Report Form for Rugby Union.[10]

The translation and cultural adaptation of the questionnaire were carried out according to Guillemin et al.,[15] which presents a set of standardized instructions to be performed in different stages: 1) translation; 2) synthesis; 3) back-translation; 4) expert committee: review and pre-final version; 5) pre-test, that is, the "pre-final" version (version 1) that was applied to 23 players; 6) analysis by the expert committee and the final version (version 2) of the instrument. These steps are described below:

1) Translation: Two Brazilian bilingual translators (Portuguese/English) independently translated the questionnaire into Brazilian Portuguese, one of whom was a professional translator in the health field, with prior knowledge of the objectives of the study, and the other an English-language teacher, to allow the identification of possible ambiguities. From this stage, we achieved two initial translations into Brazilian Portuguese.
2) Summary: The two translations were compared and analyzed in a meeting with the translators and researchers involved in the study. The meeting resulted in a combined version of the questionnaire in Portuguese from the two initial translations, comparing them to each other, reducing differences, preserving the cultural context of the Brazilian population and the original concepts of the instrument.
3) Back translation: Two other independent and qualified bilingual English teachers (original language of the Injury Report Form for Rugby Union) did the retro translation, that is, from the Brazilian Portuguese version they translated into English and found differences to the original material. The translators at this stage did not receive any information about the study or questionnaire they were working on. The translators were unaware of the original version of the Injury Report Form for Rugby Union and had no information about the form concepts.
4) Committee of experts: The minimum composition of the Committee included methodologists, health professionals, and language professionals. The two new versions were subjected to a committee of experts, composed of the four bilingual translators who participated previously, together with three health professionals (a physical educator, a physiotherapist and a doctor), four professors and three students of the Physiotherapy undergraduate course from the Federal University of Paraná. The experts assessed the semantics, idioms, cultural and conceptual equivalences and subsequently identified and discussed the discrepancies. After consensus, they established a new Portuguese version of the Injury Report Form for Rugby Union (Injury Report Form for Rugby Union – Brasil versão 1).

Participants were invited to participate in the study through convenience, that is, those who were present on the day and time that the project team went to the rugby club. Interested volunteers were informed about the objectives and those who had time available and expressed interest in participating read and signed two copies of the informed consent form.

The participants filled the form at R. Pastor Manoel Virgínio de Souza, 1020 – Capão da Imbuia, Curitiba – PR, 82810-400, headquarters of Curitiba Rugby, before or after the matches, with the prior authorization of the coaches and the club board and supervised by the club's physiotherapist.

Players were asked to fill the form considering their last injury, except for question 7 (Referring to the diagnosis of the injury and its IDC), which would be completed later by a health professional. The pre-final version (version 1) was self-administered by 23 players and the final version (version 2) by 25 players. No player that was present refused to answer the questionnaire and no questionnaire was excluded due to lack of data. The data on age, education and anthropometric values were filled in by the players before the completion the questionnaire. These data are presented in Tables 1 and 2.

5) Pre-test: in this step the Formulário para Notificação/Avaliação de Lesão em Jogadores de Rugby (version 1) was filled out by players from Curitiba Rugby. At the time of completion, the study team was present to clarify any doubts. The questions or items not understood by 20% or more of the interviewees were analyzed by the committee.
6) Analysis by the expert committee to discuss the results of the pre-test: Each player responded to the Formulário para Notificação/Avaliação de Lesão em Jogadores de Rugby (pre-final version – version 1). The questions about time in which the injury occurred and playing position at the time of the injury were not understood by 27% and 82.5% of the players, respectively. The committee of experts reviewed these questions in the Formulário para Notificação/Avaliação de Lesão em Jogadores de Rugby by editing it into version 2, in which alternatives were added in the question "*Localização no campo no momento da lesão:*" to help the players' understanding, in addition to adding the questions: "*Você entendeu o que foi perguntado?*" ("Did you understand what was asked?"), "*Se não, o que entendeu?*" ("If not, what did you understand?") and "*Sugere alguma mudança?*" ("Do you suggest any change?") to assess the understanding of each question. The consolidation of the pre-final version considered the translations; back-translations; meetings of the committee of experts, translators and back-translators; the reports of the team that was in contact with the players who answered the questionnaire; and the percentages of players' understanding the questions. These aspects were considered for the changes, being resolved with version 2 of the Formulário para Notificação/Avaliação de Lesão em Jogadores de Rugby (Appendix).

Sample size

The determination of the sample size followed the methodological indication proposed by Terwee et al.,[16] who recommend the inclusion of four to ten participants for each question of the instrument to be translated. Since the Injury Report Form for Rugby Union consists of 12 questions, the minimum number of participants recommended would be 48.

Statistical analysis

The software Microsoft Excel, version 2010, was used for statistical analysis. The results are described in absolute frequency

and percentage, and the numerical variables were described as mean and standard deviation.

RESULTS

Translation and cross-cultural adaptation

In the process of translation into Brazilian Portuguese, the two versions (translator 1 and translator 2) did not differ significantly (Chart 1). There was consensus among the committee to choose different words, without changing the meaning of the sentence. The same happened with the back translation (back translation 1 and back translation 2 – Chart 2). The Formulário para Notificação/ Avaliação de Lesão em Jogadores de Rugby (pre-final version 1) was self-administered by 23 male rugby players aged 25.9 ± 5.53 years, BMI 26.29 ± 4.64 kg/m^2 and 57.1% declared education level as complete higher education and 42.8% as incomplete higher education. Some modifications were made in the pre-final version (version 1), as it was found that the questions about: game position; time of injury and location on the field at the time of the injury were not understood by 27% and 82.5% of the players who completed version 1 (Table 1), respectively. The questions were changed, with the consent of the multidisciplinary committee of specialists, and version 2 was created (Chart 3). Therefore, a new application was needed, which was self-administered by 25 male rugby players, aged 29.44 ± 5.9 years; BMI 29.46 ± 4.32 Kg/m^2; 56% with complete higher education, 32% with incomplete higher education, 8% with complete high school education and 4% with incomplete high school education, completing the cross-cultural adaptation process (Table 2).

