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ACTA ORTOPÉDICA BRASILEIRA

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(Reviewed April 2022)

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Levels of Evidence for Primary Research Question[a]

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

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

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

SUMMARY

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Update Article

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FOOT

COMPARISON OF CHANGES IN THE ANKLE AFTER UNICONDYLAR KNEE ARTHROPLASTY AND HIGH TIBIAL OSTEOTOMY

COMPARAÇÃO CLÍNICA E RADIOLÓGICA DAS ALTERAÇÕES NO TORNOZELO APÓS ARTROPLASTIA UNICONDILAR DO JOELHO E OSTEOTOMIA TIBIAL ALTA

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ABSTRACT

Objectives: We aimed to compare the changes in the coronal alignment of the ankle joints and their clinical effects after high tibial osteotomy (HTO) and unicondylar knee arthroplasty (UKA). Methods: 50 HTO and 54 UKA patients who were operated on for medial knee osteoarthritis between 2013 and 2018 were retrospectively evaluated. The hip-knee-ankle angle (HKA), the medial proximal tibial angle (MPTA), the tibial plafond inclination (TPI) and the talar inclination (TI) angles were measured before and after operation. Visual analog scale (VAS), short form 36 (SF-36), and ankle-hindfoot scale (AHS) scores of both groups were evaluated and recorded. Results: Angular changes in the HKA, MPTA, TPI and TI values showed significantly greater values in the HTO group ($p<0.001$). When asymptomatic and symptomatic cases were compared, it was found that changes in the HKA, TPI and TI values were significantly greater in symptomatic cases in the HTO group ($p<0.05$). A significant decline was observed in the VAS, SF-36 and AHS scores in the HTO group in the postoperative period ($p<0.05$). In intergroup evaluations, a significant decline was detected in pain and functional scores of the HTO group when compared to the UKA group ($p<0.05$). Conclusion: Unicondylar knee arthroplasty can be a good alternative to HTO in selected cases for postoperative ankle complaints. ***Level of Evidence III; Therapeutic Studies Investigating the Results of Treatment.***

Keywords: Ankle. Osteotomy. Arthroplasty, Replacement, Knee.

RESUMO

Objetivos: Nosso objetivo foi comparar as alterações no alinhamento coronal das articulações do tornozelo e seus efeitos clínicos após osteotomia tibial alta (OTA) e artroplastia unicondilar do joelho (AUJ). Métodos: 50 pacientes de HTO e 54 de AUJ operados de osteoartrite medial do joelho entre 2013 e 2018 foram avaliados retrospectivamente. O ângulo quadril-joelho-tornozelo (QJT), o ângulo tibial proximal medial (ATPM), a inclinação do platô tibial (IPT) e os ângulos de inclinação talar (IT) foram medidos no pré- e pós-operatório. A escala visual analógica (VAS), forma curta 36 (SF-36), e a escala tornozelo-retropé (ETR) de ambos os grupos foram avaliadas e registradas. Resultados: Alterações angulares nos valores de QJT, ATPM, IPT e IT mostraram valores significativamente maiores no grupo OTA ($p<0,001$). Quando os casos assintomáticos e sintomáticos foram comparados, verificou-se que as alterações nos valores de QJT, IPT e IT foram significativamente maiores nos casos sintomáticos no grupo OTA ($p<0,05$). Observou-se declínio significativo nos escores VAS, SF-36 e ETR no grupo HTO no pós-operatório ($p<0,05$). Nas avaliações intergrupos, foi detectado declínio significativo na dor e nos escores funcionais do grupo OTA quando comparado ao grupo AUJ ($p<0,05$). Conclusão: Em casos de queixas pós-operatórias quanto ao tornozelo, a artroplastia unicondilar do joelho pode ser uma boa alternativa para OTA. ***Nível de evidência III; Estudos Terapêuticos Investigando Resultados de Tratamento.***

Descritores: *Tornozelo. Osteotomia. Artroplastia do Joelho.*

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INTRODUCTION

Carrying 75% of the body weight by the medial compartment of the knee causes arthrosis in this region in the early period.[1,2] In such cases, medial opening-wedge high tibial osteotomy (HTO) and unicondylar knee arthroplasty (UKA) provide relief in pain and improvement in knee functions.[3,4] Biomechanically, the weight-bearing axis is shifted from the medial to the lateral aspect of the joint in HTO, therefore 1.7-1.9 degrees of valgus is recommended for optimum load distribution postoperatively.[5] On the other hand, in UKA, the ligament tension is replaced, and the knee and leg alignment is returned to the pre-disease state where a slightly varus position is often recommended.[6,7] Both surgical procedures are known to alter the postoperative coronal alignment, while the anatomical orientation of the ankle and foot is secondarily affected.[8,9]
Our aim in this study was to compare the changes in the coronal alignment of the ankle joints and their clinical effects after HTO and UKA.

Patients and Methods

The study was approved by the institutional Ethics Committee (2020.137.05.38). Verbal consent was obtained from all patients for this study. One hundred and four patients (50 HTO, 54 UKA) who were operated on for medial knee osteoarthritis between 2013 and 2018 were retrospectively evaluated. All operations were performed by the same surgical team.
High tibial osteotomy was performed as biplanar osteotomy starting from the proximal of the tibial tuberosity. A plate-screw system (OWO Plate; TST Ltd., Istanbul, Turkey) was used for fixation, while no bone substitute was used during surgery. Unicondylar knee arthroplasty was performed using cemented ZUK (Zimmer® Unicompartmental High Flex Knee System; Zimmer Biomet, Warsaw, IN, USA).
Patients who were under 60 years of age and had symptomatic varus-aligned medial arthrosis of the knee were indicated for HTO, while those who had isolated medial arthrosis, coronal plane deformity below 10 degrees and were below 60 years of age were planned to undergo UKA. Patients who had knee flexion below 90 degrees, experienced a lateral bone cortex fracture perioperatively, underwent bilateral surgery, and had lateral or patellofemoral knee joint arthrosis, knee flexion contracture over 10 degrees, ligament instability, rheumatoid arthritis, a trauma or surgery that would disrupt the lower extremity alignment, cases with preoperative arthrosis findings or pain in the ankle, foot deformities, a BMI greater than 35, and those with insufficient registration and/or follow-up information were excluded from the study. A total of 91 cases were included in the study.
Alignment of the lower extremity was evaluated with standardized preoperative and postoperative anteroposterior radiographs (with the patella placed anteriorly and in the middle and the feet standing at attention position). The following parameters were radiologically evaluated. The hip-knee-ankle angle (HKA) was defined as the angle between the mechanical axes of the femur and the tibia. The angle between the mechanical axis of the tibia and the proximal tibial joint line was considered as the medial proximal tibial angle (MPTA), and the angle between the tangent to the tibial plafond and the horizontal line was considered as the tibial plafond inclination (TPI). While talar inclination (TI) was defined as the angle between the tangent to the talar dome and the horizontal line, the angle between the talus and the plafond was accepted as the talar tilt (TT). Varus alignment was accepted as a 'positive' angle value in all measurements. All measurements were performed using the PACS - Picture Archiving and Communication System by two separate orthopedic surgeons, who did not participate in the treatments (Figures 1 and 2).
Preoperative and postoperative visual analog scale (VAS), short form 36 (SF-36) and ankle-hindfoot scale (AHS) scores of both groups were evaluated and recorded.

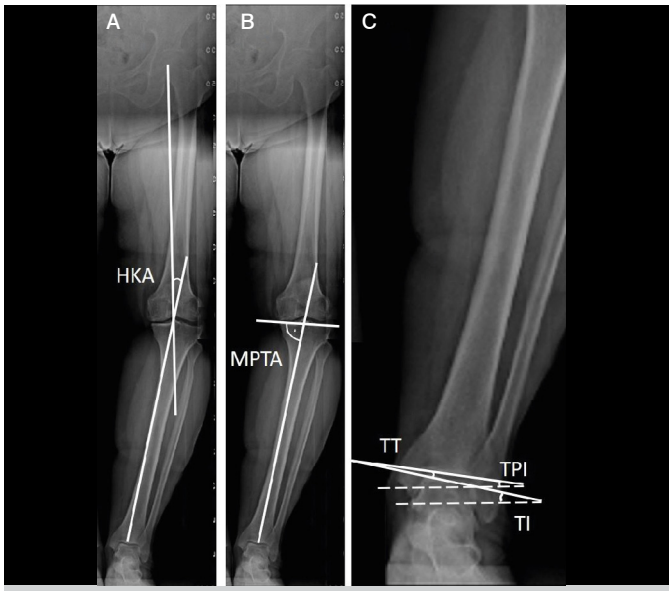

Figure 1. (A) The hip-knee-ankle (HKA) angle, (B) the medial proximal tibial angle (MPTA) and (C) the tibial plafond inclination (TPI), talar inclination (TI), and talar tilt (TT). The dashed line indicates the ground.

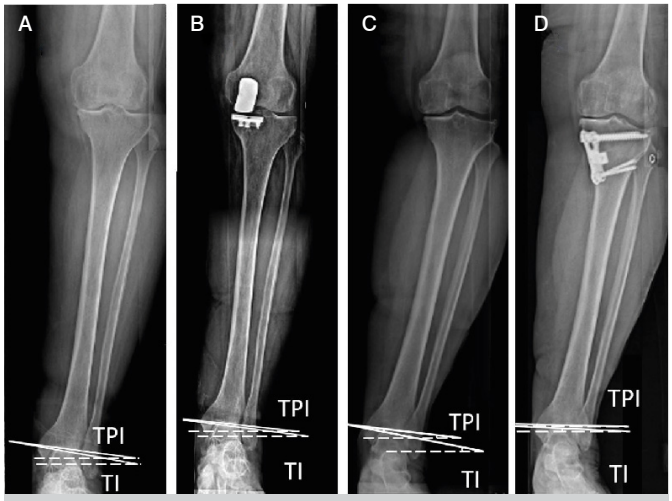

Figure 2. (A-B) Angular change in the ankle between the measurements performed before and after UKA. (C-D) Angular change in the ankle between the measurements performed before and after HTO.

Statistical Methods

Statistical analyses were performed by a biostatistician (member of authorship) using the IBM SPSS Statistics v.17.0 software. The normality of the data was analyzed using the Kolmogorov-Smirnov test. All descriptive statistics were reported as mean ± standard deviation. The Mann-Whitney U test was used to determine the average difference between two unrelated groups. All comparative tests were two-tailed, and a p value of less than 0.05 was considered statistically significant.

RESULTS

The demographic information, follow-up times and BMI values of all patients are provided in (Table 1). Newly-onset and resistant ankle complaints were detected in six HTO patients and two UKA patients. All symptomatic cases were treated conservatively. Preoperative and postoperative radiological measurements in both groups are shown in (Table 2).

The angular changes between the preoperative and postoperative radiological measurements in both groups are shown in (Table 3). Angular changes in the HKA, MPTA, TPI, and TI showed significantly greater values in the HTO group ($p<0.001$).

Angular changes in both groups were compared in asymptomatic and symptomatic cases in (Table 4). Changes in the HKA, TPI and TI values were found to be significantly greater in symptomatic cases in the HTO group ($p<0.05$).

The clinical results for the ankle are presented in (Table 5). A significant decline was observed in the VAS, SF-36 and AHS scores in the HTO group in the postoperative period ($p<0.05$). In the intergroup evaluations, a significant decline was detected in pain and functional scores of the HTO group when compared to the UKA group ($p<0.05$).

The intraclass correlation coefficient (ICC) for HKA and MPTA was 0.702-0.652 for interobserver and 0.784-0.683 for intraobserver reliability. The ICCs for TPI and TT were 0.802-0.788 and 0.683-0.634, respectively, for intraobserver reliability.

Table 1. Demographic information, follow-up and BMI data of the patients.

	HTO	UKA	Total	p
	Mean SD	Mean SD	Mean SD	
Age (yrs.)	46.32 8.84	54.58 6.36	50.86 8.59	<0.001*
Gender (n, %)				0.969†
Male	4 (9.8)	5 (10.0)	9 (9. 9)	0.969†
Female	37 (90.2)	45 (90.0)	82 (90.1)	
Follow-up period (mos.)	29.05 6.26	26.68 3.56	27.75 5.07	0.460*
BMI (kg/m²)	32.41 1.12	32.56 1.16	32.49 1.14	0.379*

BMI: body mass index, HTO: high tibial osteotomy, UKA: unicondylar knee arthroplasty, SD: standard deviation.*Mann-Whitney U test, †Chi-squared testSignificant p values are written in bold.

Table 2. Comparison of the preoperative and postoperative radiological measurements.

HTO	Preoperative		Postoperative		Angular change	
	Mean	SD	Mean	SD	Mean	SD
HKA (°)	14.05	2.42	-0.44	1.79	14.49	2.63
MPTA (°)	83.68	2.53	89.33	2.02	5.65	1.86
TPI (°)	12.12	3.10	-1.39	4.14	13.51	2.64
TI (°)	11.91	3.05	-1.32	4.09	13.23	2.66
TT (°)	0.20	0.25	0.15	0.26	0.05	0.23
UKA	**Preoperative**		**Postoperative**		**Angular change**	
	Mean	SD	Mean	SD	Mean	SD
HKA (°)	8.37	2.27	2.28	2.16	6.09	1.61
MPTA (°)	86.55	2.41	87.26	2.49	0.71	0.53
TPI (°)	7.48	3.18	1.53	2.41	5.95	1.70
TI (°)	7.40	3.17	1.63	2.42	5.77	1.66
TT (°)	0.11	0.09	0.15	0.12	0.04	0.11

HKA: hip-knee-ankle angle, HTO: high tibial osteotomy, MPTA: medial proximal tibial angle, SD: standard deviation, TI: talar inclination, TPI: tibial plafond inclination, TT: talar tilt, UKA: unicondylar knee arthroplasty.

Table 3. Intergroup comparison of the changes in radiological parameters.

Postoperative-Preoperative	HTO		UKA		p*
	Mean	SD	Mean	SD	
HKA (°)	14.49	2.63	6.09	1.61	<0.001
MPTA (°)	5.65	1.86	0.71	0.53	<0.001
TPI (°)	13.51	2.64	5.95	1.70	<0.001
TI (°)	13.23	2.66	5.77	1.66	<0.001
TT (°)	0.05	0.23	0.04	0.11	0.214

HKA: hip-knee-ankle angle, HTO: high tibial osteotomy, MPTA: medial proximal tibial angle, SD: standard deviation, TI: talar inclination, TPI: tibial plafond inclination, TT: talar tilt. *Mann-Whitney U test. Significant p values are written in bold.

Table 4. Comparison of the angular changes in asymptomatic and symptomatic patients.

HTO Postoperative-Preoperative	Asymptomatic (n=35)		Symptomatic (n=6)		p*
	Mean	SD	Mean	SD	
HKA (°)	13.95	2.38	17.65	1.71	0.001
MPTA (°)	5.65	1.64	5.60	3.06	0.941
TPI (°)	12.91	2.28	17.00	1.79	<0.001
TI (°)	12.63	2.26	16.68	2.26	0.001
TT (°)	0.13	0.14	0.43	0.44	0.057
UKA Postoperative-Preoperative	**Asymptomatic (n=35)**		**Symptomatic (n=6)**		**p***
	Mean	SD	Mean	SD	
HKA (°)	6.08	1.63	6.35	1.63	0.655
MPTA (°)	0.83	0.54	0.70	0.42	0.920
TPI (°)	5.92	1.71	6.50	2.12	0.441
TI (°)	5.74	1.66	6.40	1.98	0.442
TT (°)	0.10	0.11	0.10	0.14	0.937

HKA: hip-knee-ankle angle, HTO: high tibial osteotomy, MPTA: medial proximal tibial angle, SD: standard deviation, TI: talar inclination, TPI: tibial plafond inclination, TT: talar tilt, UKA: unicondylar knee arthroplasty. *Mann-Whitney U test. Significant p values are written in bold.

Table 5. Comparison of the preoperative and postoperative clinical scores.

	HTO	UKA	p*
	Mean SD	Mean SD	
Preoperative ankle VAS score	1.32 0.47	2.04 0.80	0.025
Postoperative ankle VAS score	2.54 2.04	2.20 1.46	
p†	0.002	0.914	
Preoperative SF-36 score	89.02 8.68	88.36 6.14	0.002
Postoperative SF-36 score	80.61 17.11	86.94 9.14	
p†	<0.001	0.108	
Preoperative AHS score	93.98 7.07	92.62 7.03	0.042
Postoperative AHS score	87.39 16.42	89.94 12.04	
p†	<0.001	0.324	

AHS: ankle-hindfoot scale, HTO: high tibial osteotomy, SD: standard deviation, SF-36: short form 36, UKA: unicondylar knee arthroplasty, VAS: visual analog scale. *Repeated measures ANOVA, †Wilcoxon test. Significant p values are written in bold.

DISCUSSION

The most important finding of our study is that HTO affects the ankle orientation more than UKA and causes more clinical symptoms. To our knowledge, changes in ankle orientation after HTO and UKA and the clinical implications of this condition have not been compared to date in the literature.

It is known that compensatory alignment changes develop in the ankle secondary to knee deformities.[10] However, this physiological adaptation deteriorates after corrective surgical procedures and causes complaints in the ankle.[11] Lee and Jeong reported ankle complaints in 21.8% of their cases after total knee arthroplasty (TKA).[9] Similarly, Shah et al. recounted that 20% of their cases were symptomatic with a marked change in ankle TPI after HTO.[8] In accordance with the literature, the change in the TPI was greater in symptomatic patients in the HTO group in our study (17.00°±1.79° vs. 12.91°±2.28°, $p<0.001$). Shah et al. also reported significantly greater angular changes in the symptomatic group (12.8°±4.9° vs. 8.1°±4.8°, $p=0.03$).[8] Although the change in the TPI in symptomatic patients in the UKA group was greater, it was not significant. Our findings in the HTO group points out to the correlation between postoperative ankle complaints and TPI.

Although it was not significant, ankle complaints were observed more in patients who underwent HTO. Regarding the pain and functional scores, the ankle scores in the HTO group declined after surgery when compared to the preoperative scores, whereas no significant change was observed in the UKA group. In comparison

between the HTO and UKA groups, significantly worse pain and functional scores were observed in the HTO group.

The main reason why HTO has a greater effect on ankle orientation angles is the more significant overcorrection effect of HTO on alignment versus UKA.[12,13] Lee et al. observed a change of 10.8 degrees in the HKA after HTO, while Asada et al. detected a change of 3.9 degrees in their study.[14,15] In another biomechanical study performed on a static model, minimal pressure changes were observed in the ankle after a 5-degree correction with HTO, while an apparent lateralization in the center of pressure was detected after a 10-degree correction.[11] The second reason regarding the effect of HTO on ankle orientation is the fact that the correction zone in HTO is closer to the ankle than in the UKA. This situation is supported by the findings from the literature that confirm that the most obvious effect on ankle pressures is observed after supramalleolar osteotomy, and the least effect after distal femoral osteotomy.[11] We, as well, obtained supportive findings in our study, showing that the HKA, MPT, TPI and TI angles were more affected by HTO. In conclusion, lower extremity alignment and thus ankle orientation is less affected after UKA than HTO.

The extent of the preoperative coronal deformity increases the risk of ankle complaints postoperatively. Lee and Jeong reported that ankle arthritis was more frequently encountered after TKA in knees with greater varus deformities.[9] Similarly, moderate or severe changes in proximal tibial alignment after HTO can significantly reduce the tibiotalar contact area, and therefore, cause an increase in intraarticular pressure in the ankle.[16]

In our study, we noticed that in the HTO group the change in the TPI was above 15 degrees in symptomatic cases and below 15 degrees in asymptomatic cases. Supportive of this finding of ours, it has been reported that posttraumatic coronal plane deformities up to 15 degrees in the proximal and middle regions of the tibia can be compensated by the subtalar joint clinically, radiologically and regarding the width of the weigh-bearing area on the ankle.[17-19] Our study had some limitations. Patients who underwent UKA were older, which can explain the preference of UKA over HTO in older cases with advanced joint degeneration. The relationship between the varus-valgus alignments of the ankle and the clinical outcomes was not evaluated since all our patients' ankles were in the varus position preoperatively. Despite the evaluation of the ankle joint regarding patient complaints, subtalar joint mobility could also be evaluated in order to eliminate possible bias. Our study demonstrates how the alignment of the ankle joints is affected after HTO and UKA, two frequently performed surgical procedures in medial arthrosis of the knee, and the clinical outcomes of this condition.

CONCLUSION

When planning an osteotomy or arthroplasty in the proximity of the knee joint, the orientation of the ankle joint, the presence of arthritis findings and the mobility of the subtalar joint should be evaluated before surgery in order to obviate possible postoperative ankle complaints. In preoperative planning, it should be noted that corrections up to 15 degrees can be tolerated by the ankle, whereas corrections with greater angles may aggregate the complaints. In conclusion, correct planning of the degree of overcorrection in HTOs is extremely important in terms of preventing future ankle complaints. It should be also kept in mind that UKA can be a good alternative to HTO in selected cases for postoperative ankle complaints.

AUTHORS' CONTRIBUTION: Each author contributed individually and significantly to the development of this article. AS: conceptualization, data analysis and final approval; YMD: data analysis, study supervision and article review; MUC: conceptualization, data analysis and article review; SK: conceptualization, data analysis and article review; BG: conceptualization and article review; MO: statistical analysis, study supervision and article review.

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DO THE CHANGES OF SCAPULOTHORACİC ANGLE AFFECT WİNGED SCAPULA DEVELOPMENT AND FUNCTİONAL SCORES DURİNG CLAVİCLE FRACTURE TREATMENT?

AS ALTERAÇÕES DO ÂNGULO ESCAPULOTORÁCICO AFETAM O DESENVOLVIMENTO DE ESCÁPULA ALADA E ESCORES FUNCIONAIS DURANTE O TRATAMENTO DE FRATURA DE CLAVÍCULA?

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ABSTRACT

Introduction: To compare surgical and conservative management of midshaft clavicle fractures according with scapulothoracic joint angle change, considering clinical, functional, and radiological outcomes. Methods: A total of 95 midshaft clavicle fracture patients aged between 18-70 years with a minimum follow-up duration of 12 months were included in this study. Patients were treated either conservatively (Group I) or surgically (Group 2). Plane deformities, scapulothoracic joint angle, shortness and isokinetic muscle strength were measured. Shoulder Pain, Disability Index (SPADI) and Short Form-36 (SF36) were assessed. Results: Scapulothoracic joint angles were higher in the conservative treatment group than in surgery group (p=0.036). Consequently, winged scapula was seen more commonly in the conservative treatment group than in the surgery group (p=0.001). Surgical treatment was associated with significantly better SF-36 physical scores and with SPADI pain and disability scores. However, the two groups did not differ in terms of isokinetic muscle strength. Negative anteroposterior plane deformity (p<0.001) and negative axial plane deformity (p=0.004) were more frequent in the conservative treatment group. Clavicle shortness was more common in the conservative treatment group. Conclusions: According to our findings scapulothoracic joint angle changes were seen in the conservative treatment group more than in the surgery group. Consequently, winged scapula was seen more commonly in the conservative treatment group than in the surgery group (p=0.001). ***Level of Evidence III; Retrospective comparative study.***

Keywords: Clavicle. Fracture, bone. Radiology. Scapula.

RESUMO

Introdução: Comparar o manejo cirúrgico e conservador das fraturas da diáfise da clavícula conforme alteração do ângulo escapulotorácico, considerando resultados clínicos, funcionais e radiológicos. Métodos: Um total de 95 pacientes com fratura do terço médio da clavícula com idade entre 18-70 anos, com um tempo mínimo de seguimento de 12 meses, foram incluídos neste estudo. Os pacientes foram tratados conservadoramente (Grupo I) ou cirurgicamente (Grupo 2). Deformidades planas, ângulo escapulotorácico, encurtamento e força muscular isocinética foram medidos. O Índice de Dor e Incapacidade do Ombro (SPADI) e a Short Form-36 (SF36) foram avaliados. Resultados: Os ângulos da articulação escapulotorácica foram maiores no grupo de tratamento conservador do que no grupo de cirurgia (p=0,036). Consequentemente, a escápula alada foi vista mais comumente no grupo de tratamento conservador do que no grupo de cirurgia (p=0,001). O tratamento cirúrgico foi associado a escores físicos SF-36 significativamente melhores e escores SPADI de dor e incapacidade. No entanto, os dois grupos não diferiram em termos de força muscular isocinética. A deformidade no plano anteroposterior negativo (p<0,001) e a deformidade no plano axial negativo (p=0,004) foram mais frequentes no grupo de tratamento conservador. O encurtamento da clavícula foi mais comum no grupo de tratamento conservador. Conclusões: De acordo com nossos achados, as alterações do ângulo escapulotorácico foram mais observadas no grupo de tratamento conservador do que no grupo de cirurgia. Consequentemente, a escápula alada foi vista mais comumente no grupo de tratamento conservador do que no grupo de cirurgia (p=0,001). ***Nível de Evidência III; Estudo comparativo retrospectivo.***

Descritores: *Clavícula. Fratura óssea. Radiologia. Escápula.*

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INTRODUCTION

Clavicle fractures constitute 2.6 to 4 percentage of all fractures,[1] and nearly 70% of these lesions occur at the mid-shaft region.[2,3] In midshaft clavicle fractures, displacement is either present at the time of initial insult or develop later.