Chart 1. Modifications made at the translation consensus meeting.

Initial questions in English	Translation into Brazilian Portuguese	Final version in Brazilian Portuguese (after the consensus meeting)
1A Date of injury	T1: Data da lesão T2: Data da lesão	Data da lesão
1B Time of injury (during match)	T1: Horário da lesão (durante partida) T2: Momento da lesão (durante a partida)	Horário da lesão (Tempo de jogo):
2 Date of return to full participation	T1: Data de retorno à participação plena T2: Data de retorno para participação efetiva	Data de retorno à participação plena
3 Playing position at the time of injury	T1: Posição do jogo no momento da lesão T2: Posição no jogo no momento da lesão	Posição no jogo no momento da lesão
4 Injured body part: Head/face; neck/cervical spine; sternum/ribs/upper back; abdomen; low back; sacrum/pelvis; shoulder/clavicle; upper arm; elbow; forearm; wrist; hand/ finger/thumb; hip/groin; anterior thigh; posterior thigh; knee; lower leg/Achiles tendon;ankle;foot/toe.	T1: Parte do corpo lesionada: cabeça/rosto; pescoço/coluna cervical/externo/costela/parte superior do dorso; abdômen; região lombar; sacro/pélvis; ombro/clavícula; braço; cotovelo; antebraço; pulso; mão/dedo/polegar; quadril/virilha; coxa anterior; coxa posterior; joelho; perna inferior/tendão de Aquiles; tornozelo; pé/dedo do pé. T2: Parte do corpo lesada: cabeça/face; Pescoço/coluna cervical; Esterno/costelas/coluna torácica; Abdômen; Coluna lombar; Sacro/pelve; Ombro/clavícula; braço; cotovelo; antebraço; punho; mão/dedo/polegar; quadril/virilha; região anterior (frente) da coxa; região posterior (posterior) da coxa; joelho; perna/tendão Aquiles (calcanear); tornozelo; pé/dedo do pé.	Parte do corpo lesionada: cabeça/rosto; pescoço/coluna cervical; esterno/costelas/ coluna torácica; abdômen; coluna lombar; sacro/pelve; ombro/clavícula; braço; cotovelo; antebraço; punho; mão/dedo/polegar; quadril/ virilha; região anterior da coxa; região posterior da coxa; joelho; perna/tendão de Aquiles; tornozelo; pé/dedo do pé; outro.
5 Side of body injured:	T1: Lado do corpo lesionado T2: Lado do corpo acometido pela lesão	Lado do corpo lesionado
6 Type of injury: concussion (with or without loss of consciousness); structural brain injury; spinal cord/compression/transection; fracture; other bone injury; dislocation/ subluxation; sprain/ligament injury; lesion of meniscus, cartilage or disc; muscle rupture/strain/tear/cramps; tendon injury/ rupture/tendinopathy/bursitis; haematoma/ contusion/bruise; abrasion; laceration; nerve injury; dental injury; visceral injury; other injury (please specify).	T1: Tipo de lesão: concussão (com ou sem perda de consciência); lesão cerebral estrutural; compressão/transecção da medula espinhal; fratura; outra lesão óssea; deslocamento/sub luxação; distensão/lesão de ligamento; Lesão de menisco, cartilagem ou disco; ruptura/ distensão/laceração de músculo/câimbra; lesão/ruptura de tendão/tendinopatia/bursite; hematoma/contusão/arranhão; abrasão; laceração; lesão de nervo; lesão dentária; lesão visceral; outra lesão(especifique): T2: Tipo da lesão: concussão (com ou sem perda de consciência); lesão estrutural do cérebro; compressão da medula espinhal/lesão completa da medula espinhal; fratura; outra lesão óssea; luxação/ subluxação; entorse/lesão ligamentar; lesão de meniscos/cartilagem ou disco; lesão muscular/distensão/ruptura fibras musculares/câimbras; lesão tendínea/ ruptura tendão/tendinopatia/bursite; edema/contusão/hematoma; escoriação; ferida; lesão nervosa; lesão nos dentes; lesão nas vísceras; outra lesão (por favor especifique):	Tipo de lesão: concussão (com ou sem perda de consciência); lesão cerebral; compressão da medula espinhal/lesão completa da medula espinhal; fratura; outra lesão óssea; luxação/ subluxação; entorse/lesão ligamentar; lesão de menisco/ cartilagem ou disco; ruptura/distensão/ laceração muscular/câimbras; lesão/ruptura de tendão/tendinopatia/bursite; contusão/ edema/hematoma; escoriação; corte/ferida; lesão de nervo; lesão nos dentes; lesão nas vísceras; outra lesão (especifique):.
7 Diagnosis of injury (text or code)	T1: Diagnóstico de lesão (texto ou código): T2: Diagnóstico da lesão (código da doença, CID).	Diagnóstico da lesão (código ou descrição da doença):
8 Has the player had a previous injury at the same site (i.e. this injury is a recurrence)? Yes;no. If YES, specify date of player's return to full	T1: O jogador já teve uma lesão anterior do mesmo tipo no mesmo local (ou seja, esta lesão é uma recorrência)? Não; sim. Em caso positivo, especifique a data de retorno do jogador à participação plena por ocasião da lesão anterior: T2: O jogador já teve lesão do mesmo tipo no mesmo local (isto é, esta é uma lesão recorrente)? Sim; não. Se respondeu SIM, especificar a data que o jogador retornou plenamente a sua participação desde a lesão.	O jogador já teve lesão do mesmo tipo no mesmo local (isto é, esta é uma lesão recorrente)? Não; sim. Se respondeu SIM, especifique a data de retorno do jogador à participação plena por ocasião da lesão anterior.
9 Was the injury caused by: overuse; trauma?	T1: A lesão foi causada por: excesso de uso; trauma? T2: A lesão foi causada por: excesso de treino; trauma?	A lesão foi causada por: excesso de treino; trauma?
10 Did the injury occur during: training; match?	T1: A lesão ocorreu durante: treinamento; partida? T2: A lesão ocorreu durante: treinamento; trauma?	A lesão ocorreu durante: treino; partida?.
11 Was the injury caused by contact? No;yes; It YES, specify the activity: tackled; tackling; maul; ruck; lineout; scrum; collision; other.	T1: A lesão foi causada por contato? Não; sim. Em caso positivo, especifique a atividade: placagem (derrubado); placagem (derrubando); formação volante; formação fixa; alinhamento lateral; formação ordenada; colisão; outro. T2: A lesão foi causada por contato? Sim; não. Se respondeu SIM especificar o tipo de contato: tackled; tackling; batida; compressão; linout; luta pela posse de bola; colisão; outro.	A lesão foi causada por contato? Não; sim. Se respondeu SIM, especifique o tipo de atividade: tackleado; tackleando; maul; ruck; lineout; scrum; colisão; outro.
12A Did the referee indicate that the action leading to the injury was a violation of the Laws? No; yes.	T1: O árbitro indicou que a ação que causou a lesão foi uma violação das leis? T2: O juiz indicou que a jogada na qual a lesão ocorreu, foi infração de regra?	O árbitro indicou que a atividade na qual a lesão ocorreu foi infração de regra? Não; sim.
12B Did the referee indicate the the action leading to the injury was dangerous play (Law 10.4)? no; yes.	T1: O árbitro indicou que a ação que causou a lesão foi uma jogada perigosa (Lei 10.4)? T2: O juiz indicou que a jogada na qual a lesão ocorreu, foi jogada incorreta (Regra 10.4)?	O árbitro indicou a atividade que resultou na lesão como jogada perigosa? (Regra 10.4) Não; sim.