Clavicle fractures can be treated either conservatively or surgically. Both treatments have high risk of malunion.[4] Despite the controversy surrounding the negative outcomes of clavicular malunion other than the cosmetic effect,[4] many studies have also reported loss of power, easy fatigability, numbness, or paresthesia of the arm in patients with clavicular malunion.[4]

Although clavicle shaft fractures have been traditionally managed conservatively in the past, recently surgery has also become a viable therapeutic option for these lesions depending on developing implant technology.[5,6] Currently the most commonly preferred surgical method is plate fixation, followed by elastic nails or intramedullary screws. The choice of treatment depends on several factors including the pre-fracture functional status, occupation involving heavy duty work, aesthetic concerns, and co-existent systemic conditions of the patient that may hamper surgery.

In this study, our aim was to compare surgical and conservative management of midshaft clavicle fractures for scapulo-thoracic angle change, clinical, functional, and radiological outcomes.

METHODS

Patients

A total of 95 midshaft clavicle fracture patients aged between 18 and 70 years were included in this study. They were treated either conservatively (Group 1) or surgically (Group 2), between March 2012 and March 2015 and follow-up lasted a minimum 12 months. The patients who were operated after initial conservative treatment, needed a revision surgery, had bilateral clavicle fractures, removal of implants, presence of congenital pseudo-arthrosis, history of or needed scapular surgery were excluded. The study protocol was approved by the local ethics committee. Conservative and surgical treatment groups were compared by means of scapulo-thoracic angle changes, clinical, radiological, and functional outcomes.

Indications for surgical treatment were as follows: displacement > 2 cm, shortening > 2 cm, fragmentation > 3 fragments, segmental fracture, open fracture, fracture threatening the surrounding soft tissue integrity, significant clinical deformity, scapular malposition as identified in the initial examination, poly-trauma requiring early functional restoration in the arm and weight bearing activity in the upper extremity, and willingness of the patient for rapid functional recovery. Other patients were managed conservatively.

Treatments

In patients with indication for surgery, an incision over the fracture line was made while the patient was in beach-chair position and the bone was exposed; if present, the butterfly fragment was fixed, followed by the temporary fixation of the main fragments by bone clamp. Then an appropriately curved plate was positioned superiorly with an adequate number of holes, and was fixed to the bone using screws in accordance with AO principles. A simple shoulder strap was prescribed to each patient postoperatively. Shoulder mobility, adherence to exercise, and potential complications were assessed at each routine follow-up visit. Nine months after surgery Shoulder Pain and Disability Index (SPADI) and Short Form-36 (SF36), were performed, and radiological assessments and isokinetic tests were done.

Radiological assessments

Anteroposterior (AP) plane deformity was estimated using the two lines passing from the medullary midline to medial or lateral fragments of the clavicle on AP radiographs. The angle between these two lines was AP plane deformity. Angling towards inferior or superior directions were considered negative or positive, respectively. Axial plane deformity was estimated using the two lines passing from the medullary midline to medial or lateral fragments of the clavicle on axial CT/MRI sections (Figure 1). The angle between these two lines was the axial plane deformity. Angling towards the anterior or posterior directions were considered negative or positive, respectively. The lines pass through the long axis of the fragments in the respective planes. The scapulo-thoracic angle was estimated using axial CT/MRI images and was defined as the angular difference on two sides formed by the intersection of the lines crossing the body of both scapulae and the tangential of the single line passing through the peak points of the ribs in both thoracic cages (Figure 2). If the scapulo-thoracic (ST) angle on the fracture side was greater than the non-fracture side, then this value was taken as a positive value, and vice versa. Presence of shortening was identified through the measurement of the line between the midline passing through the medial tip and the midline passing through the middle point of the fragments on AP radiographs. Since 20 mm is considered a critical threshold for the decision for surgery, fractures were stratified based on shortening as follows: 0 mm, < 20 mm, and ≥ 20 mm.

Functional assessments

Health-related quality of life was assessed using SF-36 scores.[7,8] SF-36 is divided into physical and mental sub-scales, with higher scores indicating better quality of life. The shoulder pain and disability were evaluated with SPADI scores,[9] which range between 0 and 100, with increasing scores reflecting more severe symptoms. The isokinetic muscle power of the shoulder during internal and external rotation was evaluated using a Biodex Sys3Pro (USA) Test and Exercise System (Figure 3). In order to minimize the effect of daytime fatigue on muscular power, the assessments took place between 10 and 12 a.m. Prior to the test, sub-maximal exercise of 5-minute duration was performed for warming the upper extremity with isokinetic ergometer. Then, patients sat in the seat with the hip and knees flexed at 90 degrees and the trunk was stabilized using

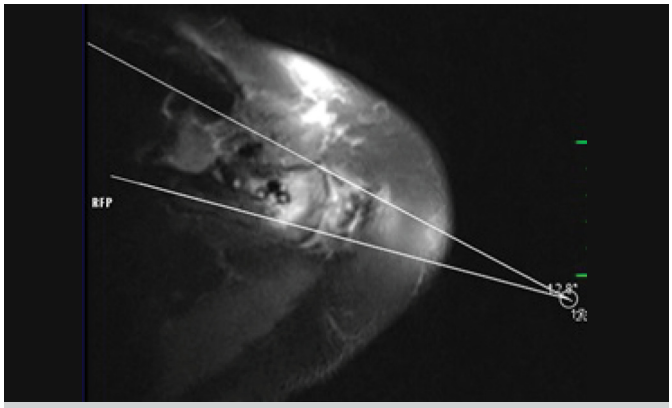

Figure 1. Axial plane defomity measurment.

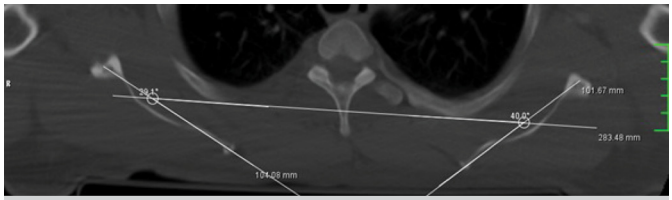

Figure 2. Scapulo-thoracic angle measurment.

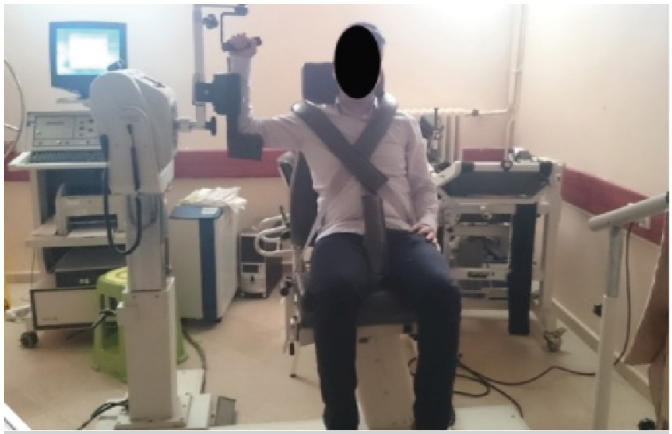

Figure 3. Isokinetic muscle power analyzes.

stabilizer bands. The elbow was placed in the elbow attachment of the device with the shoulder abducted at 90 degrees and elbow flexed at 90 degrees. The height of the dynamometer was adjusted according the axial center of the shoulder rotation. A correction factor was used for the gravity. Patients were provided information on the nature of the test and the exercise, and were asked to push and pull the effort arm as forcefully and quickly as possible. Initially exercise using three different angular velocities were performed in the concentric-concentric mode at 60 degrees/sec, 120 degrees/sec, and 180 degrees/sec (with three submaximal movements for warming up before the exercise). This was followed by three internal and external rotation movements at maximal force. For 90-degree ROM distance, the long axis of the forearm was at right angle to the ground surface at the start and fully parallel at the finish of the exercise during internal rotation, and during external rotation, the long axis was switched from a position fully parallel to the horizontal line to a position at right angle. Between each angular velocity, the intact side (control side) was allowed to rest for 2 minutes. For both upper extremities, peak torque/bw (maximal muscular power/weight in kg) corrected for weight was estimated. The percent deficit between the intact site and the fractured site was used for study analyses.

Statistical analysis

Statistical Package for Social Sciences version 16.0 (SPSS ver. 16.0) was used for the statistical analysis of data. Normality of continuous variables was tested with Kolmogorov-Smirnov test. Continuous variables were compared using Student's ''t''test for independent samples or Mann-Whitney ''U'' test depending on the normality of distribution. Categorical variables were compared using Chi-square or Fisher's Exact test, where appropriate. A p value <0.05 was considered indication of statistical significance.

RESULTS

In this study groups did not differ with regard to age, gender, fracture side, presence of additional trauma, occupation or AO classification of the fracture as demographic and clinical characteristics. However, trauma type distribution was significantly different in the two groups. About half of conservatively treated patients had fallen simply, and all patients who underwent surgery were injured with a high-energy trauma (Table 1).

In our study we found that scapulo-thoracic angle changes were statistically higher in conservative treatment group than in surgery group (p=0.036). Winged scapula was more common in the conservative treatment group (p=0.001) (Table 2). Negative AP plane deformity (p<0.001) and negative axial plane deformity (p=0.004) were more frequent in the conservative treatment group and shortness, either <20 mm (p<0.001) or ≥20 mm (p=0.024), was more common in the conservative treatment group.

Surgical treatment group was associated with significantly better SF-36 physical scores and SPADI pain, disability and total scores (Table 3). However, the two groups did not differ in terms of isokinetic muscle strength. Axial plane deformity of clavicle and scapulo-thoracic joint pain were statistically significant. Fracture skin irritation and level difference between shoulders were higher in patients who were treated conservatively. The highest SPADI pain score in surgical treatment group were found in patients who had skin scar. SPADI pain score was relevant in the patient who had skin irritation in conservative treatment group.

Table 1. Demographic and clinical characteristics of the groups.

	Group I Conservative treatment (n=60)	Group II Surgical treatment (n=35)	p
Age, y (mean SD)	33.1 12.8	35.3 12.8	0.409
Male gender	43 (71.7%)	26 (74.3%)	0.782
Right sided fracture	28 (46.7%)	14 (40.0%)	0.528
Additional trauma			
Scapula	4 (6.7%)	3 (8.6%)	0.461
Humerus	1 (1.7%)	1 (2.9%)	
Scapula plus humerus	0 (0%)	1 (2.9%)	
Rib	8 (13.3%)	5 (14.3%)	
Type of trauma			
Traffic accident (in vehicle)	14 (23.3%)[a]	18 (51.4%)	0.002
Traffic accident (outside of vehicle)	16 (26.7%)	11 (31.4%)	
Fall	27 (45.0%)[a]	4 (11.4%)	
Assault	2 (3.3%)	2 (5.7%)	
Simple trauma	1 (1.7%)	0 (0%)	
Occupation			
Heavy work	10 (16.7%)	10 (28.6%)	0.196
Light work	35 (58.3%)	14 (40.0%)	
Not working	15 (25.0%)	11 (31.4%)	
AO classification			
B1	40 (66.7%)	20 (57.1%)	0.353
B2-B3	20 (33.3%)	15 (42.9%)	

Table 2. Scapulothoracic angle changes.

Scapulothoracic angle changes	< 0	= 0	>0	
	Mean sd (Med, min, maks)	Mean sd (Med, min, maks)	Mean sd (Med, min, maks)	p
SF36 PCS	44,77 7,52[a]	51,23 7,83[b]	46,15 9,31	0,018*
Wing scapulae	0 (%0)[a]	1 (%2,1)[a]	14 (%73,7)[b]	<0,001*

DISCUSSION

According to our study winged scapula and higher scapulo-thoracic angle are more common in conservative treatment group. Shortening is higher in conservative treatment group. And increased scapulo-thoracic angle causes winged scapulae. Further winged scapulae can cause loss of power and acromioclavicular joint arthrosis. The results of our study suggest that improved radiological and functional outcomes may be obtained using a surgical approach for the management of midshaft clavicle fractures, which is increasingly preferred in recent years.[10] Also, to our knowledge, this study is the first of its kind to directly measure the impairment in the integrity of the scapulo-thoracic joint as well as representing one of the

Table 3. Comparison of functional and radiological outcomes.

	Group I Conservative treatment (n=60)	Group II Surgical treatment (n=35)	p
SF-36			
Physical score	47.5 7.6	52.6 8.0	0.003
Mental score	52.0 5.0	50.0 10.2	0.868
SPADI			
Pain score	31.9 17.6	27.0 25.4	0.018
Disability score	31.1 17.1	24.8 24.4	0.003
Total score	31.1 15.4	26.0 24.5	0.005
Winged scapula	18 (30.0%)	1 (2.9%)	0.001
AP plane deformity			
<0 degrees	50 (83.3%)	2 (5.7%)*	<0.001
0 degrees	6 (10.0%)	33 (94.3%)*	
>0 degrees	4 (6.7%)	0 (0%)	
Axial plane deformity			
<0 degrees	16 (26.7%)	1 (2.9%)*	0.043
0 degrees	41 (68.3%)	34 (97.1%)*	
>0 degrees	3 (5.0%)	0 (0%)	
Scapulothoracic angle difference			
<0 degrees	8 (16.7%)	2 (6.9%)	0.021
0 degrees	24 (50.0%)	24 (82.8%)*	
>0 degrees	16 (33.3%)	3 (10.3%)*	

few studies that involved a combined assessment of isokinetic measurements, shoulder scoring, and functional outcomes.

Until now, several studies have compared the outcomes of surgical and conservative management of clavicle fractures with controversial results. On the other hand, many reports have pointed out to an increased incidence of permanent shoulder dysfunction in adult patients with midshaft clavicle fractures treated conservatively, leading to the suggestions that surgery may represent a better option for preventing delayed complications and symptoms in displaced or irreducible fractures.[11-15] In a meta-analysis by Xu, J. et al.,[16] superior results have been identified with surgery than with conservative treatment, with plate fixation being associated with lower rates of non-union, complications, and symptomatic malunion. Again, in another meta-analysis by Wang X.H. et al. involving DASH, Constant Shoulder Score, complications, and sub-group (neurological symptoms, and complications other than non-union or symptomatic malunion) assessments, the authors have concluded that surgery may be a superior option for midshaft clavicle fractures.[17] However, these authors have not recommended the routine use of surgery as a primary option. In a 2015 study by Van der Ven Denise, J.C. et al., patients treated either surgically or conservatively were assessed using union, DASH shoulder scoring, Constant-Murley score, VAS pain scale, chronic complaints, as well as a questionnaire assessing patient satisfaction; it was found that patients in the surgical treatment group had less pain and higher function scores six weeks after surgery, although in the long term, i.e. after 24 weeks, there were no significant differences between the two methods in terms of functional outcomes.[18] In our study we found that there is less pain in surgery group than in conservative group similarly and pain in surgery group further occurs from the scar tissue in surgery area. Because of this we suggest surgeons to employ subskin suture for minimalize the scar tissue. In another study involving midshaft clavicle fractures with a follow up duration of more than 10 years,[19] 77% of the patients were treated conservatively with successful outcome, and the authors concluded that surgery should only be considered in patients with neurovascular problems or skin compromise. Furthermore, they also suggested that three out of four patients will undergo unnecessary surgery if surgical management is universally performed in all patients with displaced fractures. Altamimi SA et al. found better Constant scores and DASH scores in addition to improved patient satisfaction with surgery than with conservative management at 1 year.[20] Ban, I. et al., on the other hand, proposed that conservative management of midshaft clavicle fractures may represent a better therapeutic option on the basis of insufficient supportive evidence for surgery and also on the basis of the risk of overtreatment.[21]

Parry, J. A. et al. examined the outcomes with conservative and surgical treatments using Quick DASH Score, Constant Shoulder Score, and treatment satisfaction in a group of adolescents, and found excellent QuickDASH and Constant Shoulder Scores in both groups.[22] Better shoulder positioning and patient satisfaction were found in displaced midshaft clavicle fractures performed within 6 weeks following the injury in the study by George DM et al.[23] They suggested that early surgical management may be particularly appropriate for younger individuals, in subjects working in occupations requiring physical activity in the upper extremities, as well as in physically active individuals rather than the elderly or sedentary subjects.

In our study, shortening was more marked after conservative treatment. Stegeman SA et al. reported slight over protraction and lateral rotation as well as reduced back tilt in abduction in patients developing shortening after conservative management; also, during anteflexion, slight increase in winging in scapular orientation, slight increase in lateral rotation, and mildly reduced back-tilt were observed in the fracture side.[24] Despite these findings, Constant-Murley and DASH scores were excellent. Thus, it was concluded that negative impact of shortening may be minimal, obviating the need for surgery to achieve adequate bone length.

In the current study, better results were obtained with surgery in terms of AP plane deformity, axial plane, deformity, alteration in the scapula-thoraic angle, and wing-scapula development. Since surgery allows reconstruction of the anatomical structure, we may assume that the natural position is restored with regard to 3-dimensional angulation and scapular dyskinesia (winging) after surgery. Furthermore, SPADI scores (pain, disability, total) and SF36 physical scores exhibited a similar change after surgery, which yielded better results than conservative management with respect to these measures. As expected, wound site problems would occur at a higher rate with surgery. On the other hand, conservative management would be more likely to be associated with asymmetry and skin irritation due to impaired shoulder position, leading to a potential worsening in the physical scores after conservative therapy. This may explain the better functional and satisfaction outcomes with surgery than with conservative management in our patient group. Nevertheless, the choice of treatment should be determined based on a number of factors including the general status of the patient, fracture type, bone condition, and the expertise and knowledge level of the surgeon.

In conclusion, both conservative and surgical approaches may be used for the management of midshaft clavicle fractures. However, our results suggest better outcomes with surgery with respect to both radiological and functional assessments.

AUTHORS' CONTRIBUTION: Each author contributed individually and significantly to the development of the manuscript. MRK, IHK and MÖ were the main contributors in the drafting of the manuscript. MRK, IHK and OP made the surgery, ŞY, AS and MRK followed patients and gathered clinical data. MY and AÇY evaluated the data of the statistical analysis. MRK and MY performed the literature search, review of the manuscript and contributed to the intellectual concept of the study.

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EFFICACY OF EXTENDED ORAL TRANEXAMIC ACID ON BLOOD LOSS IN PRIMARY TOTAL KNEE ARTHROPLASTY

EFICÁCIA DO USO PROLONGADO DE ÁCIDO TRANEXÂMICO ORAL NA PERDA DE SANGUE NA ARTROPLASTIA TOTAL PRIMÁRIA DO JOELHO

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ABSTRACT

Introduction: Tranexamic acid is widely used for patients undergoing total knee arthroplasty (TKA). However, the duration of systemic tranexamic acid (TXA) administration varies in many reports. Hence, this study aims to compare blood loss between a single intravenous (IV) TXA dose, and one dose of IV TXA combined with oral TXA, during 48-hour postoperative care in primary TKA. Methods: Ninety-four patients with primary osteoarthritis, who underwent primary TKA, were randomized into two groups. The first group consisted of 47 patients and received a dose of 750 mg IV TXA and 750 mg oral TXA postoperatively at 8-hour intervals for 48 hours. In the second group, 47 patients received a single dose of IV TXA and a placebo at the same intervals for the same time duration. Hemoglobin (Hb) was measured at 4, 24 and 72 hours after operation. Results: The mean total blood loss were not different between the two groups (p=0.37). There was no difference in total Hb reduction or closed suction drainage outputs (p=0.9 and 0.07, respectively). Conclusion: The extended use of oral TXA for 48-hour postoperative care did not decrease the total blood loss following TKA compared with a single dose of IV TXA. ***Level Of Evidence I; High quality randomized trial.***

Keywords: Arthroplasty, Replacement, Knee. Tranexamic acid. Blood transfusion.

RESUMO

Introdução: O ácido tranexâmico é amplamente utilizado para pacientes submetidos à artroplastia total do joelho (ATJ). No entanto, a duração da administração de ácido tranexâmico sistêmico (ATS) varia em muitos relatórios. Assim, este estudo tem como objetivo comparar a perda sanguínea entre uma dose única intravenosa (IV) de ATS e uma dose de ATS IV combinada com ATS oral, no atendimento pós-operatório ao longo de 48 horas em ATJ primária. Métodos: Noventa e quatro pacientes com osteoartrite primária, submetidos a ATJ primária, foram randomizados em dois grupos. O primeiro grupo de 47 pacientes recebeu uma dose de 750 mg de ATS IV e 750 mg de ATS oral no pós-operatório, a cada 8 horas, durante 48 horas. No segundo grupo, 47 pacientes receberam dose única de ATS IV e placebo nos mesmos intervalos e pelo mesmo período de tempo. A hemoglobina (Hb) foi medida às 4, 24 e 72 horas de pós-operatório. Resultados: A média da perda sanguínea total não foi diferente entre os dois grupos (p = 0,37). Não houve diferença na redução da hemoglobina total ou saídas de drenagem de sucção fechada (p = 0,9 e 0,07, respectivamente). Conclusão: O uso prolongado de ácido tranexâmico oral por 48 horas de pós-operatório não diminuiu a perda total de sangue após ATJ em comparação com uma dose única de ATS IV. ***Nível de Evidência I; Estudo Clínico randomizado de alta qualidade.***

Descritores: *Artroplastia do Joelho. Ácido tranexâmico. Transfusão de sangue.*

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INTRODUCTION

Postoperative anemia, following primary total knee arthroplasty (TKA), is a problem related to postoperative allogeneic blood transfusions.[1] The drawbacks of allogeneic blood transfusions are associated with an increased risk of postoperative infection, transfusion reaction, and transfusion-transmitted viral infections; prolonged hospital stays; and increased costs of treatment.[2–4]

Presently, many strategies are being used to decrease blood loss and the rate of blood transfusions in patients undergoing TKA, including the use of tourniquets,[5] tranexamic acids (TXA),[6] topical fibrin sealant,[7] reinfusion drains,[8] and preoperative iron supplements,[9] or erythropoietin.[10]

Today, TXA is widely used by orthopedic surgeons to decrease postoperative blood loss in patients undergoing TKA.[11] The

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The study was conducted at Prince of Songkla University, Faculty of Medicine, Songkhla, Thailand.

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mechanism of action of TXA is antifibrinolytic function inhibiting clot lysis, which could decrease postoperative blood loss and the rate of allogeneic blood transfusions without increasing the risk of venous thromboembolism (VTE).[6] TXA could be administered in TKA patients through different routes, such as intravenous (IV),[12] oral,[13] intraarticular,[14] and soft tissue periarticular injections.[15] Several randomized control trials have shown no significant difference in the blood-sparing effect among the different forms of TXA.[16–18]
The duration of systemic TXA administration varies in many studies, from a single dose to an extended dose of 14 days,[19–21] because blood loss following TKA, including those from drainage and hidden blood loss, can occur for longer than 24 h postoperatively.[16] Thus, we hypothesized that extended duration of TXA administration could decrease the total blood loss and rate of allogeneic blood transfusions. However, a limited number of studies have compared single-dose TXA with multiple doses of TXA for up to 48 h of postoperative care. Thus, this study was conducted to compare the total blood loss and transfusion rates between a single dose of IV TXA and one dose of IV TXA combined with oral TXA for 48 h of postoperative care in patients undergoing primary TKA.

MATERIAL AND METHODS

This study was a prospective randomized controlled trial. The trial was conducted at a tertiary care hospital from January 2019 to March 2020. The procedures in this study were performed in compliance with the Declaration of Helsinki regarding ethical principles for medical research and experiments involving human subjects. This study was approved by the local Ethics Committee and Institutional Review Board. Written informed consent was obtained from each patient. This study was approved by the Ethics Committee and Institutional Review Board of the Faculty of Medicine, Prince of Songkla University (EC 61-228-11-1).
Thai Clinical Trials Registry (http://www.clinicaltrials.in.th) Registry number: TCTR20190114001

Participants

Patients with primary osteoarthritis aged less than 85 years scheduled for primary unilateral TKA were approached for possible inclusion in this study. The exclusion criteria were patients who were using anticoagulants, tretinoin, estrogen, or oral contraceptive pills before the operation; those with a history of deep vein thrombosis or pulmonary embolism and acute coronary syndrome or cerebrovascular accident; those with active cancer, end-stage chronic kidney disease, abnormal coagulation profile, and abnormal liver function test; those allergic to TXA; those who underwent previous knee surgery; patients required stemmed prosthesis; and those with a severe deformity that required extensive soft tissue release combined with a constrained implant or ligament reconstruction.

Accounting for all patients

One hundred and three patients were approached for possible inclusion in the study. Four patients declined to participate, and five patients were excluded because they had end-stage chronic kidney disease. Finally, 94 patients participated in the study. All patients completed the trial and were analyzed with intention-to-treat analysis.

Randomization

Block-of-four randomization was performed using computer-generated random numbers to randomize the patients into two groups. Sealed, opaque envelopes were used for allocating patients, and random allocation was conducted by a pharmacist, who was not associated with the study, at the inpatient hospital pharmacy before the patients went into the operating room. The first group, consisting of 47 patients, received 750-mg IV TXA 30 min before surgery and three capsules of 250-mg oral TXA 8 h at 8-h intervals for 48 h after surgery. The control group, consisting of 47 patients, received a single dose of 750-mg IV TXA 30 min before the operation and three placebo capsules, which looked identical to oral TXA capsules, after surgery at the same intervals for the same time (Figure 1).
All patients underwent the same surgical technique by a single surgeon and followed the same postoperative care protocol. A cemented, stabilized total knee prosthesis was used in all patients; additionally, the medial parapatellar approach was used in all patients. A pneumatic tourniquet was inflated from the skin incision until capsular closure was conducted. A femoral cut was performed with an intramedullary guide, while the proximal tibia was cut with an extramedullary guide. The patella was not resurfaced. A closed suction drain was applied before capsular closure. The drain tube was clamped for 3 h after the operation, released, and then removed on postoperative day 2. A rehabilitation protocol for ankle pumping, quadriceps isometric, and range of motion exercises was started immediately after the operation. On the day after the operation, the patients had ambulation training using a walker. All patients received a tablet of aspirin (81 mg) two times a day for VTE prophylaxis. Paracetamol (500 mg) tablets every 6 h were prescribed for all patients. If the patient had a verbal numerical pain score of more than 4, an injection of IV fentanyl (30 mcg) was administered as rescue pain medication every 2 h.
Postoperative hemoglobin (Hb) levels were measured 4, 24, and 72 h after surgery. The indication for allogeneic blood transfusion was Hb of less than 9 g/dL or if the patient had symptoms of anemia. Total blood loss was calculated from patient baseline characteristics, Hb level 72 h after surgery, and volume of blood transfusion using the Hb-balance method.[22] The number of units of allogeneic blood transfused and postoperative complications was recorded.

Statistical analysis

Patient demographic data, such as age, body mass index (BMI), preoperative Hb level, preoperative hematocrit (Hct), platelet count, tourniquet time, operative times, postoperative blood loss, postoperative Hb loss, Hct reduction, and closed suction drainage output, were compared between the groups using the independent t-test. Pearson's χ^2 test was used for evaluating gender, operative side, American Society of Anesthesiologists (ASA) classification, and transfusion rates.

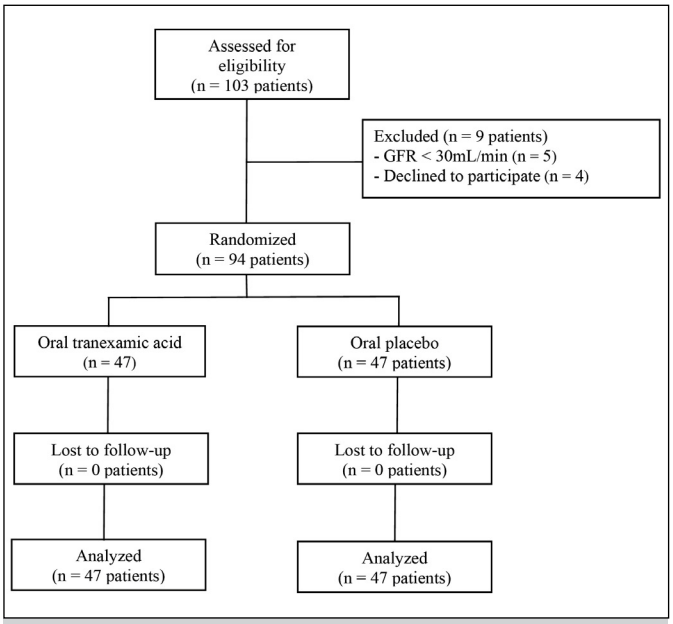

Figure 1. Flow study diagram.

The analyses were performed using R, version 3.1.0 (R Foundation for Statistical Computing, Vienna, Austria). A *p*-value of less than 0.05 was used to denote statistical significance. The sample size was calculated based on a previous TXA study involving patients undergoing TKA[15] for testing two independent means. Forty-seven patients per group were required to detect a significance level of 0.05, and power was set at 0.8 to detect a difference of 175 mL of postoperative blood volume.

RESULTS

No differences in patient demographic data, including age, gender, operative side, BMI, ASA classification, preoperative Hb level, preoperative Hct, platelet count, tourniquet time, and operative times, were observed between the two groups (Table 1).

Postoperative outcomes are shown in (Table 2). No differences in the mean total blood loss and blood loss during the first 24–72-hours after surgery were observed between the two groups ($p = 0.37$ and 0.76, respectively). Additionally, no differences in the total Hb reduction, Hb loss during the first 24–72 h postoperatively, and total Hct reduction were observed ($p = 0.9$, 0.84, and 0.97, respectively). Although the extended TXA group had lower closed suction drainage outputs than the control group, it did not reach statistical significance ($p = 0.07$). Among the patients in the extended TXA group, 8.5% (4/47) received blood transfusions, whereas no patient in the control group received blood transfusions; the difference was statistically significant ($p = 0.04$).

No postoperative complications, including deep vein thrombosis, pulmonary embolism, wound hematoma that required reoperation, prolonged wound discharge, and superficial or deep wound infections, were observed in both groups.

DISCUSSION

Currently, total blood loss and allogeneic blood transfusions in patients undergoing TKA could be decreased by several methods.

Table 1. Demographic data.

	Extended TXA group (n = 47)	Control group (n = 47)	p-value
Age (Year)	68.3 ± 7.9	67.6 ± 8	0.69
Gender (Male/Female)	7:40	2:45	0.08
Side (Left/Right)	20:27	22:25	0.68
ASA (1:2:3)	1:38:8	1:37:9	0.96
BMI (kg/m^2)	27.5 ± 4.6	28.7 ± 3.7	0.19
Pre-op Hb (g/dL)	12.9 ± 1.3	12.5 ± 1.1	0.20
Pre-op Hct (%)	39.5 ± 3.9	38.6 ± 3.1	0.21
Platelet count (x 10^3 / L)	262.57 ± 61.91	269.53 ± 55.29	0.57
Operative time (Min)	76 ± 24	73 ± 15	0.45
Tourniquet time (Min)	55 ± 18	54 ± 15	0.92

Table 2. Post-operative outcomes.

Outcome	Extended TXA group (n = 47)	Control group (n = 47)	P-value
Total blood loss (mL)	740 ± 295	691 ± 218	0.37
Blood loss during 24-72 hrs	166 ± 153	176 ± 164	0.76
Total Hb loss (g/dL)	2.4 ± 0.9	2.4 ± 0.8	0.90
Hb loss during 24-72 hrs	0.5 ± 0.5	0.5 ± 0.5	0.84
Total Hct reduction (%)	7.3 ± 2.7	7.3 ± 2.5	0.97
Closed suction drainage outputs (mL)	471 ± 215	547 ± 185	0.07
Transfusion (n)	4	0	0.04

One of these methods is TXA administration, which decreases postoperative blood loss and allogeneic blood transfusions without increasing the rate of VTE.[6]

In a study, Helito et al.[23] compared IV TXA, topical hemostatic agents, and placebo; and reported that TXA had results comparable to those of topical hemostatic agents in terms of postoperative Hb reduction, and TXA was associated with less blood loss compared with placebo.

While many studies support the efficacy of IV and oral TXA in patients who underwent TKA, most have used TXA for a short time. However, blood loss following TKA can continue for longer than 24 h postoperatively.[16] Therefore, we hypothesized that extended doses of TXA decreased both total blood loss and the rate of allogeneic blood transfusions. However, this study found that extended doses of oral TXA did not decrease postoperative blood loss or allogeneic blood transfusions.

Furthermore, this study found no differences in total blood loss and blood loss during the first 24–72 h following TKA between patients who had IV TXA combined with extended oral TXA and those who received a single dose of IV TXA. Our findings conform to those of the trial by Li et al.,[21] who compared patients receiving IV TXA before surgery and at the time of wound closure and then received supplemental IV TXA twice daily on postoperative days 1 and 2 with those who had only two doses of IV TXA. This study found no difference in total blood loss among the patients in both groups. However, another study contradicted our results. Wang et al.[20] reported that patients undergoing TKA who received IV TXA before surgery and then 3 h postoperatively with oral TXA from postoperative day 1 to 14 had less total blood loss than patients who had only two doses of IV TXA on an operative day.

Our results demonstrated that patients in the extended oral TXA and control groups had no difference in postoperative Hb reduction. This study reported results similar to those reported by Li et al.[21] and Wang et al.,[20] who reported that the extended use of TXA for 2 or 14 postoperative days did not outperform two doses of IV TXA. In addition, we found that close suction drain output in the extended oral TXA group was not significantly lower than that in the control group. Similarly, studies have found that patients who received extended TXA for two postoperative days did not have lower drain output than those who received two doses of IV TXA. [21]

In this study, the blood transfusion rates in the control group were lower than that in the extended oral TXA group with a statistical significance. We pondered this finding because we could not find any studies reporting on this issue. A randomized controlled trial by Iwai et al.[24] has reported no difference in blood transfusion rates in patients undergoing TKA who received a single dose of IV TXA compared with those in patients who received two doses of TXA. Besides, the studies by Li et al.[21] and Wang et al.[20] have reported that the extended use of TXA over 1 day did not show a reduction in the blood transfusion rate. In this study, four patients received blood transfusions, all of whom were from the extended oral TXA group. We hypothesized that this curious finding was caused by two reasons. First, the threshold for blood transfusion in this study (Hb < 9 g/dL) was lower than that in previous studies (Hb = 7–8 g/dL).[20,21,24] We considered using Hb < 9 g/dL as the threshold based on the study by Cardozo et al.[25] that set this Hb value as a minimum threshold for transfusion relative to clinical symptoms. In this study, one patient who received an allogeneic blood transfusion 4 h after surgery had Hb of 7.8 g/dL. However, the three remaining patients received blood transfusion 24 h after surgery because the Hb levels were 8.5, 8.6, and 8.8 g/dL,

respectively, 24 h after surgery. All four patients did not have anemic symptoms.

Second, three patients who received blood transfusions in the extended oral TXA group were in the top 4.23% of all patients who had the lowest Hb levels (9.0, 10.5, and 10.9 g/dL, respectively). Thus, we hypothesized that the reason why the extended oral TXA group had a higher rate of blood transfusion than the control group is by chance, but it might be because of an undiscovered reason. This study had some limitations. First, the threshold for blood transfusion in this study was lower than that in other studies. Therefore, patients who had lower baseline Hb might have a higher chance of receiving a blood transfusion, even though no anemic symptoms were observed. Second, this study was underpowered according to the post-hoc analysis due to the lower than expected differences in total blood loss. Nonetheless, we believe that this study provides valuable data, proposing further investigation on this subject.

CONCLUSION

In conclusion, this study demonstrated that the extended use of oral TXA for 48 h postoperatively did not decrease the total blood loss or the number of blood transfusions following TKA compared with a single dose of IV TXA.

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OSTEOMETABOLIC

EVALUATION OF MANAGEMENT OF PATIENTS WITH OSTEOPOROTIC FRACTURES BY ORTHOPEDIC RESIDENTS: A CROSS-SECTIONAL OBSERVATIONAL STUDY

AVALIAÇÃO DO MANEJO DE PACIENTES COM FRATURAS OSTEOPORÓTICAS POR RESIDENTES DE ORTOPEDIA: UM ESTUDO TRANSVERSAL OBSERVACIONAL

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ABSTRACT

Objective: To assess whether residents (R1, R2, or R3 - according to the year of residency) of a tertiary orthopedic service investigate, treat and/or refer the patient with osteoporotic fracture for osteoporosis (OP) treatment and whether this learning is improved over the years of residency. Methods: Residents answered diagnostic and therapeutic questions related to a clinical case of osteoporotic fracture (OF) in 4 settings, which were initial care in the emergency room, at discharge, during outpatient follow-up at 3 and 6 months. Responses were compared between years of residency. Results: Twenty R1, 21 R2, and 19 R3 raised the questions. One resident treated osteoporosis in R1, two in R2, and four in R3. Seventy-five percent of R1, 90.5% of R2, and 68% of R3 referred patients for OP treatment. Over the years, there has been improved prescribing lab tests for osteoporosis ($p = 0.028$), with 52.6% of third-year residents prescribing adequate lab tests. In the same period, 100% of R3 correctly prescribed prophylaxis for deep vein thrombosis ($p = 0.001$). Conclusion: There is learning, but not enough, for secondary prevention of FO. ***Level of Evidence I; Prospective Comparative Study.***

Keywords: Osteoporotic fracture. Secondary Prevention. Brazil. Orthopedics. Health knowledge, Attitudes and Practice.

RESUMO

Objetivo: Avaliar se residentes (R1, R2 ou R3 - de acordo com o ano de residência) de um serviço ortopédico terciário, investigam, tratam e/ou encaminham o paciente com fratura osteoporótica para tratamento de osteoporose (OP) e se esse aprendizado é melhorado ao longo dos anos de residência. Métodos: Os residentes responderam a questões diagnósticas e terapêuticas relacionadas a um caso clínico de fratura osteoporótica (OF) em 4 cenários, que foram o atendimento inicial no pronto-socorro, no momento da alta hospitalar, durante o acompanhamento ambulatorial em 3 e 6 meses. As respostas foram comparadas entre os anos de residência. Resultado: Vinte R1, 21 R2 e 19 R3 levantaram as questões. Um residente tratou osteoporose em R1, dois em R2 e quatro em R3. Setenta e cinco por cento de R1, 90,5% de R2 e 68% de R3 encaminharam pacientes para tratamento com OP. Há melhora na prescrição de exames laboratoriais para investigação de osteoporose ao longo dos anos ($p = 0,028$) com 52,6% dos residentes do terceiro ano que prescrevem exames laboratoriais adequados. No mesmo período, 100% de R3 prescreveram corretamente a profilaxia para trombose venosa profunda ($p = 0,001$). Conclusão: Há aprendizado, porém insuficiente, para a prevenção secundária da FO. ***Nível de Evidência I; Estudo Prospectivo Comparativo.***

Descritores: *Fraturas por osteoporose. Prevenção secundária. Brasil. Ortopedia. Conhecimentos. Atitudes e Prática em Saúde.*

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INTRODUCTION

Osteoporosis is the most common bone disease,[1] characterized by a progressive decrease in bone mass, leading to decreased bone strength and an increased risk of fractures[1] being considered a public health problem, since 50% of women and 20% of men over 50 years old will suffer osteoporotic fractures (OF) at some point,[2] being responsible for an expenditure of USD $ 310 million in 2018 in Brazil.[3]

With the aging of the Brazilian population, the incidence of OF is expected to increase dramatically. It is estimated that the number of proximal femur fractures will increase from 80,640 in 2015 to 198,000 in 2040.[4]

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, HC-FMUSP, São Paulo, SP, Brazil. Correspondence: Márcia Uchoa de Rezende. 333 Ovídio Pires de Campos St., Room 323B, Cerqueira Cesar, Sao Paulo, SP, Brazil. 05403-902. marcia.uchoa@hc.fm.usp.br

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In addition to the economic impact, OFs have a high social cost, since they are associated with an increase in the mortality rate, decreased independence,[5] loss of self-esteem, depression and distortion of body image.[6]

Despite the fact that osteoporosis treatment has been available since the 1990s, up to 80% of eligible patients do not receive treatment.[7] To reduce the impact of OF two intervention models have been proposed.

In the first model, there is a health professional dedicated to assessing patients and initiating treatment, when indicated. This model is commonly known as *fracture liaison service* (FLS).[8] Although these programs have proven to be cost effective[9] and capable of reducing mortality,[10] they are not easy to implement,[11] they have not been able to decrease the incidence of new proximal femur fractures, probably due to problems in the adherence to the program,[12,13] a problem faced by the program conceived by the group of osteometabolic diseases.[14]

The other model is based on the orthopedist's privileged position to diagnose osteoporosis, inform the patient about the disease, initiate investigation and treatment of osteoporosis when necessary.[15,16] The advantages of this type of approach are its ease of implementation by the orthopedist and the lack of necessity of a specific professional for this purpose, since protocols and strategies to assist the orthopedist already exist.[17–20]

Bearing in mind the importance of secondary prevention, this cross-sectional observational study aims to assess whether orthopedics residents of a tertiary service initiate the correct investigation and treatment, and / or refer the patient during OF care for the treatment of osteoporosis. To assess whether the training in orthopedics improves the management of osteoporosis, the responses of residents of the three years of specialization will be compared.

METHODS

Institute of Orthopedics and Traumatology, Hospital das Clínicas, Faculty of Medicine, University of São Paulo (IOT-HC-FMUSP) with approval by the Ethics Committee under the decision number: 4.334.441, and Ethics Committee for Analysis Certificate (CAAE) number: 38218820.1.0000.0068. Registered on the clinicaltrials.org website under the number: NCT 04911946.

Resident of the first, second and third year of orthopedics and traumatology at IOT-HC-FMUSP.

Inclusion criteria

Physicians enrolled in the medical residency program in orthopedics and traumatology at IOT-HC-FMUSP.

Exclusion criteria

Abandonment or transfer of, or withdrawal or eviction from the medical residency program in orthopedics and traumatology at IOT-HC-FMUSP.

Questionnaire

After signing the informed consent form agreeing to participate in the study, the participants answered the questionnaire summarized in (Appendix 1).

All residents answered the questionnaire after a preceptorship meeting in June 10, 2021.

The responses were divided into "Adequate", "Inappropriate" and "Absent", based mainly on the Brazilian consensus for diagnosis and treatment of osteoporosis after menopause (routine tests: complete blood count, calcium, phosphorus, alkaline phosphatase, thyroid function tests, 25 hydroxy-vitamin D, densitometry)[21] (Figure 1).

The questionnaires were digitized and stored on the Google drive, in addition to being filed in the osteometabolic disease group room. The responses to the questionnaires were tabulated on a google spreadsheet, with an updated copy kept in the cloud and another copy kept in the computer of the group of osteometabolic disease group.

Outcomes

Primary

• Assess whether the residency program is enabling the resident of IOT-HC-FMUSP to carry out secondary prevention of osteoporotic fracture, by investigating and treating osteoporosis appropriately, based mainly on the Brazilian consensus for the diagnosis and treatment of osteoporosis after menopause.[21]

Secondary

• Assess whether the residents of the IOT-HC-FMUSP, when not starting the investigation and treatment of osteoporosis, refer the patient to another professional to conduct the case.

• Assess whether more senior residents master the osteoporosis treatment.

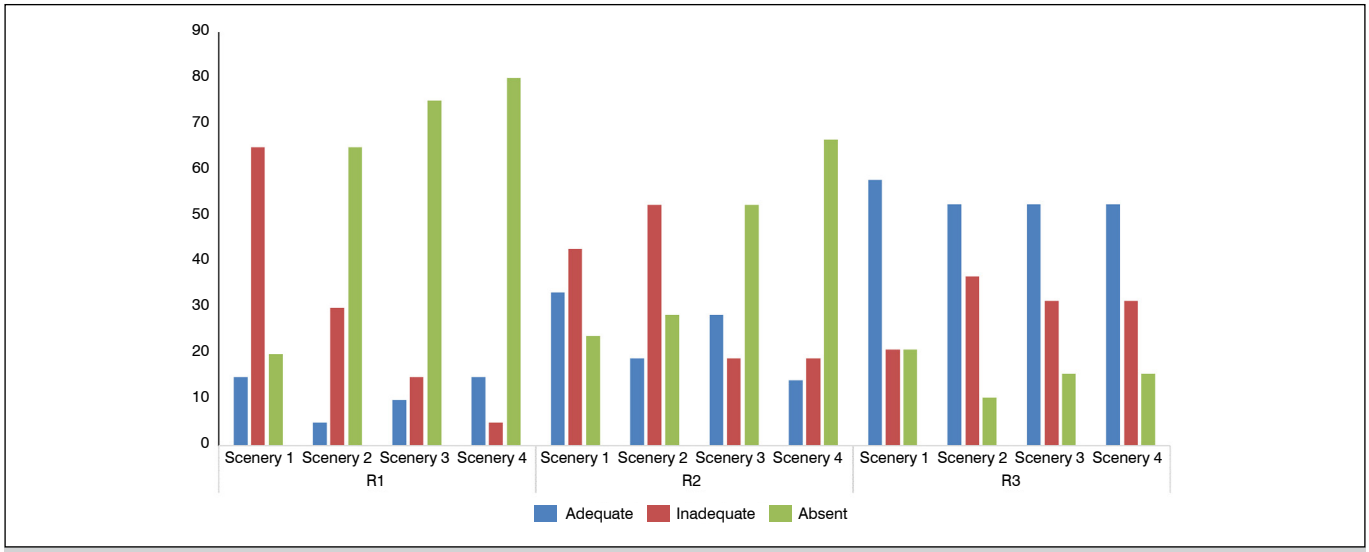

Figure 1. Percentage of adequate, inadequate and absent conducts written by residents of the first (R1) and third year (R3) of training.

Risk of bias

To reduce the chance of bias, all residents answered the questionnaire during a meeting between the residents and the preceptor.

Calculation of the sample

The sample of 60 residents was obtained for convenience, as this is the number of residents of the IOT-HC-FMUSP in 2021, except for the resident who executed the study.

Randomization

Due to the nature of the study, randomization was not performed.

Blinding

Due to the nature of the study, blinding is impossible.

Statistical analysis

Ages were described according to groups using means and standard deviations and compared between groups using analysis of variances, whereas the other characteristics of residents, as well as the adequacy of the conducts in different scenarios were described according to groups using frequencies. Associations of residents' characteristics were assessed between groups using likelihood ratio tests or chi-square test of trend.

The conducts taken were compared between groups of residents using generalized estimation equations with marginal Poisson distribution and identity link function, assuming a first-order auto-regressive correlation matrix between the scenarios for all analyzes and followed by Bonferroni's multiple comparisons to identify between which groups of residents there were differences in behavior when significant.

The analyzes were performed using the *software* IBM-SPSS *for Windows* version 22.0 and tabulated using the *software* Microsoft-Excel 2003 and the tests were performed with a significance level of 5%.

RESULTS

Sixty residents (20 R1, 21 R2, and 19 R3) answered the questionnaire. There was no loss in the number of residents. Their baseline data are shown in (Table 1). The longer the residence time, the better the training and the ability to properly classify the fracture of the clinical case in scenario 1.

The description of the levels of adequacy of the conducts for the criteria evaluated according to the groups of residents and scenarios with the comparative tests are shown in (Table 2). One resident treated appropriately (prescribed correct dosages of calcium, vitamin D and bisphosphonate, in addition to referral for clinical treatment) osteoporosis in R1, 2 in R2 and 4 in R3. Over the years, there was an improvement in the request for laboratory tests that included the analysis of the bone metabolic profile for osteoporosis ($p = 0.028$) and in the prescription of anticoagulant for the prophylaxis of deep vein thrombosis (knowing when to prescribe and when to stop) (Table 2).

Among the R1, 4 residents in 20 (20%) requested laboratory tests and referred for osteoporosis treatment. One resident (5%) requested laboratory tests but did not refer for treatment or prescribe treatment for osteoporosis. Eleven (55%) did not request tests but referred for osteoporosis treatment and four residents (20%) did not order tests, did not prescribe treatment or referred for osteoporosis treatment. Fifteen of 20 residents (75%) referred for the treatment of osteoporosis.

Nine out of 21 second-year residents (43%) requested laboratory tests and referred for osteoporosis treatment. Two (9.5%) requested laboratory tests and did not refer for osteoporosis treatment. One of these two prescribed only calcium. Ten R2 (47.5%) did not request blood tests but referred for the treatment of osteoporosis. Nineteen out of 21 (90.5%) referred for the treatment of osteoporosis.

Ten out of 19 R3 (53%) requested laboratory tests and referred for the treatment of osteoporosis. Three out of 19 (15.75%) did not request exams but referred for the treatment of osteoporosis. Another 3 (15.75%) requested laboratory tests and did not refer for clinical treatment and 6 (31.5%) did not ask for tests or referred for the treatment of osteoporosis. Among the R3, 13 out of 19 (68%) referred for clinical treatment of osteoporosis.

The improvement in the prescription of laboratory tests can be seen in (Table 3) where the difference is only between R1 and R3. It has been progressively improving in such a way that there are no significant differences between R1 and R2 and between R2 and R3, only between R1 and R3 (Table 3). Enoxaparin really should not be in the prescriptions for scenarios 3 and 4, but more among the R1 the absence was at all times and not only in the scenarios 3 and 4, a fact that the R2 and R3 comment that it is no longer indicated and had been prescribed in scenarios 1 and 2.

Table 1. Description of residents' characteristics according to groups and result of statistical tests.

Variable	R1 (N = 20)	R2 (N = 21)	R3 (N = 19)	Total (N = 60)	p
Age (years)					0.286**
average SD	27.9 ± 1.8	28.8 ± 2.5	28.7 ± 1.5	28.4 ± 2	
Nationality					0.904#
Brazilian	17 (85)	18 (85.7)	17 (89.5)	52 (86.7)	
Foreign	3 (15)	3 (14.3)	2 (10.5)	8 (13.3)	
Classification					0.007
Adequate	10 (50)	16 (76.2)	17 (89.5)	43 (71.7)	
Inadequate	10 (50)	5 (23.8)	2 (10.5)	17 (28.3)	

Chi-square trend test; # Likelihood ratio test; ** ANOVA

DISCUSSION

Postmenopausal osteoporosis has a major impact on the health budget worldwide. Undertreatment of osteoporosis is a well-known phenomenon, especially in elderly patients. Hospital initiation is one of the options to increase treatment rates and improve control of osteoporosis. However, several factors contribute to the failure to initiate adequate treatment of osteoporosis in patients with fragility fractures. This includes the lack of knowledge about osteoporosis and the lack of treatment guidelines among family doctors and orthopedic surgeons.[16, 17, 19, 22, 23] In addition, orthopedic surgeons hardly accept their responsibility for the treatment of osteoporosis, as they are not familiar with the treatment of osteoporosis.[19]

According to DataSUS,[24] in 2020 hospitalizations and surgeries were recorded for 34,430 patients with osteoporotic fractures (femoral neck and transtrochanteric) in Brazil. In 2019, that number was 34,841. However, outpatient follow-up for these patients in 2020 was hampered by the COVID pandemic19. The initiation of treatment at the hospital is necessary when all outpatient support is restricted. Knowing what should be done and guiding the patient in the hospital environment is a great chance, even though knowing that less than half will continue the oriented treatment in the hospital environment.[16]

With this study we were able to assess whether residents had adequate knowledge and used it to initiate or institute secondary prevention of osteoporotic fractures and whether more advanced residents initiated the investigation, treatment and / or referral of patients with OF more frequently than first year residents.