Chart 2. Modifications made at the back translation consensus meeting.

Questions in Portuguese from the consensus meeting	Translation into English	Final version
Data da lesão	T1: Date of injury T2: Date of injury	Date of injury
Horário da lesão (Tempo de jogo):	T1: Time of injury (Time during match): T2: Time of Injury	Time of injury (Time during match):
Data de retorno à participação plena	T1: Date of return to full participation T2: Return date of full participation	Date of return to full participation
Posição no jogo no momento da lesão	T1: Playing position at the time of injury T2: –	Playing position at the time of injury
Parte do corpo lesionada: cabeça/rosto; pescoço/ coluna cervical; esterno/costelas/coluna torácica; abdômen; coluna lombar; sacro/pelve; ombro/clavícula; braço; cotovelo; antebraço; punho; mão/dedo/polegar; quadril/virilha; região anterior da coxa; região posterior da coxa; joelho; perna/tendão de Aquiles; tornozelo; pé/dedo do pé; outro.	T1: Injured body part: head/face; neck/ cervical spine; sternum/ribs/ upper back; abdomen; lower back; sacrum/pelvis; shoulder/clavicle; arm; elbow; forearm; wrist; hand/finger/thumb; hip/groin; anterior thigh; posterior thigh; knee; leg/Achilles tendon; ankle; foot/toe; other. T2: Injured body part: head; neck/cervical spine; sternum/ribs/thoracic spine; abdomen; lumbar spine; sacrum/pelvis; shoulder/clavicle; upper arm; elbow; forearm; wrist; hand/finger/thumb; hip/groin; anterior thigh; posterior thigh; knee; leg/achilles tendon; ankle; foot/toe; other.	Injured body part: head/face; neck/ cervical spine; sternum/ribs/upper back; abdomen; lumbar spine; sacrum/pelvis; shoulder/clavicle; upper arm; elbow; forearm; wrist; hand/finger/thumb; hip/groin; anterior thigh; posterior thigh; knee; leg/Achilles tendon; ankle; foot/toe; other:.
Lado do corpo lesionado:	T1: Side of body injured: T2: Body side injured	Body side injured:
Tipo de lesão: concussão (com ou sem perda de consciência); lesão cerebral; compressão da medula espinhal/lesão completa da medula espinhal; fratura; outra lesão óssea; luxação/ subluxação; entorse/ lesão ligamentar; lesão de menisco/cartilagem ou disco; ruptura/distensão/laceração muscular/câimbras; lesão/ruptura de tendão/tendinopatia/bursite; contusão/ edema/hematoma; escoriação; corte/ferida; lesão de nervo; lesão nos dentes; lesão nas vísceras; outra lesão (especifique).	T1: Type of injury: concussion (with or without loss of consciousness); brain injury; spinal cord compression/transection; fracture; other bone injury; dislocation/subluxation; sprain/ligament injury; meniscus/ cartilage or disc injury; muscle rupture/strain/laceration /cramps; tendon injury/rupture /tendinopathy/bursitis; contusion/edema/hematoma; abrasion; cut/injury; nerve injury; dental injury; visceral injury; other injury (please specify). T2: Type of injury: concussion (with or without loss of consciousness); brain injury; spinal cord compression/ complete spinal cord injury; fracture; other lesion; dislocation/partial dislocation; sprain\ligament injury; meniscus/cartilage or disc lesion; muscular swelling/ rupture/ laceration/ cramp; tendon rupture/ tendinopathy/ bursitis; bruise/edema/ blood clot; skin abrasion; cut; nerve damage; tooth injury; internal damage (ex. organ); other injury (please specify):.	Type of injury: concussion (with or without loss of consciousness); brain injury; spinal cord compression/ complete spinal cord injury; fracture; other bone injury; dislocation/subluxation; sprain/ligament injury; meniscus/cartilage or disc injury; muscle rupture/ strain/laceration /cramps; tendon injury/ rupture/ tendinopathy/bursitis; contusion/edema/haematoma; abrasion; cut/wound; nerve injury; dental injury; visceral injury; other injury (please specify):
Diagnóstico da lesão (código ou descrição da doença):	T1: Diagnosis of injury (code or description of the disease): T2: Injury diagnosis (terminology or injury description):	Diagnosis of injury (international code of disease or description of the disease):
O jogador já teve lesão do mesmo tipo no mesmo local (isto é, esta é uma lesão recorrente)? Não; sim. Se respondeu SIM, especifique a data de retorno do jogador à participação plena por ocasião da lesão anterior.	T1: Did the player ever have the same type of injury before at the same site (that is, is this a recurrent injury)? No; yes. If YES, specify the date of the player's return to full participation after the previous injury T2: Has the player ever had a recurring injury (same injury in the same location)? No; yes. If yes, please specify return date of full training participation.	Has the player ever had the same type of injury before at the same site (that is, is this a recurrent injury)? No; yes. If YES, specify the date of the player's return to full participation after the previous injury:
A lesão foi causada por: excesso de treino; trauma?	T1: Was the injury caused by: excess training; trauma? T2: Injury was due to: overtraining; trauma?	Was the injury caused by: overtraining; trauma?
A lesão ocorreu durante: treino; partida?	T1: Did the injury occur during: training; match? T2: Injury occurred during: training; match	Did the injury occur during: training; match?
A lesão foi causada por contato? Não; sim. Se respondeu SIM, especifique o tipo de atividade: tackleado; tackleando; maul; ruck; lineout; scrum; colisão; outro.	T1: Was the injury caused by contact? No; yes. If YES, specify the type of activity: tackled; tackling; maul; ruck; lineout; scrum; collision; other. T2: Was the injury due to contact? No; yes. If yes, please specify the type of activity: tackle; tackle; maul; ruck; lineout; scrum; collision; other.	Was the injury caused by contact? No; yes. If YES, specify the type of activity: tackled; tackling; maul; ruck; lineout; scrum; collision; other.
O árbitro indicou que a atividade na qual a lesão ocorreu foi infração de regra? Não; sim.	T1: Did the referee indicate that the activity that caused the injury was a violation of the rules? T2: Did the referee indicate a foul for the sustained injury?	Did the referee indicate that the activity that caused the injury was a foul?
O árbitro indicou a atividade que resultou na lesão como jogada perigosa? (Regra 10.4) Não; sim.	T1: Did the referee indicate that the activity that resulted in the injury was dangerous play (Rule 10.4)? T2: Did the referee refer to the sustained injury as a form of dangerous play? (Rule 10.4)	Did the referee indicate that the activity resulting in the injury was dangerous play (Rule 10.4)?

Chart 3. Modifications made to the pre-final version (version 1) resulting in the final version (version 2).

Pre-final version (version 1)	Final version (version 2)
Localização no campo no momento da lesão: [Open question, that is, without alternatives].	Localização no campo no momento da lesão: ( ) Pilar Esquerdo; ( ) Hooker; ( ) Pilar Direito; ( ) Segunda linha; ( ) Oitavo; ( ) Scrum Half; ( ) Abertura; ( ) Primeiro Centro; ( ) Segundo Centro; ( ) Ponta Esquerda; ( ) Ponta Direita; ( ) Fullback; ( ) não aplicável.

Table 1. Results* of the application of the pre-final version (version 1) of the Formulário para Notificação/Avaliação de Lesão em Jogadores de Rugby.

Rugby players' characteristics and percentage of understanding	
Number of players	23
Players' age (years)	25.9 ± 5.53
Players' BMI (Kg/m^2)	26.29 ± 4.64
Players' education level (n = 14)	n = 14, 60.8% answered. n = 8, 57.1% higher education; n = 6, 42.8% incomplete higher education.
Percentage of players that did not understand the question 1A "Data da lesão:"	8.69%
Percentage of players that did not understand the question 1B "tempo de jogo em que ocorreu a lesão".	26%
Percentage of players that did not understand the question 2 "Data de retorno à participação plena:"	0%
Percentage of players that did not understand the question 3 "localização no campo no momento da lesão"	82.5%
Percentage of players that did not understand the question 4 "Parte do corpo lesionada:"	0%
Percentage of players that did not understand the question 5 "Lado do corpo lesionado:"	0%
Percentage of players that did not understand the question 6 "Tipo de lesão:"	0%
Percentage of players that did not understand the question 8 "O jogador já teve lesão do mesmo tipo no mesmo local (isto é, esta é uma lesão recorrente)?:"	0%
Percentage of players that did not understand the question 9 "A lesão foi causada por:"	4.34%
Percentage of players that did not understand the question 10 "A lesão ocorreu durante:"	0%
Percentage of players that did not understand the question 11 "A lesão foi causada por contato?:"	0%
Percentage of players that did not understand the question 12A "O árbitro indicou que a atividade na qual a lesão ocorreu foi infração de regra?"	4.34%
Percentage of players that did not understand the question 12B "O árbitro indicou a atividade que resultou na lesão como jogada perigosa? (Regra 10.4)"	4.34%

*Results are described in absolute frequency and percentage and mean and standard deviation. BMI: body mass index.

Table 2. Results of the application of the final version (version 2) of the Formulário para Notificação/Avaliação de Lesão em Jogadores de Rugby.

Rugby players' characteristics and percentage of understanding	
Number of players	25
Players' age (years)	29.44 ± 5.90
Players' BMI (Kg/m^2)	29.46 ± 4.32
Players' education level	High school (n = 2, 8%) Incomplete High school (n = 1, 4%) Higher education (n = 14, 56%) Incomplete higher education (n = 8, 32%)
Percentage of players that understood all the questions	100%

Results are described in absolute frequency and percentage, mean and standard deviation. BMI: body mass index.

DISCUSSION

The questionnaire Formulário para Notificação/Avaliação de Lesão em Jogadores de Rugby was successfully translated and cross-culturally adapted into Brazilian Portuguese, maintaining semantic, idiomatic, cultural, conceptual equivalences and following international methodological standards. The form could be considered a useful instrument, making its self-application possible, to evaluate injuries related to the practice of rugby in Brazilian players. The standardization of the record of injuries caused by the practice of Rugby through a questionnaire translated and cross-culturally adapted may provide clinical contributions to guide injury prevention programs, based on the results obtained from the self-administration of the Formulário para Notificação/Avaliação de Lesão em Jogadores de Rugby.

The stages of translation, synthesis and back-translation of the Formulário para Notificação/Avaliação de Lesão em Jogadores de Rugby were conducted in a simple way, since there were not many differences between the translated terms, always opting for grammatical changes more appropriate to Brazilian Portuguese and for alterations that aimed at the cultural equivalence used in the daily life of rugby players. Guillemin et al.[15] reported that the equivalence of expressions based on the original version should be sought, although colloquial expressions of a certain language, such as jargon used in sports, should also be considered.

The self-administration of the pre-final translation – version 1 by rugby players indicated that 26% did not understand the question "tempo de jogo em que ocorreu a lesão" and 82.5% did not understand the question "localização no campo no momento da lesão". These questions were reviewed in a meeting with experts. For the question "localização no campo no momento da lesão", it was suggested to include alternatives as answers, specifying a position in each alternative, so that the player could answer the question marking an × in the alternative that indicated their location in the field, thus making understanding easier. The suggestion that the work team had when monitoring the self-completion of the questionnaire was to change the word *localização* (location) for *posição* (position), making it easier to understand the question.

The Brazilian players that filled the final version of the study presented 29.44 ± 5.9 years as the mean age, were all male, most had complete higher education (56%) and their mean weight was 99 ± 12.3 kg.

Other studies investigated the occurrence of injuries in Brazilian rugby players but used semi-structured questionnaires, which were not validated.[2,5] Our study, through the translation of a questionnaire created by an international rugby authority, aims

to offer an assessment instrument that is easy to use and can be self-administered.

We emphasize the importance of the Formulário para Notificação/Avaliação de Lesão em Jogadores de Rugby to standardize the notification and cataloging of injuries that occur in Rugby. The reproducibility and reliability study of the Formulário para Notificação/Avaliação de Lesão em Jogadores de Rugby is under development and should contribute to increasing its usefulness as an instrument for the evaluation of injuries resulting from Rugby practice in the near future.

Our study has some limitations. The questionnaire was self-administered, which can cause memory bias when trying to remember the date of the injury and specific information about it if the questionnaire is not completed right after the injury occurred. Another limitation discussed by the work team was the use of the term "*excesso de treino*" ("overtraining"), translated from "*overuse*" in question 9. The use of this term oversimplifies the cause of injury, disregarding, for example, micro trauma and late injuries. Thus, it is suggested to add the alternative "outro" ("other") (specifying, then, which one), so that the health professional or player can specify the cause of the injuries.

We recommend that the Formulário para Notificação/Avaliação de Lesão em Jogadores de Rugby should be used by health professionals for the notification of injuries during sports practice, so that it can contribute to guide prevention strategies prevention of injuries in players Rugby.

CONCLUSION

The questionnaire Formulário para Notificação/Avaliação de Lesão em Jogadores de Rugby was translated and cross-culturally adapted to Brazilian Portuguese, allowing its self-administration to assess injuries related to the practice of rugby in Brazilian players. Validation and reproducibility studies of the form are necessary to demonstrate its reliability.

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APPENDIX

FORMULÁRIO PARA NOTIFICAÇÃO/AVALIAÇÃO DE LESÃO EM JOGADORES DE RUGBI

Nome: _____ Time: _____ Data da avaliação: _____

Posição em que joga:

- □ Forward Pilar esquerdo
- □ Forward Hooker
- □ Forward Pilar direito
- □ Forward Segunda linha
- □ Forward Segunda linha
- □ Oitavo
- □ Back Scrum half
- □ Back Abertura
- □ Back Primeiro Centro
- □ Back Segundo Centro
- □ Back Ponta esqueda
- □ Back Ponta Direita
- □ Fullback

1A. Data da lesão: _____ **1B:** Horário da lesão (Tempo de jogo): _____

2. Data de retorno à participação plena: _____

3. Localização no campo no momento da lesão:

- □ Forward Pilar esquerdo
- □ Forward Hooker
- □ Forward Pilar direito
- □ Forward Segunda linha
- □ Forward Segunda linha
- □ Oitavo
- □ Back Scrum half
- □ Back Abertura
- □ Back Primeiro Centro
- □ Back Segunda Centro
- □ Back Ponta esqueda
- □ Back Ponta Direita
- □ Fullback
- □ não aplicável