Our sample is small (60 residents comprised of 20 R1, 21 R2 and 19 R3 that add up to the total number of residents in training in this tertiary care service) and, as expected, there is a direct relation between the resident's graduation and the ability to classify the fracture of the clinical case appropriately (Table 1).

Table 2. Description of the levels of adequacy of the conducts for the criteria evaluated according to groups of residents and scenarios and the result of the comparative tests.

Variable	R1				R2				R3				p
	Scenery 1 Number (%)	Scenery 2 Number (%)	Scenery 3 Number (%)	Scenery 4 Number (%)	Scenery 1 Number (%)	Scenery 2 Number (%)	Scenery 3 Number (%)	Scenery 4 Number (%)	Scenery 1 Number (%)	Scenery 2 Number (%)	Scenery 3 Number (%)	Scenery 4 Number (%)	
Laboratory													**0.028**
Adequate	3 (15)	1 (5)	2 (10)	3 (15)	7 (33.3)	4 (19)	6 (28.6)	3 (14.3)	11 (57.9)	10 (52.6)	10 (52.6)	10 (52.6)	
Inadequate	13 (65)	6 (30)	3 (15)	1 (5)	9 (42.9)	11 (52.4)	4 (19)	4 (19)	4 (21.1)	7 (36.8)	6 (31.6)	6 (31.6)	
Absent	4 (20)	13 (65)	15 (75)	16 (80)	5 (23.8)	6 (28.6)	11 (52.4)	14 (66.7)	4 (21.1)	2 (10.5)	3 (15.8)	3 (15.8)	
RX													**0.12**
Adequate	17 (85)	17 (85)	15 (75)	10 (50)	21 (100)	21 (100)	19 (90.5)	16 (76.2)	19 (100)	15 (78.9)	19 (100)	18 (94.7)	
Inadequate	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	
Absent	3 (15)	3 (15)	5 (25)	10 (50)	0 (0)	0 (0)	2 (9.5)	5 (23.8)	0 (0)	4 (21.1)	0 (0)	1 (5.3)	
BMD													**0.626**
Adequate	0 (0)	2 (10)	2 (10)	2 (10)	2 (9.5)	4 (19)	4 (19)	3 (14.3)	5 (26.3)	5 (26.3)	5 (26.3)	5 (26.3)	
Inadequate	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	
Absent	20 (100)	18 (90)	18 (90)	18 (90)	19 (90.5)	17 (81)	17 (81)	18 (85.7)	14 (73.7)	14 (73.7)	14 (73.7)	14 (73.7)	
Vitamin D													**0.365**
Adequate	1 (5)	1 (5)	2 (10)	2 (10)	3 (14.3)	6 (28.6)	12 (57.1)	11 (52.4)	5 (26.3)	5 (26.3)	5 (26.3)	5 (26.3)	
Inadequate	1 (5)	1 (5)	2 (10)	2 (10)	3 (14.3)	4 (19)	2 (9.5)	2 (9.5)	2 (10.5)	3 (15.8)	3 (15.8)	2 (10.5)	
Absent	18 (90)	18 (90)	16 (80)	16 (80)	15 (71.4)	11 (52.4)	7 (33.3)	8 (38.1)	12 (63.2)	11 (57.9)	11 (57.9)	12 (63.2)	
Calcium													**0.334**
Adequate	1 (5)	2 (10)	4 (20)	3 (15)	5 (23.8)	8 (38.1)	11 (52.4)	11 (52.4)	4 (21.1)	4 (21.1)	4 (21.1)	4 (21.1)	
Inadequate	0 (0)	0 (0)	0 (0)	1 (5)	1 (4.8)	2 (9.5)	1 (4.8)	1 (4.8)	2 (10.5)	3 (15.8)	3 (15.8)	2 (10.5)	
Absent	19 (95)	18 (90)	16 (80)	16 (80)	15 (71.4)	11 (52.4)	9 (42.9)	9 (42.9)	13 (68.4)	12 (63.2)	12 (63.2)	13 (68.4)	
Bisphosphonate													**0.433**
Adequate	1 (5)	0 (0)	4 (20)	2 (10)	3 (14.3)	5 (23.8)	7 (33.3)	7 (33.3)	6 (31.6)	6 (31.6)	6 (31.6)	6 (31.6)	
Inadequate	0 (0)	0 (0)	0 (0)	0 (0)	1 (4.8)	2 (9.5)	3 (14.3)	3 (14.3)	1 (5.3)	0 (0)	0 (0)	0 (0)	
Absent	19 (95)	20 (100)	16 (80)	18 (90)	17 (81)	14 (66.7)	11 (52.4)	11 (52.4)	12 (63.2)	13 (68.4)	13 (68.4)	13 (68.4)	
Enoxaparin													**0.001**
Adequate	18 (90)	15 (75)	3 (15)	0 (0)	20 (95.2)	19 (90.5)	18 (85.7)	3 (14.3)	19 (100)	19 (100)	9 (47.4)	9 (47.4)	
Inadequate	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	
Absent	2 (10)	5 (25)	17 (85)	20 (100)	1 (4.8)	2 (9.5)	3 (14.3)	18 (85.7)	0 (0)	0 (0)	10 (52.6)	10 (52.6)	
Referral													**0.881**
Adequate	4 (20)	13 (65)	11 (55)	10 (50)	8 (38.1)	10 (47.6)	12 (57.1)	11 (52.4)	9 (47.4)	11 (57.9)	9 (47.4)	10 (52.6)	
Inadequate	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	
Absent	16 (80)	7 (35)	9 (45)	10 (50)	13 (61.9)	11 (52.4)	9 (42.9)	10 (47.6)	10 (52.6)	8 (42.1)	10 (52.6)	9 (47.4)	

Generalized estimation equations (GEE) with Poisson distribution and identity link function.

Table 3. Result of multiple comparisons of the levels of adequacy of laboratory and enoxaparin conducts between groups of residents.

Variable	Comparison		Mean difference	Standard Error	p	IC (95%)	
						Low	Upper
Laboratory	R1 vs	R2	0.24	0.338	>0.999	-0.57	1.05
	R1 vs	R3	0.82	0.323	0.034	0.04	1.59
	R2 vs	R3	0.58	0.309	0.189	-0.17	1.32
Enoxaparin	R1 vs	R2	0.51	0.226	0.069	-0.03	1.05
	R1 vs	R3	0.83	0.221	0.001	0.3	1.35
	R2 vs	R3	0.31	0.201	0.363	-0.17	0.79

Bonferroni's multiple comparisons.

As for the investigation, there is a learning over the years of laboratory tests necessary for the investigation of osteoporosis in patients hospitalized for osteoporotic fractures (P = 0.028, Table 2) and this difference is clear between R3 and R1 (p = 0.034, Table 3). A parallel can also be drawn by the prescription of anticoagulant where all R3 knew the dose and time of administration of enoxaparin, remembering that the questionnaire left open questions with prescription and referral guidelines and what to be prescribed for hospitalization, at discharge and at 3- and 6-months follow-ups. All R3 did not know how to treat or refer for the treatment of osteoporosis.

The correct treatment of osteoporosis was described by 4 R3 (21%), 2 R2 (9.5%) and 1 R1 (5%), showing some degree of learning during the years of residency, but still an important knowledge deficit at the time, similar to that described in orthopedics and general practice.[17,19,22,23] The referral for the treatment of osteoporosis, in a first analysis of responses between the different scenarios, showed no differences between years of residence and learning (p = 0.881, Table 2). However, there were residents who referred them at discharge and not at follow-ups and vice versa. Looking at who referred at some point 75% of R1, 90.5% of R2 and 68% of R3 referred for clinical treatment of osteoporosis, showing that if there was any learning from the first to the second year of residency, there was loss or no improvement over time in training for R3 or even this class of R3 was less oriented in their training than the younger classes. Thus, despite the serious medical and socioeconomic consequences of fragility fractures, efforts to optimize the treatment and prevention of osteoporosis are still insufficient.[19]

Among the weaknesses of the study are: 1) Small sample, however the objective is to identify errors in the training of residents in orthopedics at this institution; 2) it is a cross-sectional study where we are not following the same residents in their 3-year training; 3) there is no control group from another orthopedics service or other clinical specialty. A strong point of the study is that it is an education and training service for orthopedic surgeons, who will certainly assist patients with osteoporotic fractures. This study has

the goal of identifying the flaws in the current training process, and therefore, suggesting measures to enable orthopedic surgeons in training in the management of osteoporosis.
We agree that orthopedic trauma surgeons can play a significant role in the diagnosis and treatment of osteoporosis in hospitalized patients and may be able to reduce the incidence of secondary frailty fractures,[16] but we still have to improve this training.

CONCLUSION

There is learning over the years of training in the orthopedics residency, but still insufficient, for the secondary prevention of OF.

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Appendix 1. Scenario 1 of osteoporotic fracture of the proximal femur.

Fracture image, diagnosis request and fracture classification (implied), and guidance on how to fill out prescriptions for blood tests and images and medications. Scenario 2 with the fracture fixed and requested discharge instructions. Scenario 3 (return of 3 months) with instructions for completing exams, drug prescriptions, referrals, guidelines. Scenario 4 (return of 6 months) and guidelines for completing possible exams, medications, referrals, therapies, care.

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HAND

EPIDEMIOLOGICAL ASPECTS OF DUPUYTREN'S DISEASE IN BRAZIL

ASPECTOS EPIDEMIOLÓGICOS DA DOENÇA DE DUPUYTREN NO BRASIL

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ABSTRACT

Objectives: The purpose of this study is to describe associated factors and epidemiological aspects of Dupuytren's Disease in patients followed up in a Brazilian tertiary public hospital, at the Hand Surgery service. Methods: A cross-sectional study was performed from 2014 to 2019. Data collected included: age, gender, ancestry, associated comorbidity presence, phenobarbital, tobacco, and alcohol use, family history of Dupuytren's Disease and associated fibrotic diseases. Then, the patients underwent a clinical examination to identify and characterize the involvement of the fingers. The patients were also assessed in regard to whether they presented Dupuytren's Disease severity factors. Results: 140 patients were included, 70.7% men and 29.3% women. Only 42.3% reported being of European ancestry; 20% had first-degree relatives with the disease; 59.3% presented comorbidities, including hypertension, diabetes, chronic heart disease, dyslipidemia, epilepsy, and HIV infection; 15.8% had Ledderhose disease, 7.1% had Peyronie's disease. 31% were smokers, 16.6% were alcoholic, and 37.1% were phenobarbital users; 40% presented with a severe form of DD. Conclusion: The population studied was composed of Brazilians, most of whom did not report European ancestry; still, they presented several characteristics similar to those described in literature worldwide. ***Level of Evidence II; Prognostic Studies; Investigating the effect of a patient characteristic on the outcome of a disease.***

Keywords: Dupuytren Contracture. Cross-Sectional Studies. Health Profile. Epidemiology.

RESUMO

Obejtivo: Descrever fatores associados e aspectos epidemiológicos da Doença de Dupuytren em uma população de pacientes acompanhados em serviço de Cirurgia de Mão de hospital público terciário brasileiro. Métodos: Realizou-se um estudo transversal entre os anos de 2014 e 2019. Coletamos dados como idade, gênero, ascendência, comorbidades associadas, doenças fibróticas associadas, uso de fenobarbital, uso de tabaco e álcool e histórico familiar de Doença de Dupuytren. Em seguida, realizamos exame clínico, caracterizando o acometimento dos dedos da mão. Também foi avaliado se os pacientes da amostra apresentavam fatores de gravidade da Doença de Dupuytren. Resultados: 140 pacientes foram incluídos, 70,7% eram homens e 29,3% mulheres. Apenas 42,3% dos pacientes relataram ascendência europeia; 20% apresentaram parentes de primeiro grau com a doença; 59,3% apresentaram comorbidades, incluindo hipertensão, diabetes, cardiopatia crônica, dislipidemia e infecção por HIV; 15,8% tinham doença de Ledderhose e 7,1% tinham doença de Peyronie. 31% eram fumantes, 16,6% declararam alcoolismo, 37,1% faziam uso de fenobarbital e 40% apresentaram a forma grave da DD. Conclusão: A população estudada foi composta por brasileiros que apesar de, em sua maioria, não relatarem ascendência europeia, apresentaram diversas características semelhantes às descritas na literatura mundial. ***Nível de Evidência II; Estudos Prognósticos; Investigação do efeito de característica de um paciente sobre o desfecho da doença.***

Descritores: Contratura de Dupuytren. Estudos Transversais. Perfil de Saúde. Epidemiologia.

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INTRODUCTION

Dupuytren's Disease (DD) is a chronic and progressive disease characterized by fibrotic changes in the palmar and digital fascia. Such changes can lead to small nodules on the hand, causing contractures that limit the extension of the fingers and, consequently, cause a significant functional impact.[1]

The etiology of the disease remains unknown. Genetic factors are suspected to be involved in pathogenesis, considering their heredity and racial predominance.[2] The incidence of DD is predominant in men, Caucasians, or Nordic origin, and the age onset is usually above 50 years.[3] Diabetes mellitus, hypercholesterolemia, liver disease, epilepsy, alcoholism, and smoking are comorbidities

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The study was conducted at Universidade de São Paulo, Faculty of Medicine, Hospital das Clínicas, Institute of Orthopedics and Traumatology, Hand Surgery Service, HC/FMUSP, São Paulo, SP, Brazil.
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associated with DD.[4,5] The literature also shows the use of anticonvulsants, local trauma, manual work activities, and low BMI as correlated factors.[4]
Despite the high prevalence and the documentation of several factors associated with DD in scientific studies, performed mainly in Europe, few studies analyze the epidemiological aspects of this pathology in Latin America and Brazil.[6]
This study aims to describe associated factors and epidemiological aspects of DD in patients followed up in a Brazilian tertiary public hospital, at the Hand Surgery service.

MATERIAL AND METHODS

A cross-sectional study was performed from 2014 to 2019 with patients followed up in a Brazilian Tertiary Public Hospital, at the Hand Surgery Outpatient Service. The inclusion criterion was: adults resident in Brazil previously diagnosed with DD after clinical evaluation performed by a specialist in Hand Surgery.
Although it is a tertiary hospital, at the outpatient service specialized in DD, we treat patients with varying degrees of clinic presentation, from nodules, without contractures to severe contractures. This is mainly because patients arrive at the clinic not only through the referral system. There is also a spontaneous demand, since there is an advertisement on the internet informing that we accept to follow up and treat new patients with DD.
Patients were invited and submitted to individual interviews. Data collected included: age, gender, ancestry, associated comorbidities, phenobarbital, tobacco, and alcohol use, family history of DD, and associated fibrotic diseases (Ledderhose and Peyronie's disease). The patients underwent a clinical examination to identify and characterize the involvement of the fingers. It was also assessed whether the patients presented with DD severity factors (diathesis score).[7] The occurrence of bilateral palmar disease, family history of DD, association with Ledderhose disease, disease onset under 50 years of age, male gender, and involvement of the thumb or more than two fingers were considered severity criteria.
The data obtained was stored and organized in a table on the REDCap platform. Then, a descriptive analysis of the collected variables, including quantitative and qualitative aspects, was performed.
The study was approved by the Ethics Committee of the Hospital under the number 2.071.185, and the patients included signed a Free and Informed Consent Form to participate in the study.

RESULTS

In our study, 140 patients were included, 99 men (70.7%) and 41 women (29.3%), in a 2.4:1 ratio. The mean age was 62.6 years, with a minimum age of 38 years and a maximum age of 85 years. (Figure 1) shows the age distribution curve of patients studied.
The study sample was stratified by age into four groups to complement the analysis. Patients aged up to 50 years were included in group A, composed of 16 patients, 13 men (81.3%), and three women (18.7%). Those aged between 51 and 60 years were included in group B, composed of 45 patients, 32 men (71.1%), and 13 women (28.9%). Patients aged between 61 and 70 years were included in group C, composed of 46 patients, 30 men (65.3%), and 16 women (34.7%). And those over 70 years were included in group D, composed of 33 patients, 24 men (72.7%), and nine women (27.3%). (Figure 2) shows the gender distribution between these Groups.
When questioned about their ethnicity, 65 patients (50%) declared to be Brazilian, denying any known foreign ancestry. On the other hand, 55 patients (42.3%) reported being of European ancestry. Four patients (3.1%) claimed to be of Asian ancestry and two (1.5%) of African ancestry. Only three patients (2.3%) declared to be unaware of their ancestry. Four patients who were not born in Brazil were included in this study: two of them were born in Portugal, one in Lebanon, and one in Paraguay.
Regarding the family history of DD, 28 patients (20%) reported having first-degree relatives with the disease. Out of the total sample, 83 patients (59.3%) presented with known clinical comorbidities. The following comorbidities were reported: 56 (40%) patients were hypertensive, 27 (19.3%) were diabetic, 16 (11.4%) had a chronic heart disease, 13 (9.3%) had dyslipidemia, 8 (5.7%) had epilepsy, and 1 (0.7%) was HIV-positive.
Regarding the associated fibrotic pathologies, 19 patients (15.8%) had Ledderhose disease, and nine patients (7.1%) had a previous diagnosis of Peyronie's disease.
The questionnaire included an assessment of patients' habits, as well as of chronic use of medications. Forty patients (31%) were smokers, and 21 patients (16.6%) declared alcoholism. Also, 52 patients (37.1%) were Phenobarbital users.
During clinical evaluation, 41 patients (32.6%) presented with involvement of only one hand, while 85 patients (67.4%) presented with bilateral involvement. In the study, the ulnar digits were the most affected. The thumb involvement frequency corresponded to 41 cases (29.2%), while there were 18 cases (12.8%) of index involvement, 60 cases (42.8%) of middle finger involvement, 133 cases (95%) of ring finger involvement, and 111 cases (79.2%) involving the 5th finger.
Regarding the diathesis score, the prevalence of those risk factors was analyzed separately in this study. Bilaterality was observed in 67.4% of cases; positive family history, in 20%; association with Ledderhose disease, in 15.8%; Peyronie's disease, in 7.1%; symptoms onset before 50 years of age, in 11.4%; male gender, in 70.7%; and 1st ray involvement, in 29.2%. Finally, 56 patients (40%) presented with a severe form of DD, characterized by the presence three or more diathesis criteria, 42 patients (30%) presented 2 of those risk factor, 32 patients (22,8%) presented 1 risk factor and 10 patients (7,2%) did not present any risk factors.

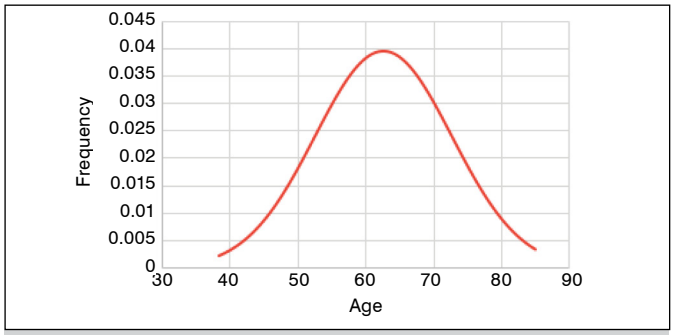

Figure 1. Age distribution of the study sample.

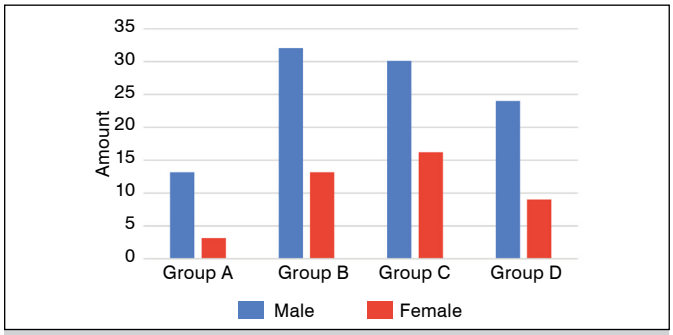

Figure 2. Gender distribution according to the age stratification.

DISCUSSION

The epidemiological aspects of DD have been widely studied by researchers worldwide, mainly in Europe. However, few studies analyze these factors in the Latin American population. Although there are no studies regarding the prevalence of DD in Brazil, the frequency of cases seems to be quite relevant in the outpatient routine.
The epidemiology of some diseases has been changing over the years in Brazil due to the intense European immigration, especially in the 20th century, and to the well-known miscegenation that occurred throughout our history. Published studies show that DD is more common in Caucasian men from Northern Europe.[3] Although DD etiology remains unknown, case reports of the disease concerning identical twins and the heredity of the disease suggest a genetic cause[8] In this study, 47% of the patients are of foreign ancestry, mainly of European origin, also including two European-born patients. It is also observed that 20% of the patients evaluated have first-degree relatives with DD, corroborating data found in the literature on the disease genetic association and relation with European ancestry. In contrast, most of our patients (53%) are of no European ancestry, which may be related to the history of the miscegenation of the Brazilian population.
The literature points to a higher prevalence of DD in male individuals. In our study, its incidence was 2.4 times higher in men than in women, which is considerably lower than the ratio found in Europe (5.9:1) and higher than the one found in Korea (1.9:1) and in another brazilian study (1.2:1).[6,9,10] The mean age of patients was 62.6 years, and a later presentation of the disease onset was observed in women, which is consistent with previous studies.[11] A study conducted in Europe also showed that the mean age at diagnosis was 62 years.[12] Regarding comorbidities, it is known that systemic arterial hypertension is not a disease commonly related to DD; however, the association is frequent due to the high mean age of the affected population.[9] 40% of the patients in our study are hypertensive, but there is not a significant difference to the prevalence of such comorbidity in the Brazilian population, considering the mean age of the sample.[13] Mansur et al. also reported a high prevalence of arterial hypertension on the brazilian patients with DD.[6] Further studies are needed to understand the actual association of systemic arterial hypertension with DD.
Studies show that diabetes mellitus is a risk factor for DD, especially in insulin-dependent patients. Diabetes mellitus can be up to two times more prevalent in patients with DD than in the general population.[9,12] In the present study, the prevalence of diabetes mellitus was observed in 19.3% of patients. On the other hand, the association of DD with dyslipidemia is described in several articles; however, few link heart disease with DD.[8] In this study, 11.4% of patients present chronic heart disease, and 9.3% of patients are dyslipidemic. Just like in systemic arterial hypertension, this association can be understood as due to the advanced age of the population affected by DD. However, a recent study showed an increase in the mortality from cancer, cardiovascular diseases, liver diseases, and diabetes in patients with DD.[14]
The prevalence of DD in patients with HIV varies in the literature, reaching 36%. The presence of DD was related to advanced infection and increased activity of free radicals.[15] The mechanisms by which these pathologies imply an increased risk of developing DD are not fully understood yet. Our experience is limited, as the study had only 1 HIV-positive patient.
Several studies correlate DD with epilepsy and the use of anticonvulsants. The present study included patients using phenobarbital due to any neuropsychiatric disease. There was a more significant association of DD with the use of phenobarbital (37.1% of patients) than with epilepsy (5.7% of patients). It corroborates research results that concluded that DD is associated with the use of anticonvulsants and not directly with epilepsy.[8] This correlation is still controversial, requiring further studies.
Alcoholism and smoking being risk factors for DD are also controversial in the literature. Some studies associate both habits with DD,[16] but there is a significant variation depending on the population studied.[17,18] In the present study, 31% of patients included were smokers, and 16.6% were self-declared alcoholics.
DD typically presents some criteria that are predictors of greater severity and risk of recurrence,[7] known as diathesis score. The following criteria define the diathesis score: bilateral involvement, family history of DD, knuckle pads (Garrod's nodules), association with other fibrotic diseases (such as Ledderhose disease), symptoms onset before 50 years of age, male gender, multiple fingers involvement (more than two fingers),[19] and 1st ray involvement.[20] Out of the total patients included, 40% presented with the severe form of DD according to the diathesis score parameter – it shows a population with many severity criteria. However, there may be sampling bias, since the public hospital at issue is a tertiary reference service in the context of the local health system.

CONCLUSION

Although many factors are still controversial, DD has a broad clinical spectrum and several remarkable epidemiological aspects that are widely known. However, there is little data in the literature on DD in the South American population.
In the present study, we presented a sample of 140 patients seen during six years of attendance at a specialized outpatient service. Many characteristics were similar to those found in the literature worldwide, despite having a distinct sample population composed mostly of Brazilians who do not report European ancestry.
For a better understanding of DD and its local epidemiological aspects, further studies in Latin American populations are required.

AUTHORS' CONTRIBUTION: Each author made significant individual contributions to the development of this manuscript. Nakamoto HA, Gonçalves RB, Oliveira LT, Macedo LS, Sambuy MTC, Rodrigues MP and Mattar Júnior R: researched literature and conceived the study, was ethical approval, patient recruitment, was involved in patient interview and assessment, was involved in patient interview and assessment and approved the final version of the manuscript.

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EXTENSOR MECHANISM TRANSPLANTATION AFTER KNEE PROSTHESIS: 70-MONTH FOLLOW-UP

TRANSPLANTE DE MECANISMO EXTENSOR APÓS PRÓTESE DE JOELHO: SEGUIMENTO 70 MESES

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ABSTRACT

Objective: This article reports the range of motion, failure rate, and complications of patients with extensor mechanism injury after total knee arthroplasty (TKA) treated with extensor mechanism allograft with mid-term follow-up. Methods: Patients undergoing post-ATJ extensor mechanism transplantation from 2009 to 2018 were retrospectively evaluated. Demographics, the reason for transplantation, elapsed time from arthroplasty to transplantation, related surgical factors, immobilization time, range of motion, transplant failure, and complications were collected. The minimum follow-up was 24 months. Results: Twenty patients were evaluated. The mean follow-up was 70.8 +/- 33.6 months. The most common cause of extensor mechanism rupture was traumatic in 10 (50%) cases. Six patients underwent associated surgeries, one case of medial ligament complex reconstruction, and 5 cases of TKA revision. Eleven patients (55%) had transplant-related complications. The most common complication was an infection. Five cases presented transplant failure. Conclusion: Patients who underwent extensor mechanism allograft transplantation after total knee arthroplasty had a 25% failure rate with a mean follow-up of 6 years. Although there was no loss of flexion with the procedure and prolonged immobilization, the complication rate was not low. ***Level of evidence IV; case series.***

Keywords: Knee Arthroplasty. Partial Knee Replacement. Knee Replacement Arthroplasties.

RESUMO

Objetivo: O objetivo do estudo foi relatar amplitude de movimento, taxa de falha e complicações de pacientes com lesão do mecanismo extensor após artroplastia total do joelho (ATJ) tratados com aloenxerto do mecanismo extensor com acompanhamento no médio prazo. Métodos: Pacientes submetidos a transplante de mecanismo extensor pós-ATJ de 2009 a 2018 foram avaliados retrospectivamente. Foram avaliados dados demográficos, motivo do transplante, tempo decorrido da artroplastia ao transplante, fatores cirúrgicos relacionados, tempo de imobilização, arco de movimento, falha do transplante e complicações. O acompanhamento mínimo foi de 24 meses. Resultados: Vinte pacientes foram avaliados. O tempo médio de acompanhamento foi de 70,8 +/- 33,6 meses. A causa mais comum de ruptura do mecanismo extensor foi traumática em 10 (50%) casos. Seis pacientes foram submetidos a cirurgias associadas, um caso de reconstrução do complexo ligamentar medial e 5 casos de revisão de ATJ. Onze pacientes (55%) tiveram complicações relacionadas ao transplante. A complicação mais comum foi a infecção. Cinco casos apresentaram falha do transplante. Conclusão: Pacientes submetidos a transplante de aloenxerto de mecanismo extensor após artroplastia total de joelho apresentam taxa de falha de 25% com seguimento médio de 6 anos. Embora não tenha havido perda de flexão com o procedimento e com a imobilização prolongada, o índice de complicações não foi baixo. ***Nível de evidênvia IV; série de casos.***

Descritores: *Artroplastia do Joelho. Substituição Parcial do Joelho. Artroplastia de Substituição do Joelho.*

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INTRODUCTION

Despite the satisfactory results presented by patients undergoing total knee arthroplasty (TKA), the incidence of postoperative complications is not negligible.[1,2] In absolute numbers, estimates point to the occurrence of a greater number of complications due to the increase in the number of surgeries performed annually.[3]

Among the complications, rupture of the knee extensor mechanism, despite the low incidence, occurring between 0.1% and 2.5% of all TKAs, represents a serious and difficult to manage complication, often evolving with limited clinical results, a high number of reoperations and a high failure rate in patient follow-up.[4,5]

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, Department of Orthopedics and Traumatology, Knee Group, HC-DOT/FMUSP, Sao Paulo, SP, Brazil and Instituto Nacional de Traumatologia e Ortopedia, Sao Paulo, SP, Brazil.
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Lesions of the extensor mechanism after TKA show inferior results than those reported for the surgical treatment of these injuries in patients without arthroplasty.[6] In a study evaluating the treatment of patellar tendon injury, Fiquet et al.[6] found 33% of allograft treatment failure in patients with TKA and no failure when the same surgical technique was applied in patients without a prosthesis. Also, direct repair of an extensor mechanism lesion in patients with an arthroplasty showed poor results, especially when the injury occurred in the patellar tendon.[7] Thus, alternatives for surgical treatment should be evaluated.

Currently, the two most widely used surgical treatment options for injuries of the extensor mechanism after arthroplasty are allograft reconstruction and reconstruction with synthetic mesh.[8,9] A systematic review by Shau et al. found a failure rate of approximately 25% in both methods.[10] Survival rates were also similar for the two techniques in a meta-analysis performed by Deren et al.[8] However, most of the studies included in these reviews had a follow-up of fewer than 5 years (only Ricciardi et al[11] reported a follow-up of more than 5 years for the allograft technique) and a reduced number of studied knees (only Ricciardi et al., Brown et al. and Diaz-Ledezma et al., who used an Achilles tendon, presented series with more than 20 knees using allografts).[11-13]

Thus, this present study aims to report the range of motion, failure rate and complications of patients with extensor mechanism injury after TKA treated with extensor mechanism allograft with a medium-term follow-up. As a hypothesis, we assume the failure rate will be similar to the literature in short-term follow up studies since we believe that the initial complications are the most significant for graft survival.

METHODS

Patients who underwent post-TKA extensor mechanism transplantation from 2009 to 2018 in two high-volume services for the treatment of post-TKA complications (blinded for review purposes) were retrospectively evaluated with prospective data collection. Only patients with allograft composed of quadriceps tendon, patella, patellar tendon, and tibial tuberosity were included. (Figure 1) The grafts were previously-stored frozen at -800C and not irradiated. Any procedure with an extensor mechanism graft without this configuration or reconstructions with Achilles tendon, possible other tendons or reconstruction with synthetic material, even if associated with allograft, were not included. Patients with primary or revision arthroplasty were included. Only patients with 24 or more months of follow-up were included. Patients who died were not excluded, and the last assessment before death was used for data collection purposes.

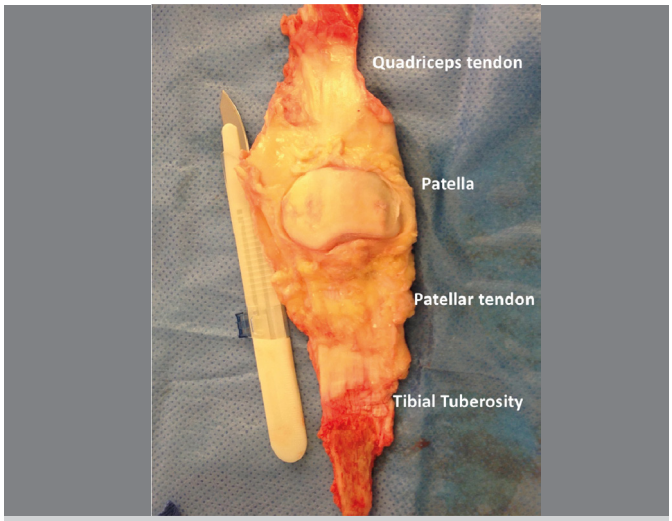

Figure 1. Extensor mechanism allograft.

Demographic data of the patients were evaluated, including age, gender, comorbidities, and ASA classification, the reason for the transplantation of the extensor mechanism, time from arthroplasty to transplantation, surgical factors as the technique used, combined surgeries with the transplantation or post-transplant, replacement of the patella at the time of transplantation, immobilization time, range of motion before and after transplantation, the eventual failure of the transplant and associated complications.

Transplant failure was considered as the need to remove the transplant for any reason or limitation of active knee extension greater than 30 degrees. Patients who presented with knee flexion restriction after transplantation were not considered as failure.

The data will be presented as mean and standard deviation for nominal variables and absolute numbers and percentages for categorical variables. Statistical analysis was performed to assess the range of motion pre- and postoperatively with the Mann-Whitney test. Institute of Orthopedics and Traumatology, Hospital das Clínicas, Faculty of Medicine, University of São Paulo (IOT-HC-FMUSP) with approval by the Ethics Committee.

RESULTS

Twenty patients who underwent transplantation of the knee extensor mechanism were evaluated according to the established criteria. The mean age of the patients was 68.6 +/- 14.3 years, 14 of which were female and 6 male and 8 on the left side and 12 on the right side. Fourteen patients had at least one clinical comorbidity of which 35% had diabetes, 35% were obese, 10% were smokers, and 5% presented inflammatory disease (rheumatoid arthritis). The vast majority of patients (90%) were classified as ASA 2 at the time of transplantation, with only 1 patient being classified as ASA 1 and one as ASA 3. The mean follow-up time was 70.8 +/- 33.6 months. The average time between arthroplasty and transplantation was 47.6 +/- 30 months, with 16 patients having primary implants and 4 patients revision implants (two semi-constrained, and two hinge). Joint replacement before rupture of the extensor mechanism was performed by medial parapatellar access in all cases and in only one patient a lateral release was performed. In 15 patients, the patella had been replaced during the arthroplasty. The most common cause of rupture of the extensor mechanism was traumatic due to falling from height in 10 (50%) cases, followed by iatrogenic in 4 cases, one case due to closed manipulation for stiffness after primary TKA, and 3 due to intraoperative injury in additional surgeries after arthroplasty. The causes of injury are described in (Table 1). Regarding the surgical technique, 17 cases were operated with fixation of the tibial tuberosity bone block with the press-fit technique associated with screws, one case with screws only, one case with the press-fit technique associated with wires and screws and a case with press-fit technique associated with wires only, without using screws. (Figure 2) At the time of the transplant, six patients underwent associated surgeries, one case of associated reconstruction of the medial ligament complex, and 5 cases of TKA revision. The patellar component was implanted in the allograft in 14 cases and the patella was kept native in 6 cases. (Figure 3) The post-transplant immobilization time was 6.5 +/- 0.9 weeks, ranging from 6 to 8 weeks. Regarding the range of motion, the average preoperative extension deficit was 70.2 +/- 22.3 degrees, with 10 patients having a complete extension disability. The average postoperative deficit was 10.5 +/- 22.0 degrees, with 10 patients not having any deficit in postoperative active extension. Regarding flexion, the preoperative average was 100.5 +/- 19.3 degrees and the postoperative was 99.2 +/- 14.1 degrees. The extension deficit showed statistical

Table 1. Demographic data of patients subjected to extensor mechanism allograft after total knee arthroplasty.

Age (years)	**68.6 +/- 14.3**
Gender	Female 14
	Male 6
Side	Left side 8
	Right side 12
Presence of Comorbidities	14 (70%)
ASA classification	ASA 1 – 1 (5%)
	ASA 2 – 18 (90%)
	ASA 3 – 1 (5%)
Type of Arthroplasty	Primary 16 (80%)
	Semi-constrained 2 (10%)
	Hinge 2 (10%)
Average time between arthroplasty and transplantation (months)	47.6 +/- 30.0
Cause of injury to the extensor mechanism	Traumatic (fall) 10
	Iatrogenic 4
	Patellofemoral disorders 3
	Infection 1
	Tumor resection 1
	Patellar necrosis 1
Follow-up time (months)	70.8 +/- 33.6
Surgical technique for the extensor mechanism allograft tibial fixation	Press-fit + screw 17
	Screw only 1
	Press-fit + screw + wires 1
	Press-fit + wires 1
Associated procedures	5 TKA revision
	1 medial ligament complex reconstruction
Patellar resurface in allograft	14 (70%)
Immobilization time (weeks)	6,5 +/- 0,9

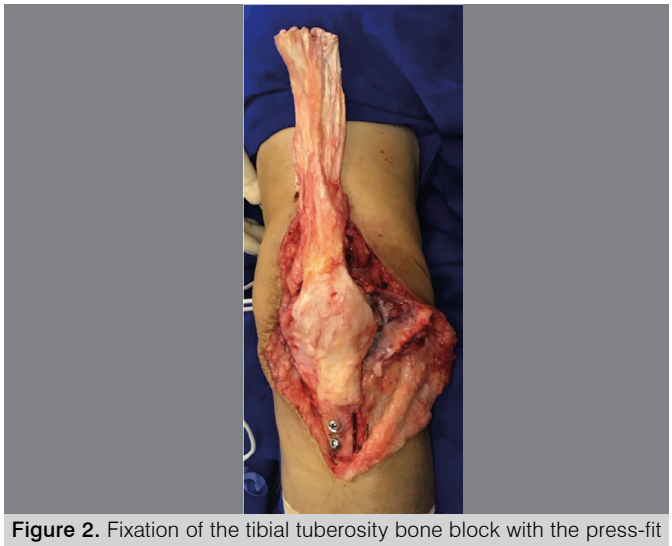

Figure 2. Fixation of the tibial tuberosity bone block with the press-fit technique associated with screws.

improvement between the pre and postoperative periods and the maximum flexion remained similar. (Table 2)

Eleven patients (55%) had complications related to transplantation and required 22 new surgical procedures (average of 2 per patient). The most common complication was infection, being superficial treated only with antibiotics in two cases, and deep requiring surgical procedures in three cases. Five cases also presented transplant

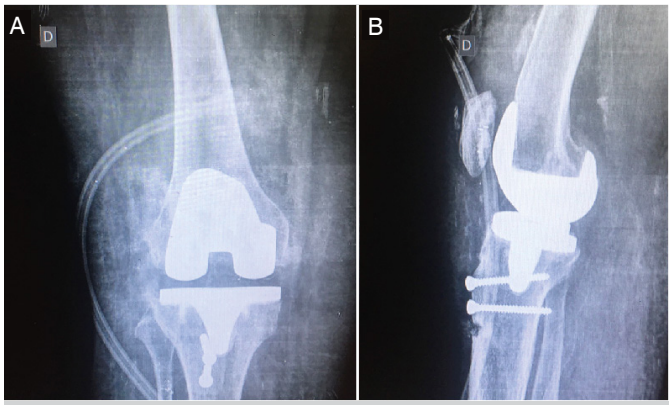

Figure 3. Post-operative X-rays.

Table 2. Pre- and post-operative range of motion of patients subjected to extensor mechanism allograft transplantation after total knee arthroplasty.

Pre-operative Extension deficit	Post-operative Extension deficit	p	Pre-operative maximum flexion	Post-op maximun flexion	p
70.2 +/- 22.3	10.5 +/- 22.0	<0.00001	100.5 +/- 19.3	99.2 +/- 14.1	0.589

failure, with 3 cases of persistent extension deficit, one case of infection with skin and allograft necrosis, and one case of late patella fracture with osteosynthesis failure and transplant loss. In 3 cases, despite the incorporation of the transplant, the patients' maximum flexion was below 90 degrees. Two failed patients underwent a successful post-failure transplant review.

DISCUSSION

The main finding of this study is that the survival rate of the allograft of the extensor mechanism with an average follow-up of 6 years was 75% and there was no loss of flexion compared to the preoperative period, but the rate of complications and re-operations was not low. The rupture of the extensor mechanism after primary or revision arthroplasty, although rare, represents a serious complication associated with a high number of reoperations, as shown in our study, and with limited postoperative functional results.[14,15] Thus, despite the existence of several techniques to treat this complication, the controversy persists whether the transplantation of the extensor mechanism presents superior results for the treatment of these lesions.[8]

The initial results of transplanting the extensor mechanism in patients with knee joint prostheses was limited; however, graft fixation was performed with 60 degrees of flexion, which was later related to this high failure rate.[4,16,17] The tension of the graft in full extension was initially described by Nazarim and Booth, who had a higher success rate.[15] Similar results were also observed by Brown et al, Diaz-Ledezma et al, who used Achilles tendon allografts, and Courtney et al, who reported success in 62%, 58.6%, and 55.8%, respectively.[7,12,13] In our study, we were successful in transplanting the extensor mechanism in 75% of cases, numbers that agree with those presented by Deren et al. in a recent meta-analysis, showing a 72.8% rate of treatment success with allograft and 78% with synthetic mesh.[8] In addition to tensioning in extension, the immobilization time must be at least 6 weeks. Even with the prolonged immobilization time, there was no loss of flexion compared to the preoperative period after rehabilitation.

In our study, half of the patients did not have a deficit in knee extension, with an average limitation of 10 degrees. Our results are in line with the study by Shau et al.[10] who demonstrated an average extension deficit of 7.7 degrees and without repercussions

on maximum flexion. However, worse knee extension capacity was reported by Wood et al. with an average deficit of 26 degrees. [18] We believed that such functional limitation can be attributed, at least partially, to the fact that the authors used Achilles tendon grafts in 43% of these patients and, mainly, to the fact that 86% of the grafts were irradiated. The graft irradiation can compromise the structural integration, as admitted by the authors and, thus, we understand that there may be impairment in the functional result and alteration of the graft incorporation capacity, in addition to the possibility of progressive loss of graft tension and consequent stretching with time.[18,19]

In the study by Ricciardi et al., in medium-term follow-up, the success rate and retention of transplants of the extensor mechanism was 69%, however, the authors highlighted the high number of complications and reoperations, so that the reoperation-free survival was only 42%, similar to our study which was 45%.[11] These authors also demonstrated that patients with less age or those who underwent a concomitant revision surgery at the time of transplantation were associated with a higher rate of graft failure. Ricciardi et al. demonstrated that several reoperations were performed on transplant patients, however without progression to graft failure.[11] Complications related to fixation of the transplanted graft were also observed in the study by Brown et al., mainly in the tibia.[13] In our series, we observed only one complication not directly related to the fixation of the transplanted graft, in which there was a periprosthetic fracture in an area of weakness between the bone block and tunnels used to perform a medial complex reconstruction. Possibly we had few complications related to fixation due to the care given in preparing the tibial bone block to be transplanted, as well as careful preparation of the receiving tibial bed, avoiding the exaggerated weakening of the tibial cortices and also the adherence to a conservative rehabilitation protocol.

At the beginning of the study, we believed that the initial complications are the most significant for graft survival. Burnett et al. demonstrated an initial failure rate of 23% in 13 transplant patients followed for 3 years.[14] In a subsequent study, the same authors published a series of 47 patients who underwent 50 transplants under long-term follow-up and found graft failure, on average after 21 months, in 38% of cases, with a graft survival of 56% in 10 years. Similarly, the 10-year graft survival in the series by Brown et al. was 56.2%.[13] According to these authors, 38% (19 knees) of the transplants evolved with failure criteria on average 21 months after the reconstruction without it being possible to identify risk factors for failure or complications after the transplant. Contrary to our initial understanding, Brown et al. report the degradation of results over time due to the high rate of complications, leading to a 10-year survival of just over half of the grafts.[13] We emphasize, however, that the criteria used in the definition of graft failure were more rigorous than most series.

In the study by Ricciardi et al. infection was the main cause of transplant failure, accounting for 50% of cases.[11] The rupture of the patellar tendon accounted for another 25% of the failures. In our study, most of the failures were due to the non-incorporation of the graft and lag of extension greater than 30 degrees. Only one case had an infection as the cause of failure, although 25% of cases had some type of infection after transplantation. Infection after transplantation of the extensor mechanism is a concern in the scenario of patients with a complex medical history and frequently undergoing several previous joint surgeries, however, Deren et al. demonstrated a relative risk of infection similar to patients undergoing reconstruction of the extensor mechanism with synthetic material. [8] Similarly, the number of revisions for any reason was also indistinct between the two techniques (14.2% for transplant versus 16% for synthetic reconstructions).

This study is not without limitations. Although it was performed in two reference institutions with a high volume of knee arthroplasties, only 20 cases of transplantation of the extensor mechanism were identified in 10 years, corroborating the rarity of this complication. Also, the technique performed was not exactly the same in all cases, as well as the time the patients were kept immobilized. In any case, few series with this amount of cases and exclusively using a complete extensor mechanism allograft have a medium follow-up and the reported findings are of significant importance.

CONCLUSION

Patients undergoing extensor mechanism allograft transplantation after total knee arthroplasty have a failure rate of 25% with an average follow-up of 6 years. Although there was no loss of flexion with the procedure and prolonged immobilization, the rate of complications was not low.

AUTHORS' CONTRIBUTION: Each author contributed individually and significantly to the development of this article. CPH: substantial contributions to the conception and design of the manuscript and performed the sur-geries. APM: background theory and performed the surgeries. BBV: editing and submitting. MKD: revising the text and performed the surgeries. RGG: Revising the figures, and performed the surgeries. STNM: data analysis and interpretation. HAABC: writing of the article and per-formed the surgeries.

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HOW USEFUL IS ELASTOGRAPHY IN THE FOLLOW-UP OF ACHILLES TENDON REPAIR?

QUÃO ÚTIL É A ELASTOGRAFIA NO ACOMPANHAMENTO DO REPARO DO TENDÃO DO CALCÂNEO?

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ABSTRACT

Introduction: In addition to conservative modalities in the treatment of Achilles tendon injuries, open, percutaneous and minimally invasive semi-open techniques, as well as biological open surgical repair methods are used as surgical options. Compression elastography is one of the methods used for the follow-up of treatment in Achilles tendon injuries. Methods: 23 patients were included in our study between July 2013 and June 2014, as long as they had at least 4 years of follow-up. In the final control, the intact side and the operated side were both examined and compared. The variables were the American Orthopedic Foot and Ankle Score (AOFAS) which is measured as a functional score considering plantar flexion and dorsiflexion; calf circumference; Achilles tendon anteroposterior (AP) diameter; and elastographic examination. Results: The strain ratio value and AP diameter of the patients was significantly higher on the operated side than on the non-operated side ($p < 0.001$). There was no significant difference between the plantar flexion and dorsiflexion degrees on the operated side of the patients ($p > 0.05$). No correlation was observed between strain ratio and AOFAS (p: 0,995). Conclusion: Elastography is not a useful technique to evaluate functional results on long-term tendon healing. ***Level of Evidence III; Retrospective comparative study.***

Keywords: Achilles tendon. Tendon Injuries. Elasticity Imaging Techniques.

RESUMO

Introdução: Além de métodos mais conservadores de terapia, utilizam-se, como opções cirúrgicas para o tratamento das lesões do tendão do calcâneo, técnicas abertas, percutâneas e semiabertas minimamente invasivas, bem como métodos cirúrgicos de reparo aberto. A elastografia por compressão é um dos métodos utilizados para o acompanhamento do tratamento das lesões do tendão do calcâneo. Métodos: Entre julho de 2013 e junho de 2014, 23 pacientes com pelo menos 4 anos de seguimento foram incluídos em nosso estudo. No controle final, o lado intacto e o lado operado foram examinados e comparados. As variáveis foram o American Orthopaedic Foot and Ankle Score, que foi medido como pontuação funcional por meio da flexão plantar e dorsiflexão; a circunferência da panturrilha; o diâmetro anteroposterior (AP) do tendão do calcâneo; e exame elastográfico. Resultados: O índice de tensão e o diâmetro AP dos pacientes foram significativamente maiores no lado operado do paciente que no lado não operado. Não houve diferença significativa entre os graus de flexão plantar e dorsiflexão dos pacientes no lado operado ($p > 0,05$). Não foi observada correlação entre strain ratio e AOFAS(p: 0,995). Conclusão: Acreditamos que a elastografia não seja uma técnica útil para avaliar os resultados funcionais na cicatrização do tendão em longo prazo. ***Nível de evidência III; Estudo comparativo retrospectivo.***

Descritores: *Tendão do Calcâneo. Traumatismos dos Tendões. Técnicas de imagem por elasticidade.*

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INTRODUCTION

Achilles tendon is one of the most frequently injured tendons in the human body.[1] The tendon is mainly formed by parallel structured type 1 collagen. The amount of type 3 collagen fibers increases during the healing period and the tendon becomes a heterogeneous structure.[2] As a result of this fibrosis, the tendon becomes stiffer and has reduced elasticity.[3] In addition to conservative modalities in the treatment of Achilles tendon injuries; open, percutaneous, minimally invasive semi-open techniques and biological open surgical repair method defined by Arslan et al. are available as surgical options.[4] Ultrasound-dependent methods used in the follow-up of the treatment are preferred because they are easily accessible,

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

The study was conducted at Gaziosmanpaşa Training and Research Hospital, Istanbul, Turkey.
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quick and low cost methods.[5] There are two main techniques in the elastographic method, which are compression elastography and shear-wave elastography.[6] Compression elastography (Figure 1) is a qualitative or semiquantitative method based on the application of compression waves to the tissue.[7] The practitioner performs rhythmic and regular compressions to obtain an axial tension in the relevant area. When a certain amount of stress is applied, flexible tissues undergo more deformation, resulting in more tension than hard tissues.

The aim of the study is to evaluate the long-term results of Achilles tendon rupture cases operated with biological open surgical repair in terms of functional and elastographic aspects and to examine the correlation between them.