4. Parte do corpo lesionada: (Deve ser preenchido um formulário para cada lesão)

- □ cabeça/rosto
- □ braço
- □ região anterior da coxa
- □ pescoço/coluna cervical
- □ cotovelo
- □ região posterior da coxa
- □ esterno/costelas/coluna torácica
- □ antebraço
- □ joelho
- □ abdômen
- □ punho
- □ perna/tendão de Aquiles
- □ coluna lombar
- □ mão/dedo/polegar
- □ tornozelo
- □ sacro/pelve
- □ quadril/virilha
- □ pé/dedo do pé
- □ ombro/clavícula

5. Lado do corpo lesionado: □ esquerdo □ direito □ bilateral □ não aplicável

6. Tipo de lesão:

- □ concussão (com ou sem perda de consciência)
- □ outra lesão (especifique): _____
- □ escoriação
- □ lesão cerebral
- □ entorse/lesão ligamentar
- □ corte
- □ compressão da medula espinhal/ lesão completa da medula espinhal
- □ lesão de menisco/cartilagem ou disco vertebral
- □ lesão de nervo
- □ fratura
- □ ruptura/distensão/lesão muscular/câimbras
- □ lesão nos dentes
- □ outra lesão óssea
- □ lesão/ruptura de tendão/tendinopatia/bursite
- □ lesão nas vísceras
- □ luxação/ subluxação
- □ contusão/edema/hematoma

7. Diagnóstico da lesão (Código Internacional de Doenças 10 ou descrição da doença): (Deve ser preenchido por um profissional da saúde) _____

8. O jogador já teve lesão do mesmo tipo no mesmo local (isto é, esta é uma lesão recorrente)?
□ não □ sim

Se respondeu SIM, especifique a data de retorno do jogador à participação plena por ocasião da lesão anterior: _____

9. A lesão foi causada por:
□ excesso de treino (“*overuse*”) □ trauma?

10. A lesão ocorreu durante:
□ treino □ partida?

11. A lesão foi causada por contato?
□ não □ sim

Se respondeu SIM, especifique o tipo de atividade:

□ *tackleado*	□ *tackleando*	□ *ma*
□ *ruck*	□ *lineout*	□ *scrum*
□ colisão	□ outro	

12A. O árbitro indicou que a atividade na qual a lesão ocorreu foi infração de regra?
□ não □ sim

12B. O árbitro indicou a atividade que resultou na lesão como jogada perigosa? (Regra 10.4)
□ não □ sim

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WHICH CLINICAL OUTCOME SCORES ARE MORE FREQUENTLY USED IN THE LITERATURE ON OSTEOCHONDRAL LESIONS OF THE TALUS? A SYSTEMATIC REVIEW

QUAIS ESCORES DE DESFECHOS CLÍNICOS SÃO USADOS COM MAIS FREQUÊNCIA NA LITERATURA LESÕES OSTEOCONDRAIS DO TÁLUS? UMA REVISÃO SISTEMÁTICA

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ABSTRACT

Objective: This study aimed to identify the most used scales in the assessment of the clinical outcomes for the treatment of osteochondral lesions of the talus. Methods: We performed a systematic review of the PubMed/MEDLINE databases from September 1999 to September 2019, based on the guidelines established by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). The research strategy was: osteochondral [All Fields], AND ("talus" [MeSH Terms] OR "talus" [All Fields]) AND lesion [All Fields]. Of the 364 articles found in the literature, 166 (45%) were included in the study and 198 (55%) excluded. In total, 23 clinical assessment tools were used in the studies. Results: We found 49.4% of the studies to use the American Orthopaedic Foot and Ankle Society Ankle-Hindfoot Scale (AOFAS Ankle-Hindfoot Scale) and 29.5% the Visual Analogue Scale (VAS). Conclusion: The use of AOFAS increased in relation to VAS in the last 6 years ($p = 0.046$), and these two scales, either alone or combined, were the most used for studying osteochondral lesions of the talus. ***Level of Evidence III, Systematic Review of Level II studies.***

Keywords: Talus. Cartilage, Articular. Arthroplasty, Subchondral. Treatment Outcome.

RESUMO

Objetivo: Este estudo propõe revisar sistematicamente a literatura para identificar as escalas mais utilizadas da avaliação clínica de resultados do tratamento das LOTs. Métodos: Foi realizada revisão sistemática das bases de dados do PubMed/MEDLINE, desde setembro de 1999 a setembro 2019 baseado nas diretrizes PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses). A estratégia de pesquisa foi: osteochondral [All Fields], AND ("talus" [MeSH Terms] OR "talus" [All Fields]) AND lesion [All Fields]. De 364 artigos, foram incluídos no estudo 166 (45%) e excluídos 198 (55%). Foram observadas 23 escalas de avaliação clínica utilizadas. Resultados: A escala AOFAS e EVA de dor foram as mais utilizadas, ocorrendo em 49,4% e 29,5% dos artigos, respectivamente. Foi observado aumento de uso de AOFAS e diminuição EVA nos últimos 6 anos ($p = 0,046$). Conclusão: As ferramentas Escala AOFAS e EVA para dor demonstraram ser as mais usadas na literatura para avaliação de resultados do tratamento da lesão osteocondral de tálus, tanto isoladamente, quanto combinadas. ***Nível de Evidência III, Revisão Sistemática de Estudos de Nível II.***

Descritores: *Tálus. Cartilagem Articular. Artroplastia Subcondral. Resultado do Tratamento.*