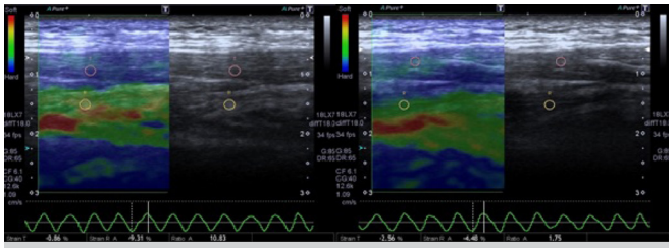

Figure 1. Comparative elastographic examination of the patients' intact and operated sides.

MATERIAL AND METHODS

This study was conducted in accordance with the 'Declaration of Helsinki and approved by the ethics committee of authors' previous affiliated institution. Approval number: 16.9.15.30

Patients between 18-50 years old who underwent biological open surgicalrepair for traumatic Achilles tendon rupture between July 2013 and June 2014 with at least 4 years offollow-up were included in our study. Patients with previous ankle fracture or ankle arthrosis, diabetes mellitus and rheumatoid arthritis, as well as any Achilles tendinopathy, collagen tissue disease or infection in the postoperative period and those who did not come to the final control were excluded. Finally, 23 patients between 28-46 years old were included in the study.

The same surgical method was applied to all patients by the same surgeon. Short leg circular cast in 25°-30° plantar flexion was applied to all the patients postoperatively and was kept in place until the sutures were removed. The daily wound care was performed through the plaster window opened from the incision line.

The plaster was removed at the second week and the same position was maintained with range of motion (ROM)walker without weightbearing. Starting from the third week, partial weightbearing was initiated. In full active plantar flexion, dorsiflexion was increased by 10° degrees weekly and normal ankle ROM was achieved after eight weeks. After the eight week, full weightbearing and active Achilles stretching exercises were started.

In the last control, while the patients were lying in the prone position with their feet hanging over the edge of the examination (Table 1), ROM of both ankles were measured with goniometry. In the standing weightbearing position, the calf circumference was measured on both sides from the widest part of the calf by placing the tape measure parallel to the ankle joint. Patients were evaluated functionally according to the AOFAS.

Imaging

The operated patients underwent ultrasonographic examination with a real-time sonoelastographic scanner (Aplio 500; Toshiba, Tokyo, Japan) at a frequency rangeof 7–18 MHz.

The Achilles tendon was examined ultrasonographically while the patient was lying in the prone position with the foot hanging over the edge of the examination (Table 1) in a fixed neutral dorsiflexion position. The tendons were evaluated axially and longitudinally by a radiologist.[8] Apart from this, measurements were made with the help of a probe holder to prevent differences in the probe's grip. In this procedure, thecalculation of tissue elasticity distribution was performed in real-time and the examination results were represented on acolor map superimposed on the B-mode image. The colorpresented the relative stiffness of the tissues within the region of interest and ranged from blue (stiff) to red (soft) inthe spectrum. Green and yellow indicated medium stiffness.

The Achilles tendon was compressed with the same pressure. Real-time sonoelastographic scans were repeated by compression and relaxation of the scan area for at least four cycles so that findings could be verified as reproducible. The Achilles tendons with elastographic image evaluation were divided into the following thirds: proximal (musculotendinous junction), middle (2–6 cm above insertion at the calcaneus), and distal (insertion at the calcaneus).[9] Central part of the Achilles tendon in the 2-6 cm proximal of calcaneal insertion point were selected for review and evaluated in the longitudinal plane. Localized Kager fat plan posterior to the tendon was selected for strain ratio. The operative tendon and intact tendon of each patient were measured.

Table 1. Comparison of measurements between the operated side and the intact side.

	Average	Standart Deviation	Median	Percentile 25	Percentile 75	P
AP Diameter (O)	11,08	11,07	6,80	5,50	14,10	<0,001†
AP Diameter (NO)	3,97	0,98	3,50	3,20	4,60	
StrainRatio(O)	8,83	5,20	7,88	5,80	10,19	<0,001†
StrainRatio(NO)	1,81	1,06	1,51	1,03	2,52	
PF(O)	35,02	5,22	34,75	30,00	39,00	0,534*
PF(NO)	35,04	5,31	35,00	30,00	40,00	
DF(O)	26,96	3,96	27,00	24,00	29,00	0,521*
DF(NO)	26,26	4,67	7,00	24,00	28,00	
Calf Circumference (O)	36,98	2,97	36,50	35,00	40,00	0,039*
Calf Circumference (NO)	37,59	2,89	38,00	35,00	40,00	

O: Operated Side, NO: Nonoperated Side†Wilcoxon Test *Paired Sample T test.

RESULTS

The average age of the patients was 34.35 ± 6.47 years and the mean follow-up period was 61.74 ± 5.72 months. The operation side is on the right side in 13 patients (56.5%) (Table 2).

The measurements between operated side of the patients and the measurements on the intact side were evaluated as dependent groups. The AP diameter value (median: 6.80) of the patients on the operated side was significantly higher than the non-operated side (median: 3.50) ($p < 0.001$) (Figure 2). The strain ratio value (median: 7.88) of the patients on the operated side was significantly higher than the non-operated side (median: 1.51) ($p < 0.001$) (Figure 3). There was no significant difference between the plantar flexion and dorsiflexion values of the patients ($p > 0.05$). However, the calf circumference (mean: 36.98 ± 2.97) on the operated side was significantly lower than the non-operated side (mean: 37.59 ± 2.89) (p: 0.039) (Figure 4). When the correlation between the age, follow-up time, AOFAS, AP diameter difference and strain ratio difference was examined; there was a moderate negative correlation between age and follow-up period (r: -0.431, p: 0.040). Most importantly, no correlation was observed between strain ratio and AOFAS in patients (r: -0,001 p: 0,995) (Table 3).

Table 2. Demographic data of patients.

		Mean s.s	Median (Min-Max)
Age (year)		34,35 ± 6,47	34,00 (25.00-46.00)
Follow-up time (month)		61,74 ± 5,72	60,00 (56.00-76.00)
Operated side*	Right	13	56,5
	Left	10	43,5

*n is used instead of mean standard deviation while % is used instead of median.

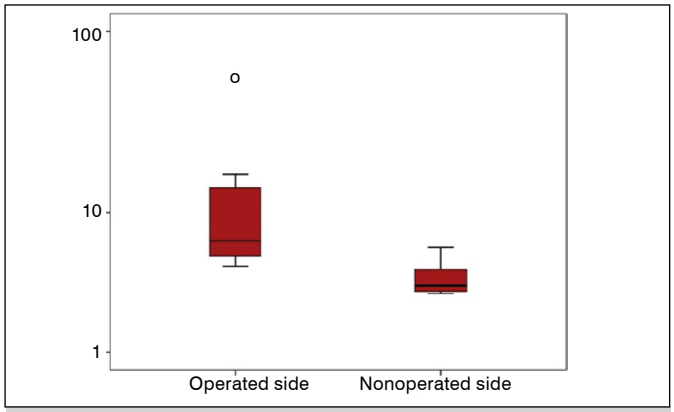

Figure 2. AP Diameters of Operated and Non-operated sides.

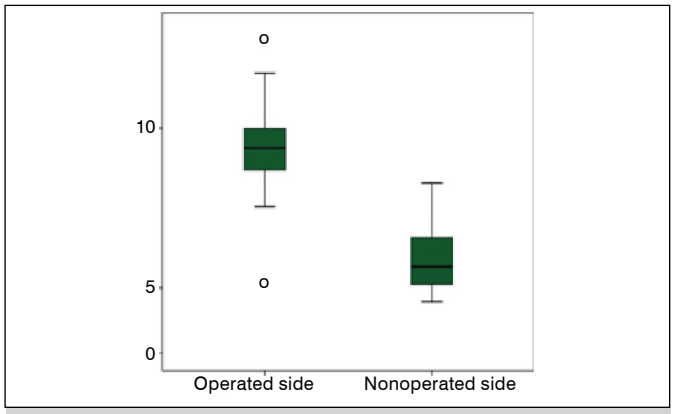

Figure 3. Strain Ratio Values of Operated and Non-operated Sides.

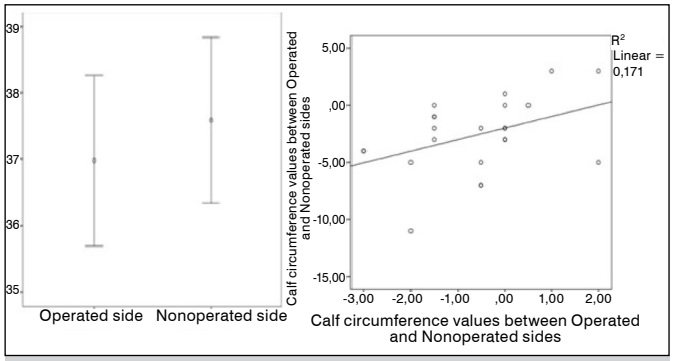

Figure 4. Calf Circumference values of Operated and Non-operated Sides.

DISCUSSION

Achilles tendon is the strongest and the most frequently injured tendon of the body. As a result of injury, the mechanical properties of the tendon and lower extremity functions may vary. Surgical repair and rehabilitation is accepted to be the standard treatment for providing the original mechanical properties of the tendon.[10]

Table 3. Correlation between patients' age, follow-up time, AOFAS, AP diameter difference, Strain ratio difference.

		Age	Follow-up time	AOFAS	AP diameter difference
Follow-up time	r	-0,431*			
	p	0,040			
AOFAS	r	-0,186	0,368		
	p	0,395	0,084		
AP diameter difference	r	0,284	-0,199	-0,178	
	p	0,189	0,362	0,417	
Strain ratio difference	r	0,150	0,199	-0,001	-0,063
	p	0,496	0,363	0,995	0,776

There are open, minimally invasive and percutaneous techniques described for the surgical treatment. In the literature; there are articles stating that the open technique is better,[11] as well as articles reporting that percutaneous technique is superior.[12] Also some authors indicated that there was no difference between the two techniques.[13]

Arslan et al. have described the biological open technique by protecting the paratenone and tendon blood flow, and reported that theyachieved near-perfect results in terms of AOFAS, range of motion and proprioception with this method.[4] In the presented series the same technique desribed by Arslan et al. was used, however no correlation between the long term functional scores and elastographic results was detected.

Although we obtained good functional results similar to the authors, a significant difference was observed in favor of the intact tendon in elastographic measurements. This might be due to the fibrosis occurring while the tendon heals and the increased amount of collagen type 3. This is also supported with the difference between the AP diameter of the repaired tendon and the intact tendon.

As we know the tendon elasticity varies with age but this will not affect the results of the presented series. Because we had a relatively young patient population and the comparison was made with the patients' own intact tendons. This was also confirmed by that the age did not have a correlation with other parameters in our study.

Compression elastography depends on the depth of the affected tissue, the probe position, and the person who performed it.[14] In our study, after measuring the neutral dorsiflexion angle while thepatient was lying in the prone position, measurements were made perpendicular to the tendon with the probe holder by the same radiologist. Thus, differences that may occur depending on the practitioner have been removed.

Karatekin et al. conducted a study including patients with at least 4 years of follow-up examining two different suture methods, and stated that regardless of the suture technique, all operated Achilles tendons showed lower elasticity compared to the intact side.[15]

Zhang et al. reported that different phases of tendon healing correlated with elastographyand this was correlated with the AOFAS score.[10] Yamamoto et al. in their experimental study on rabbit Achilles tendon, showed a marked increase in strain ratio and found that the tendon was more stiff. In addition, they found a correlation between the histological and mechanical properties of the tendon that healed with strain ratio.[16] In our study, while the functional results of the patients who were followed up for a long period were quite satisfactory, significant differences were observed between the elastographic results. It was observed that high or low difference between elastography results did not correlate with tendon's functional results. Even similar functional results were detected in the patient with 26-times strain ratio variation and the case with 2.5-times strain ratio variation.

Some authors argue that the elastic properties of the tendon correlate with the clinical situation and find this method to be useful in the follow-up of the treatment.[10,17] In this study no correlation was

detected between strain ratio and AOFAS score. For this reason we don't agree that elastography is efficient in determining the effectiveness of the treatment in patients who have finally completed recovery and who have a long-term follow-up.

Although the blood-supply of the tissue was preserved as much as possible by protecting the paratenone, we would like to point out that the repaired tendon tissue was found to be significantly weak when compared with the intact tendon in terms of elasticity.

The strengths of this study are that the measurements were made by a single radiologist, all patients were operated by a single surgeon with the same suture material and the same surgical technique, the same rehabilitation method was applied and there is a long period of follow-up. The weaknesses include the absence of a control group and a relatively low number of patients.

CONCLUSION

Even after a long follow-up period of approximately 5 years, there was no correlation between the functional results of the tendon and elastography. In this context, we think that elastography is not a useful technique to evaluate functional results on long-term tendon healing.

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SPINE

IMPACT OF THE COVID-19 PANDEMIC ON SPINE SURGERY IN A TERTIARY HEALTH CARE INSTITUTION

IMPACTO DA PANDEMIA DE COVID-19 NAS CIRURGIAS DE COLUNA EM UMA INSTITUIÇÃO TERCIÁRIA DE SAÚDE

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ABSTRACT

Objectives: To assess postoperative complications, including COVID-19 infection, among patients undergoing surgeries at a tertiary institution during the pandemic, and to develop a local epidemiological profile of spine surgery patients. Methods: Retrospective descriptive study of all patients who underwent spine surgery between March 2020 and 14 January 2021 in a tertiary institution in Latin America. All patients who underwent spine surgery were included, without age restrictions. The main outcomes were postoperative complications, including COVID-19 infection. Results: 74 patients were included in the study, 43 males and 31 females. The average age was 49.6 years. The mean duration of hospitalization was 11.5 days. Urgent surgeries were performed in 60.81% of cases. During hospitalization, only 5 of 74 patients were diagnosed with COVID-19, and only 1 patient had pulmonary involvement estimated to be greater than 50%. On average, 1.9 surgical debridements were required after postoperative surgical site infection. Conclusions: During the hospitalization period, only 6.7% of patients were diagnosed with COVID-19 infection. The COVID-19 infection death rate was 1 in 5 cases. The postoperative surgical site infection rate was 10.8%, similar to the level before the pandemic. ***Level of Evidence IV;*** **Observational retrospective descriptive study.**

Keywords: COVID-19. Pandemic, COVID-19. Surgical Wound Infection. Spine. Surgery.

RESUMO

Objetivos: Avaliar complicações pós-cirúrgicas, incluindo infecções por COVID-19, entre pacientes cirúrgicos numa instituição terciária de saúde durante a pandemia, e desenvolver um perfil epidemiológico local de pacientes de cirurgias da coluna. Métodos: estudo descritivo e retrospectivo de todos os pacientes que passaram por cirurgias da coluna entre março de 2020 e 14 de janeiro de 2021, numa instituição terciária na América Latina. Todos os pacientes que passaram por cirurgias na coluna foram incluídos, sem restrição de idade. Os principais resultados foram complicações pós-cirúrgicas, incluindo a infecção por COVID-19. Resultados: 74 pacientes foram incluídos no estudo, 43 do sexo masculino e 31 do feminino. A média de idade foi de 49.6 anos. A duração média da hospitalização foi de 11.5 dias. Cirurgias urgentes foram realizadas em 60.81% dos casos. Durante a hospitalização, apenas 5 dos 74 pacientes foram diagnosticados com COVID-19, e apenas 1 deles teve envolvimento pulmonar estimado em mais que 50%. Em média, 1,9 desbridamentos cirúrgicos foram necessários após infecção do sítio cirúrgico. Conclusões: Durante o período de hospitalização, apenas 6,37% dos pacientes foram diagnosticados com infeção por COVID-19. A taxa de mortes devido à infecção por COVID-19 foi de 1 em 5. Infecções do sítio cirúrgico atingiram uma taxa de 10.8%, nível similar àquele prévio à pandemia. ***Nível de evidência IV*****; Estudo observacional retrospectivo descritivo.**

Descritores: COVID-19. Pandemia COVID-19. Infecção da Ferida Cirúrgica. Coluna vertebral. Cirurgia.

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INTRODUCTION

An acute respiratory disease caused by the new SARS-CoV-2 (COVID-19) has spread from China to other countries and has attracted attention worldwide. On January 30, 2020, the World Health Organization officially declared the COVID-19 pandemic. The clinical symptoms include fever, cough, fatigue, and gastrointestinal symptoms. Elderly people are the most vulnerable to infection and severe complications. However, to date, there is no specific treatment available for the disease.[1]

Several individuals have spinal problems, many of whom require an urgent surgery to minimize or prevent neurological damage. However, in the current pandemic, the actual level of risk of exposing

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The study was conducted at Universidade de São Paulo, Faculty of Medicine, Hospital das Clínicas, Institute of Orthopedics and Traumatology, HC-FMUSP, São Paulo, SP, Brazil.
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the patient to the hospital environment and the impact of operating on a patient infected with COVID-19 are not known.
Postoperative infection alone has a substantial negative effect on patient survival, quality of life and the health system due to the high cost of managing postoperative complications.[2-6]
However, when a patient infected with COVID-19 is undergoing surgery, there is no way to estimate the possible risk of infection or other negative outcomes, as there are no current data in the literature. Thus, determining the epidemiological profile of patients undergoing urgent surgeries during the pandemic, including the COVID-19 infection rate, is essential to propose measures to minimize the risks. Thus, the present study aimed to assess postoperative complications, including COVID-19 infection, among patients undergoing surgeries at a tertiary institution during the pandemic and develop a local epidemiological profile of spine surgical patients.

METHODS

A retrospective descriptive study of all patients who underwent spine surgery between March 2020 and January (until day 14) 2021. All patients who underwent spine surgery were included, without age restrictions.
The following measures were used for standardization: age measured in years, sex (male or female), etiology of the underlying pathology involving the patient's spine, and length of hospitalization measured in days.
The main outcomes were postoperative complications, including COVID-19 infection.
The other outcomes included postoperative infections; the number of surgical debridements required after the infection; American Society of Anesthesiologists and Frankel scores; comorbidities; whether emergent or urgent surgery was needed; deaths during hospitalization; smoking status; preoperative hemoglobin, leukocyte, platelet, and lymphocyte counts; and postoperative hemoglobin and platelet counts.
The data were stored in a spreadsheet in Excel 2010 for Windows for descriptive analysis. Informed consent was not required, as contact with or the identification of patients was not required.
Protocol adopted at the institution during the pandemic:
• Asymptomatic patients were kept in a COVID-19-free environment, wore a surgical mask for the first five days and were monitored for the appearance of symptoms. Swabs for COVID-19 were collected on admission; if the patient had symptoms, he or she was transferred to the hospital's COVID-19 sector, and PCR was performed to diagnose the infection.
• Symptomatic patients were transferred to the inpatient COVID-19 sector, and PCR was performed.
• Indications for admission to the intensive care unit were based on the clinical indication of severity.
• All elective spine surgeries cases had a PCR exam performed 72 hours in advance; if the results were positive, it was necessary to wait 30 days and conduct a new exam before the patient could undergo the surgical procedure.
• Acute respiratory distress syndrome was defined as respiratory frequency greater than 24 breaths per minute and/or oxygen saturation less than 95% (room air).
Risk groups were defined as elderly adults, people with chronic disease (i.e., cardiopathy, diabetes, cancer, hypertension), immunosuppression, or obesity.
The study was approved by the institutional review board. Informed consent was not required.

RESULTS

A total of 74 patients met the inclusion criteria and were included in the study, including 43 males and 31 females. The average age was 49.6 years. The mean length of hospitalization was 11.5 days. Urgent surgeries were performed on 60.81% of patients.
Of the surgical procedures performed, only 2 lasted more than 4 hours. The comorbidities and the Frankel and ASA scores are shown in (Table 1). A total of 29.73% of the patients were smokers. During the hospitalization period, only 5 of the 74 patients were diagnosed with COVID-19, and only 1 patient had pulmonary involvement estimated to be greater than 50%. The COVID-19 death rate was 1 in 5 cases (20%).
The postoperative surgical site infection rate was 10.8% (8 cases). On average, 1.9 surgical debridements were required.
The diagnoses and surgeries performed are shown in (Tables 2 and 3). Other postoperative complications observed in the study were urinary tract infection (5 cases), acute renal failure (1 case), subarachnoid hemorrhage (1 case), cerebrospinal fluid fistula (1 case), meningoencephalitis (1 case), and herniated disc recurrence (1 case).
(Table 4) shows the mean values of the hemoglobin, platelet, leukocyte and lymphocyte counts preoperatively as well as the hemoglobin and platelet counts postoperatively.

Table 1. Comorbidities and Frankel and ASA Scales.

ASA	**Number**	
I	57	77.0%
II	13	17.6%
III	4	5.4%
Frankel		
A	7	9.5%
B	2	2.7%
C	11	14.9%
D	10	13.5%
E	44	59.4%
Comorbidities		
Hypertension	19	54.3%
Diabetes Mellitus	11	31.5%
Hashimoto Thyroiditis	3	8.6%
Fibromyalgia	1	2.8%
Rheumatoid Arthritis	1	2.8%

Table 2. Spinal Pathologies.

	Number of cases	
Fracture and/or vertebral dislocation	30	40.5%
Degenerative disc disease	17	23.0%
Cervical stenosis with myelopathy	11	14.9%
Lumbar stenosis	9	12.2%
Cauda equina syndrome	3	4.0%
Cervical traumatic disc herniation	3	4.0%
Lumbar spondylolisthesis	1	1.4%

Table 3. Surgeries Performed.

	Number of cases	
Thoracolumbar arthrodesis +/- decompression	25	33.7%
Lumbar decompression + discectomy	14	18.9%
Cervical discectomy + arthrodesis, anterior approach	12	16.2%
Decompression + cervical arthrodesis, posterior approach	8	10.8%
Lumbar decompression without instrumentation	7	9.5%
Halo cervical traction	4	5.4%
Odontoid fixation	2	2.7%
Cervical decompression, combined approach	1	1.4%
Cervical open-door laminoplasty	1	1.4%

Table 4. Laboratory Values.

Mean hemoglobin level preoperatively	13.45 mg/dL
Mean hemoglobin level postoperatively	11.57 mg/dL
Mean platelet count preoperatively	260.830/mcl
Mean platelet count postoperatively	245.220/mcl
Mean leukocyte count preoperatively	9.390/mcl
Mean lymphocyte count preoperatively	1960/mcl

DISCUSSION

The COVID-19 pandemic has profoundly altered the delivery and scheduling of surgeries in many different institutions worldwide, due to patients' and health care providers' fear of contracting the virus, the difficulty of accessing institutions capable of dealing with a large volume of patients and the various difficulties in isolating patients appropriately to hinder the spread of the virus, especially in underdeveloped countries. Thus, many patients who require urgent surgical procedures arrive late to the health care institution or do not even seek a specialized service for diagnostic assessments and treatment.[7,8]

Specific surgical procedures in orthopedic spine surgery are often urgently needed to minimize sequelae or prevent neurological damage, as well as to restore mechanical stability and relieve patients' pain. Thus, an adequate systematization of patient care from the time of entry into the emergency room until hospital discharge must be well established to hinder the spread of COVID-19. In the present study, the rate of COVID-19 infections diagnosed in patients who were hospitalized for surgical procedures was 6.7% (5 cases), and the associated mortality rate was 20%.

In the institution, the internationally recommended standard safety protocols were performed when patients who were suspected or confirmed to have COVID-19 infection were treated.[9,10] For this purpose, reverse transcriptase-polymerase chain reaction (RT-PCR) was performed, and chest computed tomography (CT) scans were performed to diagnose or exclude infection in patients who were suspecting of having infection and planning to undergo surgery. N95 masks and other individual protective equipment were used, as recommended by the local hospital infection control services, and the patients were isolated in a private room with negative pressure when a COVID-19 diagnosis was suspected or confirmed. All suspected or confirmed cases were reported early to minimize further spread of the virus. This strategy was successful as the contraction rate in the department was maintained at an acceptable level (less than 10%). All indications for surgery during the pandemic period followed the recommendations of the North American Spine Society,[11] the American College of Surgeons,[12] and the document signed by the Brazilian Spine Society, the Brazilian Society of Neurosurgery, and the Brazilian Society of Orthopedics and Traumatology.[13,14]

It should be noted that the prevalence of smoking was high among the patients in the study (29.73%), and smoking is known to impair lung function and the prognosis if an infection develops, especially pulmonary infections such as that caused by COVID-19.[15] Among the comorbidities observed in the study, there were no divergent findings regarding the prevalence of chronic diseases in the population, and hypertension was the most prevalent chronic disease, followed by diabetes mellitus.[16]

The most common pathologies addressed were fracture and/or dislocation (40.5%), degenerative disc disease (23%) and cervical stenosis (14.9%). The following surgical procedures were among the most common: thoracolumbar arthrodesis with or without decompression (33.7%), lumbar decompression + discectomy (18.9%) and cervical discectomy. This finding is in agreement with the prevalence of vertebral pathologies observed in the general population and their main proposed treatments.[17-19] The other complications that occurred in the study include urinary tract infection (5 cases), acute renal failure, subarachnoid hemorrhage, meningoencephalitis and herniated disc recurrence (1 case each). The ASA score was not relevant since more than 90% of the patients were healthy (ASA I) or had well-controlled comorbidities (ASA II). Regarding the Frankel scale, which evaluates neurological function, a significant number of patients had neurological deficits (Frankel A, B, C). This finding can be justified by the severity of the traumas addressed and sometimes by the difficulty that patients have in accessing specialized health services, as they often arrive to the institution after their condition has progressed considerably. Regarding the findings of the pre- and postoperative laboratory examinations, no significant changes were found. This finding can also be explained by the fact that the vast majority of patients were healthy or had well-controlled comorbidities.