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INTRODUCTION

Osteochondral lesions are injuries with articular surface and/or subchondral bone involvement.[1-4] Osteochondral lesion of the talus (OLT) is a broad term used to describe injuries or abnormalities of the talar articular cartilage and adjacent bone.[5] The term "osteochondritis dissecans" was first used by Franz König in 1888 to describe the presence of free

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The study was conducted at the Universidade de Campinas, Faculty of Medical Sciences, Department of Orthopedics and Traumatology.
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bodies in the knee joint, which the surgeon believed to be fragments of an avascular bone lesion.[6] In 1932, Rendu reported an intra-articular lesion of the talus that matched this description,[7] and in 1959 Berndt and Harty coined the term "transcondral fracture of the talus".[8]
People diagnosed with OLT are often active, with previous history of ankle sprain.[9] Fong et al.[2] conducted a study with 70 sports modalities and found ankle injuries, especially sprains, to be the most common in 24 of them. In a systematic review conducted by Ramponi et al.[10] on lesion size as a predictor of clinical outcomes after bone marrow stimulation, the authors reported that no evaluation method was maintained throughout studies with a significant correlation between them, regardless of the several good and optimal short-term results. Dahmen et al. performed a systematic review on the treatment for primary osteochondral talar lesions[11] and verified the use of 25 different clinical evaluation systems. As a limitation to the study, the authors emphasized the impossibility of performing the conventional measurement of efficacy estimates, which precluded comparisons between studies. Despite the lack of a scoring system validated for evaluating the clinical outcomes of OLT, some studies also report the decrease in the use of existing scores over time.[12]
Thus, our study aims to perform a systematic review of the literature to identify the most used tools in the evaluation of clinical outcomes for osteochondral lesions of the talus, assisting further research to decide on which scales to use. We also sought to evaluate the most appropriate scales in enabling the comparison and reproducibility of future studies on the theme.

MATERIALS AND METHODS

This study included a systematic review of the PubMed/MEDLINE databases from September 1999 to September 2019, based on the guidelines established by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).[13] The protocol was registered on the international prospective register of systematic reviews (PROSPERO) database, under the number 130017. The study design means there is no need for its analysis and approval by the Research Ethics Committee.
The research strategy was: osteochondral [All Fields], AND ("talus" [MeSH Terms] OR "talus" [All Fields]) AND lesion [All Fields]. Complete articles, conducted with patients with osteochondral lesion of the talus, evaluating clinical outcome using scale/score, published between 1999 and 2019, and written in English were eligible for this study. Case reports, review articles, and studies conducted on cadavers or animal models were excluded. Two authors screened the publications for the eligibility criteria, agreeing with the number of articles shown in Figure 1.

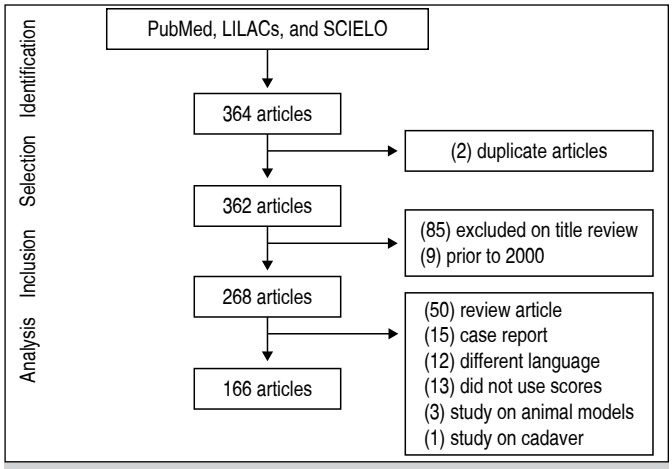

Figure 1. PRISMA flowchart illustrating the eligibility criteria applied to publications.

Information on the used clinical outcome score was collected for each article included in the study. The data were tabulated in Excel spreadsheets (Office 16; Microsoft) and statistically analyzed using the 16.0 Statistical Package for Social Sciences (IBM SPSS), with descriptive and comparative methods. Two-tailed Fisher's exact test was used to compare the frequency of use of scales between two arbitrarily chosen intervals of time. The significance level was set at 95%.

RESULTS

The electronic database search identified 364 articles, of which 166 (45%) met the eligibility criteria and were included in the study and 198 (55%) were excluded (Figure 1).
Eighty-nine of the included articles described their level of evidence within the text body: 46 with evidence level IV (four), 25 with level III (three), and 18 with level II (two). The remaining articles (n = 77) did not indicate the level of evidence.
In total, 23 clinical assessment tools were used in the studies, mostly in combination. Most studies used either the American Orthopedic Foot and Ankle Society: Ankle-Hindfoot score (AOFAS; 49.3%) or the Visual Analog Scale (VAS; 29.5%) for pain, as shown in Figure 2.

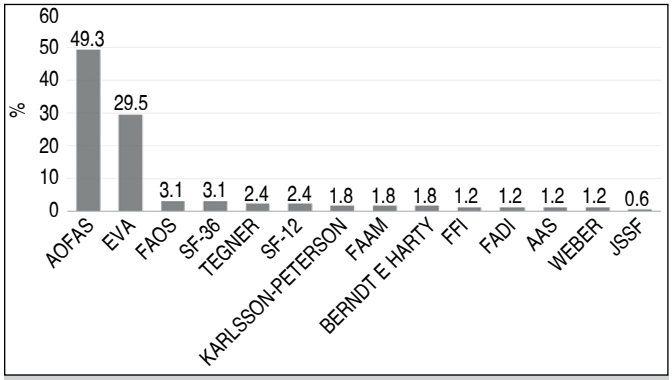

Figure 2. OLT assessment scales used in the articles included in the analysis. The use of each scale is presented in percentage of studies.