Limitations of the study include the fact that it was a retrospective study without comparison of or subdivision by specific pathologies. During the pandemic, the complication rates were within the expected range for urgent or emergent surgeries. In addition, although the vast majority of procedures were performed urgently, the protocols followed at the institution to combat COVID-19 appear to have been effective as they kept spine surgeries safe from contamination with the virus and other general complications. It is worth mentioning that in urgent cases, it is often not possible to perform ideal patient preparation; nonetheless, the management of cases seems to have been satisfactory. This fact warrants further investigation to elucidate the real benefit of the protocols followed by the institution and encourage others to follow well-structured protocols to prevent virus contamination for a successful outcome.

Data should be collected continuously to improve the institution's ability to plan and provide care, and data on more cases will help outline the epidemiological findings in more detail, which can improve the quality of education provided to residents and spine surgery fellows.

CONCLUSIONS

During the hospitalization period, only 5 of the 74 patients were diagnosed with COVID-19 infection. The COVID-19 infection death rate was 1 in 5 cases. The postoperative surgical site infection rate was 10.8%, which was similar to the level before the pandemic.

AUTHORS' CONTRIBUTION: Each author contributed individually and significantly to the development of this article. MCMTJ and RJGBS: review of the literature, collected and analyzed the data and wrote the project and manuscript. RMM, AFC and TEPBF: analyzed the data, final review of the literature and project. OBL: analyzed the data, final review of the literature and project and designed the study.

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INTRAOPERATIVE EVALUATION AND LEVEL OF CONTAMINATION DURING TOTAL KNEE ARTHROPLASTY

AVALIAÇÃO E NÍVEL DE CONTAMINAÇÃO INTRA-OPERATÓRIA DURANTE A ARTROPLASTIA TOTAL DO JOELHO

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ABSTRACT

Introduction: Despite numerous articles on intraoperative contamination in total knee arthroplasty (TKA) procedures, the available data on tissue contamination are scarce and mainly based on evaluating bacteriological swabs. Methods: Two hundred and forty specimens, divided between bone and soft tissue, were obtained from 40 consecutive unilateral primaries TKAs. The specimens were evaluated for aerobic and anaerobic bacterial growth. Colony-forming units/gram (CFU/g) were calculated on the contaminated specimens to determine the level of contamination. Results: The contamination rate in intraoperative specimens was 15% during TKA. The contamination level had a mean of 10.6 and a median of 5, ranging from 1-70 CFU/g. The most common contaminating organisms in all samples were Staphylococcus aureus (38.9%) and Staphylococcus epidermidis (30.6%). No clinical infections were detected in TKAs in the follow-up period. Conclusion: The contamination rate during TKA is relatively high, despite the practice of standard preventive measures. Contamination levels, measured by CFU/g, are considered low when compared to the infection threshold of 105 reported in the literature. However, contamination should not be underestimated due to the presence of foreign bodies (implants), which are known to significantly lower this threshold. ***Level of evidence IV; case series.***

Descriptors: Knee Arthroplasty. Intraoperative Period. Surgical Wound Infection.

RESUMO

Introdução: Apesar dos inúmeros artigos sobre a contaminação intraoperatória em procedimentos de artroplastia total do joelho (ATJ), os dados disponíveis sobre a contaminação tecidual são escassos e baseiam-se principalmente na avaliação de swabs bacteriológicos. Métodos: Duzentos e quarenta espécimes, divididos entre ossos e tecidos moles, foram obtidos de 40 ATJ primárias unilaterais consecutivas. Os exemplares foram avaliados quanto ao crescimento bacteriano aeróbio e anaeróbio. As unidades formadoras de colônias/grama (UFC/g) foram calculadas nas amostras contaminadas para determinar o nível de contaminação. Resultados: A taxa de contaminação em espécimes intraoperatórios foi de 15% durante a ATJ. O nível de contaminação teve uma média de 10,6 e uma mediana de 5 variando de 1-70 UFC/g. Os organismos contaminantes mais comuns em todas as amostras foram Staphylococcus aureus (38,9%) e Staphylococcus epidermidis (30,6%). Nenhuma infecção clínica foi detectada nas ATJ durante o período de acompanhamento. Conclusão: A taxa de contaminação durante a ATJ é relativamente alta, apesar da prática de medidas preventivas padrão. Os níveis de contaminação, medidos por UFC/g, são considerados baixos quando comparados ao limiar de infecção de 105, relatado na literatura. No entanto, a contaminação não deve ser negligenciada devido à presença de corpos estranhos (implantes) que são conhecidos por reduzir significativamente esse limiar. ***Nível de evidência IV; series de casos.***

Descritores: *Artroplastia do Joelho. Período intraoperatório. Infecção da Ferida Cirúrgica.*

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INTRODUCTION

Total knee arthroplasty (TKA), which was first performed in 1968, has been the standard of care in patients with end-stage arthritis.[1,2] It is estimated that over 1,324,000 TKAs are performed annually around the world.[3]

The satisfaction rate after TKA is high, reaching up to 86% in terms of pain relief and 84% for functional improvement.[4] However, post-operative complications, including infection, can lead to a devastating outcome.[5,6]

The risk of deep infection in TKA ranges from 0.39-3.4 percent.[7-9] This dreaded complication is the most common cause behind revision procedures.[10] Numerous studies in the literature discussed the causes, prevention and management of infection in TKA.[11,12]

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

The study was conducted at College of Medicine in King Saud University and conducted at the Medical Microbiology Laboratory Riyadh, Saudi Arabia.
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The fear from infection in arthroplasty led the surgeons to investigate the intraoperative contamination in the gloves, electrocautery devices and splash basins among many other factors related to the surgeons, patients and intraoperative environment.[13-15] Furthermore, researchers have investigated the air contamination in the operating rooms (ORs); they found various levels of microbial contamination which were mainly influenced by the type of ventilation system.[16,17] Despite the numerous articles on the intraoperative contamination in TKA procedures, the available data about tissue contamination is scarce and are mainly based on the evaluation of bacteriology swabs.[18]
Our aim is to investigate the contamination rate and level during TKA surgery. Our hypothesis was that the intraoperative contamination rate is high with a low level of colony forming units/gram (CFU/g) below the 10^5 threshold reported in the literature.

MATERIALS AND METHODS

After the institutional review board approval of this study, 240 specimens divided between bone and soft tissue were obtained from 40 consecutive primary unilateral TKAs. The procedures were performed by three staff surgeons, with ten to fifteen years of experience, in two ORs designated for elective clean orthopedic cases. Those two ORs had unidirectional laminar flow ventilation systems equipped with high-efficiency particulate air (HEPA) filters.
All patients received 1-2 grams of Cefazolin 30 minutes before surgery with two additional doses administered post-operatively 8 hours apart. Pre-operatively, the three surgeons used a combination of isopropyl alcohol and povidone-iodine for skin preparation, and they followed similar draping techniques. A standard medial parapatellar approach was utilized in all procedures. Under meticulous sterile conditions intraoperatively, the anterior cruciate ligament (ACL), after its resection, was taken to a sterile back table and cut into three identical pieces representing the soft tissue specimens. After performing the distal femoral cut with an oscillating saw, the resected osteochondral block was transferred to the back table. Three osteochondral specimens with intact cartilage were retrieved. All specimens were collected in dry sterile containers and immediately sent to the microbiology lab in the same building.
In the microbiology lab, each specimen was weighed and rolled onto sheep blood agar and MacConkey plates for a minimum of 20 seconds. Robertson cooked meat medium was used afterwards for the cultivation of organisms. The aforementioned plates and medium were incubated in 5% carbon dioxide for 72 hours and 7 days to allow for aerobic and anaerobic bacterial growth, respectively. All isolated organisms were assessed through gram stain and colony morphology. Furthermore, an automated identification system (MicroScan WalkAway-96 System; Dade Behring) along with the identification and susceptibility panels (Negative Combo 42 and Positive Combo 28) were utilized to identify the contaminating microorganisms.
The calculation of the CFU/g was performed using the colony counter: Count D-37079; Schuett Biotec.de.
The IBM SPSS Statistics for Windows, Version 21.0 (Armonk, NY: IBM Corp.) was used to analyze the data. Descriptive analysis was performed for all variables. Chi-square test was used to compare between the contamination rates in bone and soft tissue groups. P-value $<.05$ was considered statistically significant.
All patients were seen in their routine clinical follow-up with a minimum follow-up duration of 3 years. In each visit, any signs or symptoms of superficial or deep surgical site infection (SSI) such as fever, erythema, local warmth, sinus tract and discharge were documented.
The study was approved by the Institutional Review Board (IRB) of the College of Medicine in King Saud University and conducted at the Medical Microbiology Laboratory of King Saud University Medical City (Research Project No. E-13-959).

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

RESULTS

The contamination rate was 15% during TKA. The contamination level had a mean of 10.6 CFUs/g and a median of 5 CFUs/g. The range of the contamination level was from 1-70 CFUs/g. The contamination did not significantly differ between bone (16.7%) and soft tissue specimens (13.3%) ($p = .47$).
The most common contaminating organisms in both groups were staphylococcus aureus and staphylococcus epidermidis, represented by 38.9% (n=14) and 30.6% (n=11), respectively (Figure 1).
No post-operative SSI was detected throughout the follow-up period which ranged from 3-6 years.

DISCUSSION

Maintaining the sterility in joint replacement surgeries cannot be overemphasized especially in the presence of a compromised immune system.[19,20] Despite practicing standard precautions to minimize intra-operative contamination in hip and knee arthroplasty, it has been reported that up to 63% of the surgical field is contaminated.[21]
In the current study, the intraoperative contamination rate and level in TKA were assessed using various microbiological methods to ensure accuracy. The contamination rates of the bone and soft tissue specimens were similar. The gram positive staphylococci were the most common contaminating organisms in both groups. The highest level of tissue contamination in our series was 70 CFU/g. The microbiology profile in our study matched those reported in the literature with staphylococcus aureus and staphylococcus epidermidis as the most common contaminating organisms in total joint arthroplasty.[22] Nevertheless, numerous etiologic agents, exceeding those reported in our study, have been identified.[12,23]
The patients' follow-up in this study ranged from 3-4 years. Although none of our patients, even those with contaminated specimens, had a post-operative infection, the development of infection is out of this study's scope since other factors can have an influential effect on the outcome. For instance, irrigation, especially when antibiotics or antiseptics are added to the solution, can alter the contamination status and reduce the risk of infection.[7,24] While infection is usually associated with a contamination level greater than 100,000 CFUs, the presence of implants can significantly

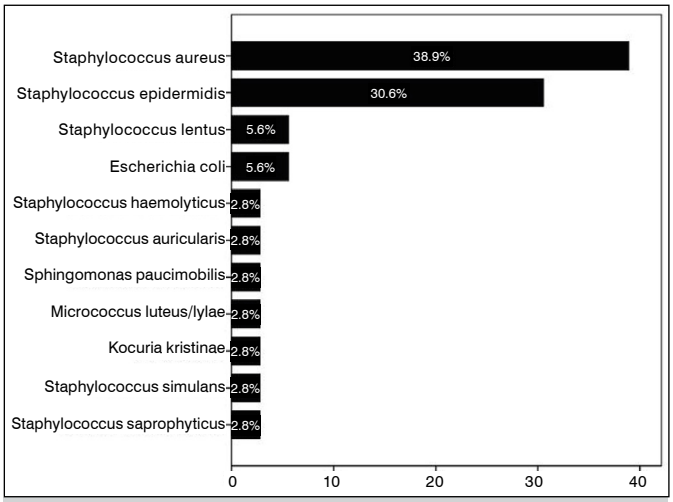

Figure 1. The identified organisms in the contaminated specimens.

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reduce that threshold leading to a periprosthetic infection.[22] That being said, the contamination in bone and soft tissue specimens should not be neglected based on the low number of CFUs.

In the recent literature, Haenle et al. investigated the intra-operative contamination in TKA through obtaining bacteriology swabs immediately after opening the joint capsule. The contamination rate in their study was 43% with staphylococcus epidermidis as the main contaminating organism (27.8%). Approximately 2.9% of their patients had a periprosthetic infection; they found no association between positive bacteriology swabs and the development of post-operative infections in those patients In our point of view, this could possibly be related to a contamination that occurred after obtaining the swabs.

Several intraoperative contamination rates have been reported. For instance, around 15.2% of the surgeons' gloves in total joint replacement are contaminated.[14] It is estimated that the contamination rates in skin and inside blades are approximately 9.4% and 3.2%, respectively, and the intraoperative contamination rates are even higher in suction tips (11.4%) and light handles (14.5%).[25] Coagulase negative staphylococci were the most common contaminating organisms.[14,25] Therefore, surgeons and nurses should be very careful as these organisms were the most identified in our contaminated tissue specimens.

The ventilation systems in the OR have been thoroughly discussed in the literature.[16,26,27] The unidirectional laminar flow with HEPA filter, which is the utilized ventilation system in our ORs, has been known for its efficiency in removing greater than 99.97% of airborne particles.[26] Nevertheless, it is recommended to minimize the number of people in the OR along with the number of door openings since they positively correlate with the intraoperative air contamination.[27] Despite using the unidirectional laminar flow ventilation system with HEPA filter and minimizing the number of people and door openings, we still cannot rule out airborne particles as a potential source of contamination in our series.

This article presents the contamination rates of bone and soft tissue biopsies which have proven to be relatively high. Despite the low contamination level, based on analyzing the CFU/g, care must be taken intra-operatively since high level of bacterial contamination can occur at any time. The gloves, drapes and suction and electrocautery tips are known sources of contamination in arthroplasty procedures.[13,14,28,29] Thus, double gloving and changing the outer gloves regularly is advised.[28,30] In addition, surgeons should avoid using the suction tip for any fluid collection on the drapes.[29] We also advise surgeons not to use any potentially contaminated instruments after surgical site irrigation.

Our specimens were retrieved at a relatively early stage during the procedure and not at various intervals throughout the surgery; thus, the possibility of further contamination was not assessed. Another limitation is that we did not investigate the effect of irrigation and lavage, usually performed at end of surgery, on the rate of contamination. We could not correlate the detected strains in our series to any of the known contamination sources since we did not take any intraoperative samples from those potential sources. Although none of our patients developed an infection, this study was not meant to address the rate or risk of post-operative infection because of the insufficient sample size. The follow-up was solely based on our clinical assessment. Laboratory work-up, including the ESR and CRP levels, were not requested; thus, we were not able to detect any alterations in the inflammatory markers based on the contamination status or level in the absence of infection. Furthermore, we did not investigate the effect of patient-related risk factors for infection development such as diabetes, corticosteroid use and smoking.

In conclusion, the contamination rate during TKA is relatively high despite practicing the standard preventive measures. The levels of contamination, measured by CFU/g, are considered low compared to the 10^5 infection threshold reported in the literature. However, the contamination should not be neglected due to the presence of implants which are known to significantly reduc be that threshold

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IS VOLAR PLATING IN DISTAL RADIUS FRACTURES SAFE REGARDING PRONATOR QUADRATUS?

O USO DE PLACAS VOLARES EM FRATURAS DISTAIS DO RÁDIO É SEGURO PARA O PRONADOR QUADRADO?

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ABSTRACT

Objective: This study aimed to investigate whether isokinetic strength decrease significantly after using volar plating for distal radius fractures and evaluate the pronator quadratus muscle regarding atrophy. Methods: This study took place between 2011 and 2015 and included 18 distal radius fracture patients (group 1) who were treated via volar plating at least one year prior and 14 healthy controls (group 2). All participants were tested isokinetically. Grip strength, radiological evaluation, wrist range of motion, disabilities of the arm, shoulder, and hand and visual analog scale scores were assessed for clinical and functional outcomes. Ultrasonography evaluated the pronator quadratus muscle thicknesses. Results: The peak supination torque (PT) and supination work per repetition (WPT) strength values significantly decreased (p:0.039, p:0.025, respectively). Although we determined an 11% pronation PT deficit and a 19% pronation WPT deficit, neither were significant. In group 1, the pronator quadratus muscle thickness decreased 5.9% ± 13.3 in the radial area and 9.7% ± 10.5 in the interosseous area according with ultrasonography; these results were not statistically significant compared to group 2. All clinical and functional outcomes were not statistically significant between the groups. Conclusion: The use of volar plating after distal radius fractures is a safe method regarding isokinetic strength and pronator quadratus muscle atrophy. ***Level of evidence III; Retrospective case-control study.***

Keywords: Muscle strength. Radius fractures. Open fracture reduction.

RESUMO

Objetivo: Este estudo teve como objetivo investigar se as forças isocinéticas diminuem significativamente após o uso de placa volar para tratamento de fraturas do rádio distal e avaliar o músculo pronador quadrado quanto à atrofia. Métodos: Este estudo realizado entre 2011 e 2015 incluiu 18 pacientes com fratura do rádio distal (grupo 1) que tenham sido tratadas com placa volar pelo menos um ano antes e 14 pessoas saudáveis como controle (grupo 2). Todos os participantes foram testados isocineticamente. Força de preensão, avaliação radiológica, amplitude de movimento do punho, deficiências do braço, ombro e mão e escores da escala visual analógica foram avaliados clinica e funcionalmente. A ultrassonografia avaliou a espessura do músculo pronador quadrado. Resultados: A força máxima do torque de supinação (TM) e do trabalho por repetição (ER) de supinação diminuíram significativamente (p: 0,039, p: 0,025, respectivamente). Embora tenhamos determinado um déficit de TM de pronação de 11% e um déficit de ER de pronação de 19%, nenhum dos dois foi significativo. No grupo 1, a espessura do músculo pronador quadrado diminuiu 5,9% ± 13,3 na área radial e 9,7% ± 10,5 na área interóssea, segundo ultrassonografia; estes resultados não foram estatisticamente significativos em comparação com o grupo 2. Nenhum resultados clínico ou funcional foi estatisticamente significativo entre os grupos. Conclusão: O uso de placa volar após fraturas do rádio distal é um método seguro em relação à força isocinética e atrofia do músculo pronador quadrado. ***Nível de evidência III; estudo retrospectivo de caso-controle.***

Descritores: *Força muscular. Fraturas do rádio. Redução aberta.*

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INTRODUCTION

Distal radius fractures - the most common among long bone fractures - constitute an orthopedic emergency due to trauma; they account for one-sixth of all fractures.[1] Distal radius fractures represent a significant public health problem given the increased life expectancy of the general population. While there has been a historical shift from conservative to surgical treatment [2] and many related studies have been conducted, there is still no clear consensus on the preferred treatment. Surgical treatment is applied either for unstable fractures or when adequate anatomical reduction

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The study was conducted at İstanbul Üniversitesi, Faculty of Medicine, Istanbul, Turkey.
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is not achieved with conservative treatment.[3] The most commonly used surgical method is open reduction and internal fixation with volar plating.[4] In the volar approach, the pronator quadratus muscle is elevated from the radial side and is usually repaired at the end of the surgical procedure. However, after the implementation of this approach, it is not known exactly how dissection of the pronator quadratus muscle affects clinical and functional outcomes; therefore, research is ongoing on this subject.[5,6] The aims of this study were to determine any changes in isokinetic strengths after the use of volar plating for distal radius fractures and whether this could have a negative impact on functional clinical outcomes as well as a correlation with sonographic measurements of the pronator quadratus muscle.

MATERIALS AND METHODS

Study population

This retrospective case-control study was performed at a single Level 1 trauma centre after receiving approval from the ethics committee and written informed consent from each of the 32 participants. Initially, 41 patients who were treated with volar plating after a distal radius fracture in our department between 2011–2015 met the inclusion criteria. Of those 41 patients, 18 agreed to participate in this study (Group 1), and 14 healthy volunteers served as the control group (Group 2). (Table 1) The inclusion criteria included being between ages 18 and 65 years; having an AO type 23-C fracture; having undergone an open reduction via the volar approach; having at least a 12-month postoperative follow-up; and being operated on by the same surgeon with the same type of locking plate (Aculoc-Acumed). All included participants were mobile, sedentary, and cooperative. The exclusion criteria included the use of external fixation or pinning; the use of an additional dorsal incision for reduction or plating; an open fracture; an ipsilateral or contralateral upper extremity fracture; either non-union or malunion, and the inability to cooperate. Group 2 had similar baseline features to those of group 1, but they had no past upper extremity fractures or neurological diseases that could have negatively affected their muscle function.

The dominant sides of the patients and whether the fracture was on the dominant or non-dominant side were determined. The time from surgery until 2015 December was determined in months.

Surgical approach and rehabilitation protocol

A standard modified Henry approach was used by the same experienced surgeon. During this approach, the pronator quadratus muscle was cut with a longitudinal incision. It was carefully stripped from the radial side to the ulnar side, leaving 2-3 mm on the radial side to allow repair. The fractures were then reduced and fixed with an anatomical volar locking plate (Acu-Loc®, Acumed, Portland, OR, USA). The pronator quadratus muscles were repaired with a braided, absorbable, synthetic 3/0 polyglactin suture (Vicryl®, Ethicon, Somerville, NJ, USA) at the end of the operation. The goal was a complete repair, but the surgery reports noted a loose or partial) repair due to either a traumatic injury or disruption of the muscle in seven of the patients.

The rehabilitation protocol started after 5–7 days of plaster cast immobilization for pain and swelling subsidence. A removable splint was used for another five weeks, and active wrist exercises were started and advised for all patients during this period. Strengthening therapies for wrist musculature were initiated at the sixth week to improve the patients' functional status.

Table 1. Characteristics of included subjects.

		Study groups			
		Plating group		Control group	
		n	%	n	%
Sex	Female	3	16.7	3	21.4
	Male	15	83.3	11	78.6
Dominant side	Right	16	88.9	14	100.0
	Left	2	11.1	0	0
Injured side	Right	10	55.6	*	
	Left	8	44.4		
AO type	23C1	7	41.2	*	
	23C2	6	35.3		
	23C3	4	23.5		
Age (mean, SD)		43.8 10.2		38.8 13.2	
Weight (mean, SD)		79.3 12.1		74.9 13.1	
Time from surgery (months)		55.3 21.8		*	

SD: Standard derivation, *No data for the group.

Isokinetic test protocol

A computed dynamometer (Humac Norm II, CYBEX, Stoughton, MA, USA) was used for the isokinetic strength measurement of individuals by the same physiotherapist (TŞ). All measurements were performed at 10:00 and 13:00 to minimize the effect of day-to-day hormonal changes while the participants were tested. The test procedure was performed primarily after a five-minute warm-up of the Cybex Upper Body Ergometer. Two isokinetic tests were performed for each upper extremity of each participant: forearm pronation/supination and wrist extension/flexion. The patients were seated in an upright position with their hip joint at 90° flexion and their elbow joint at 90° flexion. Forearm pronation/supination and wrist flexion/extension movements were repeated four times to determine peak torque (PT) (N·m), work per repetition (WPT) (J), and PT deficit at a velocity of 90°/sec. PT is the maximum torque produced by any repetition of the test set, and WPT is the work done in each repetition. [7] The PT deficit is the percentage loss of the strength relative to either the dominant or the uninjured side.

We performed grip strength measurements using a Jamar dynamometer (Asimow Engineering, Los Angeles, CA, USA). The shoulders were kept in adduction and in neutral rotations. The elbow was flexed at 90°, and the forearm was in a neutral position. Power measurements of each side were successfully repeated three times. Kilogram-force was used as the measurement unit.

Sonographic evaluation

In total, 11 patients from group 1 and 11 members of group 2 agreed to participate in wrist ultrasound imaging. They were all evaluated for thickness of the pronator quadratus muscle. Scanning was done prior to the isokinetic testing to avoid affecting the results. The same senior radiologist performed all the examinations (FB). A General Electric LOGIQ P5 device was used for the imaging of all participants. Each participant's hand was laid comfortably on a rectangular flat table, and the shoulder was positioned in adduction and a neutral rotation while allowing the elbow to remain at 90°. Sagittal and axial images of the pronator quadratus muscle were provided by using a linear probe. Measurements were taken from the point where the muscle was its thickest.

The interosseous area measurement was taken at approximately 3 cm proximal of the radiocarpal joint in sagittal views (Figure 1). For the radial area measurement, the diameter of the pronator quadratus muscle was measured from 3 cm proximal to the radiocarpal joint and 5 mm lateral of the radius medial contour in axial views (Figure 2).