We performed an extra analysis of articles published during the last six years to verify whether they presented a new trend in the use of clinical questionnaires in relation to previous years. This analysis verified a significant different (p = 0.046) pattern in the two most used scales, indicating an increase in the use of AOFAS and a decrease in the use of pain VAS (Figure 3).

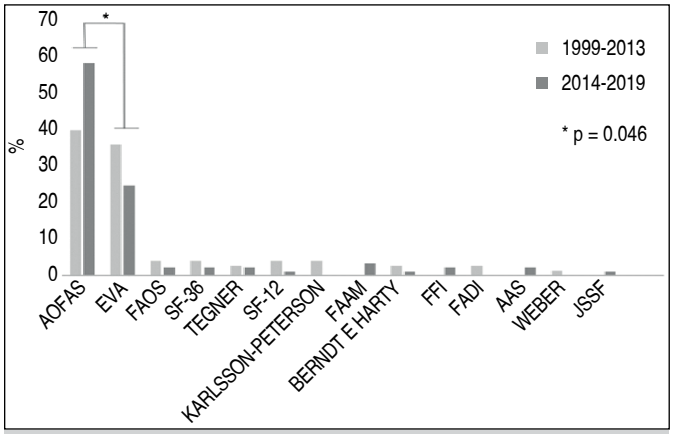

Figure 3. Comparison of the use of OLT assessment scales in articles included in the analysis published between 1999 and 2013 and between 2014 and 2019.

DISCUSSION

Validated tools for assessing outcomes are useful not only for research, but also for orthopedic clinical practice in evaluating the effects of intervention on patients.

Our systematic review found the American Orthopedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot scale to be the most commonly used by studies assessing the treatment of osteochondral lesions of the talus (OLT). Developed by Kitaoka et al. in 1994, the AOFAS Ankle-Hindfoot scale assesses function (0-50 points), pain (0-40 points), and joint alignment (0-10 points) in the ankle, subtalar, talonavicular, and calcaneocuboide joints, obtaining a maximum sum of 100 points.[14] Guyton described several limitations of this scale, such as the small number of available answers per item and the use of negative options (none, no limitations, no difficulty) to reach higher scores in some categories.[15] Combining multiple concepts into a single numerical score may also lead to non-informational conclusions. In pathologies where functional limitation or stiffness play a more crucial role, focusing on pain assessment may likewise lead to erroneous interpretations. The authors did attempt to create arbitrary cutoff points, but the indication of acceptable outcomes in AOFAS varies.[14] Despite these facts, AOFAS has been the most used scale for assessing ankle and hindfoot injuries – a result corroborated in this review. We attribute its widespread use in the investigated studies to its wide dissemination and validation in different languages, as well as to comprising the pain and joint alignment domains, important in the assessment of OLT treatment.

First used in 1923 by Freyd, the pain Visual Analog Scale (VAS) consists of a subjective representation of the patient's pain portrayed by a straight line whose extremities denote "painless" to "the worst pain ever felt".[16] Several studies showed VAS to be sensitive to treatment effects and positively related to other pain measurement tools.[17] However, although frequently used by studies approaching OLT, VAS score is insufficient to characterize treatment outcomes by itself. This explains why its association with other scales is common in the literature – as demonstrated in our study, which found 45 articles (28.1%) to use VAS in combination with other assessment tools.

Macaulay et al.[18] found a strong negative correlation between AOFAS and EVA, indicating the questionnaire ability to quantify symptoms. In 2011, AOFAS published a position statement indicating that their clinical rating system was not considered valid or reliable, advising against its continued use.[19] However, a study conducted in 2017 by Hasenstein et al.[20] found AOFAS to be the clinical outcome assessment tool most used by authors and published in medical journals.

The Foot and Ankle Outcome Score (FAOS) is a 42-item questionnaire divided into five categories: pain, other symptoms, function in daily life, sports and recreation, and quality of life. Each category has five possible answers (absent, mild, moderate, severe, and extreme), scored from zero to four, and the sum of the results is transformed into a worst to best scale, ranging from zero to 100.[21] Veltman, Hofstad, Witteveen[22] conducted a meta-analysis and concluded that FAOS was the best assessment tool for ankle osteoarthritis. However, only patients with ankle reconstruction were assessed for its validation, hampering the generalization of its use for other diseases or intervention methods, including those related to OLT.[8] Combining multiple evaluation systems may provide a better characterization of the clinical progress of treated patients. Yet, comparing studies and treatment methods for OLT remains a challenge.

Our search identified the use of 23 assessment tools – none of which was developed specifically for assessing the treatment and follow-up of osteochondral lesions of the talus. This review does not intend to prove that the most used instrument is necessarily the best. However, we stress the importance of the use of a common tool for assessing the clinical outcomes of osteochondral lesions of the talus by studies from different parts of the world, thus enabling comparison among results. We also verified a reversal in the most used scale during the last six years, whereby the use of the pain VAS scale decreased while that of AOFAS increased. AOFAS is a functional scale when compared to VAS, which offers more simplistic information based solely on the pain reported by the patient. Considering that, such a reversal is an interesting advance. This systematic review may help future trials to decide which clinical assessment tools are most appropriate for osteochondral lesions of the talus until a validated score is available with this end.

CONCLUSION

Our results indicate that AOFAS and pain VAS scale, either alone or combined, were the most used in the literature for assessing the outcomes of osteochondral lesions of the talus. However, we did not find a specific score validated for assessing the treatment of patients with this condition.

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