Clinical evaluation

The same physician measured the wrist range of motion (ROM). Each patient's functional status was evaluated for disabilities of the arm, shoulder, and hand (DASH) [8] outcome measure score,

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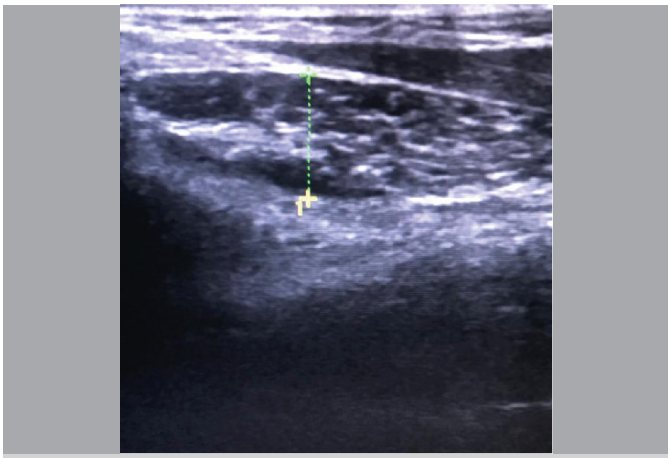
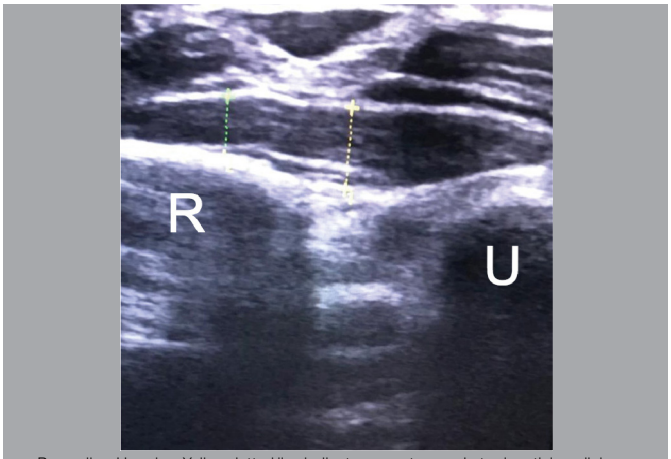


Figure 1. Measurement of pronator quadratus thickness in interosseous area in sagittal view.



R = radius, U = ulna. Yellow dotted line indicates pronator quadratus length in radial area.

Figure 2. Measurement of pronator quadratus thickness in axial view.

and their pain status was evaluated with the visual analog scale (VAS) score. Standard wrist anteroposterior and lateral radiographs of all patients were taken bilaterally and were examined for volar tilt, ulnar variance, radial inclination, and radial length. The measurements were taken by the same physician (NT) using computer software.

Statistical analysis

Descriptive characteristics were indicated by the appropriate number, percentage, average, and standard deviation values. To compare the measurements between the groups, a t-test in independent groups and a one-way ANOVA test were used in the parametric data. Chi-square and Fisher's exact tests were used to compare categorical data. For statistical significance, $p < 0.05$ was accepted. SPSS 20 for Windows (SPSS Inc., Chicago, IL, USA) was used in the analysis of the study.

RESULTS

This study included 18 patients (group 1) with a mean age of 43.8 ± 10.2 and 14 healthy volunteers (group 2) with a mean age of 38.8±13.2. The mean weight was 79.3 ± 12.1 kg in group 1 and 74.9 ± 13.1 kg in group 2. The mean follow-up was 55.3 ± 21.8 months. All participants had dominance in their right hand except two in group 1. There were no significant baseline characteristics, including mean age, weight, and follow-up between the groups ($p > 0.05$).

Isokinetic strength evaluation

Isokinetic PT and WPT values were compared within the groups. For group 1, the mean supinator PT and mean supinator WPT were significantly higher in the uninjured sides than they were in the injured sides (p: 0.039 and p: 0.025, respectively). The mean pronator PT values were 9.7 ± 2.9 N·m in the uninjured side and 8.4 ± 2.4 N·m in the injured side (p: 0.159). The mean pronator WPT values were 19.7 ± 5.2 N·m in the uninjured side and 16.8 ± 6.0 N·m in the injured side (p: 0.141). Although there was a trend toward decreased pronation strength, it was not statistically significant. (Table 2) Neither flexor nor extensor strength values were considered significant ($p > 0.05$).

For group 2, this study showed no difference between the dominant and nondominant upper extremities, except the pronator WPT (p: 0.041) in the mean PT and the mean WPT in group 2.

We observed no statistically significant difference between the groups when comparing the PT and the work deficits ($p > 0.05$). (Table 3)

Sonographic outcomes

For group 1, the radial area measurement was 5.6 ± 1.3 mm on the injured side, while it was 6.0 ± 1.1 mm on the uninjured side. The interosseous area measurement for group 1 was 7.6 ± 2.5 mm on the fractured side, while the uninjured side was 8.4 ± 2.4 mm. The percentage of thickness deficit was 5.9% in the radial area and 9.7% in the interosseous area in group 1, while the same variables for group 2 were 1.2% and 3.3%, respectively. There was no statistically significant difference between the groups. (Table 4)

Clinical outcomes

The clinical results (Table 4) were similar in both groups. There was no statistically significant difference in grip strength when comparing

Table 2. Results of isokinetic testing.

	Plating group		p [a]	Control group		p [a]
	Uninjured side	Injured side		Dominant side	Nondominant side	
	Mean and standard deviation			Mean and standard deviation		
Pronator PT	9.7 ± 2.9	8.4 ± 2.4	0.159	9.1 ±2.1	10.3 ±2.6	0.187
Pronator WPT	19.7 ± 5.2	16.8 ± 6.0	0.141	17.3 ±4.8	21.1 ± 4.7	0.041
Supinator PT	8.0 ± 2.9	6.3 ± 1.6	0.039	8.8 ±3.7	6.7 ± 2.0	0.076
Supinator WPT	16.3 ± 5.7	12.2 ± 4.5	0.025	15.2 ±6.0	13.5 ± 4.8	0.409
Extensor PT	10.9 ± 3.5	10.8 ± 5.2	0.916	11.4 ±3.3	12.2 ±3.9	0.533
Extensor WPT	9.6 ± 2.9	8.7 ± 4.4	0.525	12.1 ±3.9	13.1 ±4.5	0.535
Flexor PT	14.8±4.8	12.9±6.1	0.319	15.0 ±5.4	12.9 ±4.9	0.296
Flexor WPT	14.1±4.8	11.2±6.2	0.147	16.1 ± 5.5	14.1 ±5.4	0.343

SD: Standart deviation, PT: Peak torque, WPT: Work per repetition, [a] One way ANOVA test. PT values are Newton-metre (N·m), WPT values are joule (J).

Table 3. Peak torque deficit and work per repetition deficit between sides.

	Study groups	
	Plating group	Control group
	Mean and standard deviation	
Pronator PTD	11.5 ± 14.4	9.2 ± 17.0
Pronator WPTD	19.0 ± 22.2	16.0 ± 17.3
Supinator PTD	19.1 ± 25.8	16.4 ± 10.9
Supinator WPTD	25.1 ± 29.7	14.4 ± 17.0
Extensor PTD	9.7 ± 31.4	7.4 ± 17.6
Extensor WPTD	15.5 ± 35.7	9.6 ± 25.0
Flexor PTD	14.4 ± 29.8	16.1 ± 15.4
Flexor WPTD	18.2 ± 34.1	16.9 ± 14.8

PTD: Peak Torque Deficit, WPTD: Work Per Repetition Deficit, [a] One way ANOVA test. All numbers are percentage.

Table 4. Comparison of sonographic measurements, grip strength and functional outcomes.

	Study groups		P[a]
	Plating group	Control group	
	Mean and standard deviation		
Injured side USG Radial area (mm)	5.6 1.3	5.6 0.9	0.957
Injured side USG interosseous area (mm)	7.6 2.5	7.3 0.9	0.709
Uninjured side USG Radial area (mm)	6.0 1.1	5.7 1.2	0.685
Uninjured side USG interosseous area (mm)	8.4 2.4	7.5 1.0	0.343
Injured side grip strength (kgf)	32.4 11.9	41.1 8.8	0.182
Uninjured side grip strength (kgf)	39.4 12.1	43.2 10.0	0.912
Grip strength deficit percentage	17.8 18.5	3.7 9.8	0.232
DASH score	5.4 5.4	11.6 11.5	0.066
VAS score	0.0 0.0	0.4 1.2	0.168
Flexion	68.6 9.7	70.5 8.2	0.653
Extension	59.7 8.1	62.5 8.1	0.262
Pronation	79.3 10.2	86.1 7.2	0.183
Supination	81.4 8.3	82.6 5.0	0.131

[a] One way ANOVA test, mm: milimeter, kgf: kilogram-force, USG: ultrasonography. Dominant side is chosen as uninjured side, nondominant side is chosen as injured side for control group.

the two groups. The percentage of grip strength difference between the sides was compared within and between the groups, and no statistically significant difference was found. We compared the injured sides of Group 1 and the non-dominant sides of Group 2 for ROM, DASH and VAS scores evaluation. The groups did not differ in their ROM and DASH scores. The mean ulnar variance was 0.0 ± 1.9 mm; the radial length was 11.6 ± 2.4 mm; the volar tilt was +3.8° ± 5.4; and the radial inclination was 22.4° ± 4.6. All acceptability criteria for distal radius fractures were achieved in group 1 regarding these parameters.

DISCUSSION

Pronation force is thought to be formed by combinations of muscle forces, with the pronator quadratus muscle being the primary contributor to pronator PT.[9] However, the pronator quadratus is dissected and elevated from its origin during volar plating. There is not enough data in the literature to determine whether pronator quadratus muscle dissection reduces this pronator force. Therefore, we sought to investigate isokinetic forearm strength after the occurrence of distal radius fractures.

McConkey et al. measured isometric pronation strengths both before and after they paralyzed the pronator quadratus muscle with lidocaine.[10] They reported a 21% decrease in pronation torque after inducing paralysis in their study. Huh et al. reported that they showed 8% pronation PT and 20% supination PT deficits after volar plating of a distal radius fracture at 12-month follow-up. Similar results were obtained in this study; the supinator PT and WPT deficits were greater than the pronator PT and WPT deficits. The deficits in pronation PT, pronation WPT, supination PT, and supination WPT were 11%, 19%, 22%, and 26%, respectively.

This study confirmed that volar plating of distal radius fractures did not change the pronation strength at mid- and long-term follow-ups, which it had in other studies; however, the supination torque and supination WPT strengths were significantly lower in group 1.[6,11] One study showed that the loss of supination strength in particular was correlated with worse Patient-Rated Wrist Evaluation scores.[12] Contrarily, this study and Huh et al.'s study showed that supination strength loss did not affect functional outcomes.[6] Here, patients in group 1 were evaluated via DASH scores (mean 5.4 ± 5.4); there was no significant difference between the groups regarding grip strength, DASH scores, wrist ROM. Functional impairment had improved for the surgery group at mid- and long-term follow-ups.

McConkey et al. emphasized that the pronator quadratus may heal in a lengthened position and may function at the same power that it had in the past.[10] When we performed postoperative ultrasonography to detect healing of the pronator quadratus, the data showed that the pronator quadratus muscle's thickness had improved after the surgery. Pronator quadratus thicknesses were measured on the radial side in the interosseous area, as mentioned previously, and there was no statistically significant difference compared to group 2, although the pronator quadratus was traumatized. The pronation strength's lack of significant change may have been because the muscle of the pronator quadratus had somehow healed.

The topic of whether the pronator quadratus should be repaired with the volar approach to plating is an interesting debate. Limited isokinetic research has been indecisive about this issue. When we repaired the pronator quadratus, no significant change in pronator strength resulted. Nho et al.'s study isokinetically and functionally supported the idea that the pronator quadratus has minimal impact on pronator strength and forearm rotation function.[11] They examined a repaired pronator quadratus muscle during hardware removal at the mean 9th month and found that 68% of the original muscle length was reached at that time; they found no significant differences in either the isokinetic or the functional outcomes. In another study, pronation strength after a repair showed no difference at the 6th and 12th weeks, but the authors stated that pronator repair might be better for pain control in the early postoperative period and for reducing complications.[13] Although the pronator quadratus was not repaired in Huh et al.'s study, they found that pronator strength had not diminished significantly.[6] On the contrary, Armangil et al. used a small-sized group and showed that the pronator quadratus muscle, which had been dissected and repaired after volar plating of distal radius fractures, resulted in a decrease in pronator strength.[5] When Hershman et al. and Ahsan et al. investigated outcomes clinically and functionally, they found no advantages to repairing the pronator quadratus during the volar plating of distal radius fractures.[14,15] Similarly, researchers found no significant difference regarding functional outcomes, ROM, grip strength, post-operative pain, and complications between repair and no repair groups in a recent systematic review.[16] If we look at this issue from another perspective, pronator quadratus repair will also cover the plate; therefore, it will hypothetically reduce the risk of rupture by increasing the distance between the flexor tendons and the plate. In an ultrasound study, distance from the flexor pollicis longus tendon to the volar prominence of the plate decreased significantly when the pronator quadratus was not repaired, and the authors stated the importance of repair.[17]

This study has some notable limitations. Firstly, the included patients had undergone surgery at least one year prior; hence, early outcomes of surgery were not evaluated. In addition, the time since surgery was rather variable among patients, and the initial trauma characteristics and quality of the pronator repair changed among the patients.

CONCLUSION

This study showed that, although pronator strength does not significantly change after the volar plating of a distal radius fracture, supinator strength statistically significantly decreases. We believe that this phenomenon is not related to either the anatomical or functional results of the pronator quadratus muscle. In addition, the pronator quadratus muscle does heal, which we observed via ultrasonography, and it continues to contribute to pronation strength.

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AUTHORS' CONTRIBUTION: Each author contributed individually and significantly to the development of this article. NT and TA: study conception and design and article writing; FB: sonographic evalutation and article writing. TŞ, AŞK, and ÖA: result interpretation and data collection. CŞ: conception and design and critical review of the article.

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LIGAMENT PRESERVING TOTAL HIP ARTHROPLASTY PREVENTS DIFFERENT LEG LENGTH AND FEMORAL OFFSET

ARTROPLASTIA TOTAL DO QUADRIL COM PRESERVAÇÃO DE LIGAMENTOS PREVINE COMPRIMENTOS DIFERENTES DA PERNA E OFFSET FEMORAL

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ABSTRACT

Objectives: The leg length (LL) and femoral offset (FO) discrepancy following total hip arthroplasty (THA) are important factors for postoperative outcomes and restoring native hip biomechanics is essential for THA. Hip capsular ligament contributes to joint stability; however, there are few studies about the influence of ligament preservation on LLD and FO following THA. Methods: We conducted a retrospective study involving 60 patients who underwent primary THA using a short stem through the anterolateral approach between June 2016 and August 2018. From August 2017, we preserved the vertical band of iliofemoral ligament and the pubofemoral ligament in THA, and the compared pre- and postoperative radiographic LLD and FO difference between the ligament preservation (n = 30) and ligament excision (n = 30) groups. Results: Postoperative LLD was significantly smaller in the ligament preservation than in the ligament excision group. The ratio of excessive LLD and FO difference was lower in the ligament preservation group than the ligament excision one. Conclusion: The preservation of the hip capsular ligament suppressed the increased LLD and FO difference. ***Level of Evidence II; Prognostic Study - Investigation of the Effect of a Patient Characteristic on the Outcome of a Disease.***

Keywords: Arthroplasty. Arthroplasty, Replacement, Hip. Ligaments. Leg Length Inequality.

RESUMO

Objetivos: A discrepância do comprimento da perna (CP) e do offset femoral (OF) após a artroplastia total do quadril (ATQ) são fatores importantes para os resultados pós-operatórios, e a restauração da biomecânica original do quadril é essencial para a ATQ. O ligamento capsular do quadril contribui para a estabilidade articular; entretanto, existem poucos estudos sobre a influência da preservação ligamentar no LLD e FO após ATQ. Métodos: Realizamos um estudo retrospectivo envolvendo 60 pacientes submetidos à ATQ primária com haste curta por via anterolateral entre junho de 2016 e agosto de 2018. A partir de agosto de 2017, a banda vertical do ligamento iliofemoral e do ligamento pubofemoral na ATQ foram preservadas e compararadas à diferença de LLD e FO radiográficas pré- e pós-operatórias entre os grupos de preservação ligamentar (n = 30) e excisão ligamentar (n = 30). Resultados: O LLD pós-operatório foi significativamente menor no grupo de preservação do ligamento que no grupo de excisão do ligamento. A razão de diferença de LLD e FO excessivas foi menor no grupo de preservação do ligamento do que no grupo de excisão do ligamento. Conclusão: A preservação do ligamento capsular do quadril suprimiu o aumento da diferença de LLD e FO. ***Nível de evidência II; Estudo Prognóstico - Investigação do Efeito da Característica de um Paciente no Desfecho da Doença.***

Descritores: *Artroplastia. Artroplastia de Quadril. Ligamentos. Desigualdade de Membros Inferiores.*

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INTRODUCTION

Total hip arthroplasty (THA) is an effective treatment for hip osteoarthritis (OA) in long-term studies;[1,2] however, hip dislocation is a major complication which severely decreases patient satisfaction following THA.[3] Lower leg length and offset decrease the soft tissue tension and increase risk of dislocation;[4] thus, surgeons have to be careful not to reduce leg length and offset after THA. In previous studies, the leg length of the operative side tends to be longer than that of the contralateral side after THA.[5] However, more than 10 mm leg length discrepancy (LLD) decreases patient satisfaction following THA, and excessive LLD is associated with many postoperative complaints such as lower back pain, abnormal gait, decreased

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walking distance, and nerve palsies.[6,7] An increased femoral offset (FO) showed positive effect on abductor muscle force in several studies;[8] however, excessive FO leads negative effect such as thigh pain.[9] Finally, the proper leg length and offset is an important factor for proper soft tissue tension and joint stability, and restoring normal hip biomechanics seems to be one of the most important goals of THA.[10] Joint instability leads to the risk of postoperative dislocation and increased revision rate.[11] The joint capsular ligament is an important factor for hip joint stability, and some authors reported that the excision of capsular ligament increased joint instability in cadaveric studies.[12,13] Previous studies reported that restoring native leg length and offset was improved by using navigation systems,[14] intraoperative radiographic fluoroscopy.[15] However, there are no studies regarding the relationship between the preservation of hip capsular ligament and limb length discrepancy and hip offset differences.

The present study aims to investigate the relationship between hip capsular ligament and postoperative leg length and hip offset between patients after THA with a ligament excision procedure and those after THA with a ligament preservation procedure. We hypothesized that the patients who underwent THA with ligament preservation had suppressed postoperative LLD and FO difference compared to those who had THA with ligament excision.

MATERIAL AND METHODS

Patients

The study protocol was approved by the ethics committee of our institution, and informed consent was obtained from all participants. The Institutional Review Board number of the published article was 2018-26. This retrospective cohort study enrolled 164 consecutive patients with hip OA who underwent primary unilateral THA at our institutions between June 2016 and August 2018. Our inclusion criteria were patients who had substantial pain and difficulty in daily activities with hip OA and understood primary unilateral THA using a cement-less cup, G7 (Zimmer- Biomet, Warsaw, IN) cement-less short stem; Minima (Lima Corporate, Villanova, Italia), or Fitmore (Zimmer Biomet, Warsaw, IN, USA) through the anterolateral approach in the supine position. The exclusion criteria were active infection, revision THA, and operative history on the contralateral side. Of 164 patients, 4 patients underwent THA through the direct lateral approach because of severe OA with joint collapse, 10 patients underwent revision THA, 3 patients had rheumatoid arthritis, 2 patients had osteonecrosis, 4 patients had the history of hip fracture, 15 patients had the history of contralateral THA, 6 patients underwent bilateral THA, and 62 patients underwent THA using other types of implants. Finally, 60 patients who met the criteria were included in this study (54 women and 6 men; age: 69.1 ± 10.4 years, body mass index (BMI): 24.3 ± 4.8 kg/m2). From August 2017, we changed the surgical procedure from the ligament excision technique to the ligament preservation technique. Therefore, patients were divided into two groups: underwent THA with ligament excision procedure from June 2016 to July 2017 (excision group; n = 30) or underwent THA with ligament preservation procedure from August 2017 to August 2018 (preservation group; n = 30). There was no significant difference in patient characteristics between the two groups (Table 1).

Table 1. Patients' characteristics.

Characteristic	Preservation group	Excision group	P-value
Number of cases	30	30	
Sex, female / male	28 / 2	26 / 4	0.39
Age, years	68.4 ± 11.3	69.8 ± 9.5	0.61
Height, cm	152.4 ± 7.7	152.8 ± 8.2	0.88
Weight, kg	54.2 ± 11.9	58.8 ± 11.7	0.14
Body mass index, kg/m^2	23.3 ± 4.7	25.2 ± 4.4	0.12

Operative procedures

One senior surgeon (T.F.) performed all surgeries. The patients were placed on a horizontal operative table in the spine position, and the anterolateral approach was performed. An approximately 12-cm straight incision starting distally and behind the anterior superior iliac spine and proceeding to the greater trochanter and femur was made. The incision was deepened to the deep fascia, and the iliotibial muscle was incised along the skin incision and retracted anteriorly and posteriorly. The interval between the gluteus medius and vastus lateralis was spread using retractors that were placed under the gluteus medius superior to the capsule ligament, inferior to the femoral neck and anterior to the acetabulum.

In the ligament preservation group, the vertical band of the iliofemoral ligament and the pubofemoral ligament were completely preserved, and only the horizontal band of the iliofemoral ligament was excised to open a minimum window for visualization of the femoral head and acetabular roof. In the ligament excision group, all of the iliofemoral ligaments and pubofemoral ligaments were removed in the traditional procedure.

According to preoperative templating, the femoral neck was cut upon acetabular exposure, and the acetabulum was reamed and the cup was implanted. Reaming and implantation of the femoral stem was performed according to preoperative templating. After trial reduction, a senior surgeon (T.F.) evaluated the joint stability using manual extension, internal rotation, and external rotation. When the dislocation was easily performed, the stem neck size was enlarged while checking limb length discrepancy and offset using intraoperative fluoroscopic imaging. After final implantation, the interval of muscles was directly sutured, and soft tissue and skin were closed in layers.

Radiographic measurement

Preoperative and postoperative antero-posterior radiographs of the pelvis were obtained in a supine position with 15° internal limb rotation. Measurements on the radiographs were performed using a PACS client (IMPAX EE, AGFA HealthCare GmbH, Bonn, Germany). The distance between the trans-teardrop line and the most prominent aspect of the lesser trochanter line was measured, and the difference between operative side and non-operative side was obtained as LLD. The femoral offset was measured as the distance between the centre of femoral head and the anatomic axis of the femur line (Figure 1). All radiographies were assessed by two investigators (MF, TF), and all measurements were performed twice one month apart to evaluate the intra-observer and inter-observer variability. The intraclass correlation coefficient was 0.84–0.91 (intra-observer) and 0.81–0.88 (inter-observer).

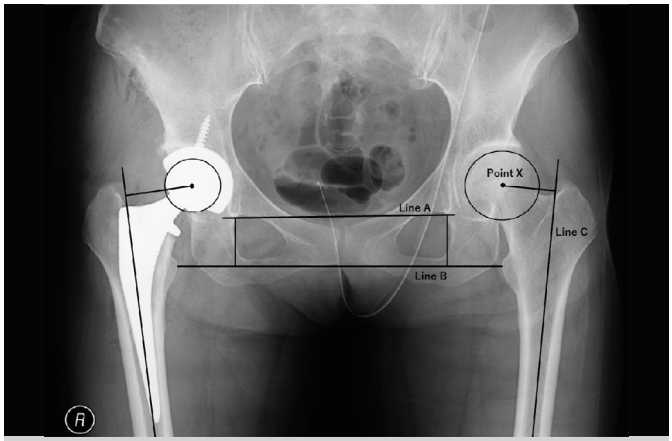

Figure 1. Measurement of leg length and offset discrepancy. Line A is the trans-teardrop line. Line B is the lesser trochanter line. Line C is the anatomic axis of the femur. Point X is the centre of the femoral head.

<< SUMÁRIO

Statistical analysis

Outcomes were reported as mean ± standard deviation (SD). Statistical analysis was performed using StatView 5.0 (Abacus Concepts Inc., Berkeley, CA, USA). The Student t-test was used to compare LLD and FO between the ligament preservation group and the ligament excision group following THA. Mann-Whitney's U test was used to compare the ratio of postoperative excessive LLD and FO difference between two groups. Post-hoc power analysis was performed using G*Power 3. The present study had 0.86 power(1-β) to detect a difference in 0.80 effect size at the $p < 0.05$ level.

RESULTS

(Table 2) shows the summary of LLD. Postoperative LLD was significantly smaller in the ligament preservation group than in the ligament excision group (0.6 ± 3.4 mm in preservation group and 3.6 ± 7.3 mm in excision group). The rate of excessive LLD following THA was significantly smaller in the preservation group than in the excision group; more than 5mm and 10mm were 6.7% (2/30 cases) and 0% (0/30 cases) in preservation group, and 30.0% (9/30 cases) and 16.7% (5/30 cases) in excision group. The rate of excessive LLD following THA was significantly smaller in preservation group than excision group. The absolute LLD and ratio of excessive absolute LLD following THA were also significantly smaller in the preservation group than in the excision group.

(Table 3) shows the summary of FO. Postoperative FO overlengthening was suppressed in the ligament preservation group (-1.1 ± 4.9 mm in preservation group and 1.4 ± 5.6 mm in excision group), but not significantly. However, the rate of more than 5mm FO difference following THA was significantly smaller in the preservation group than in the excision group. Postoperative FO difference of more than 5mm and 10mm were 20.0% (6/30 cases) and 3.3% (1/30 cases) in the preservation group, and 40.0% (12/30 cases) and 6.7% (2/30 cases) in the excision group. The absolute FO difference and ratio of excessive absolute FO difference following THA was also smaller in the preservation group than in the excision group, but not significantly.

Table 2. Comparison of leg length discrepancy and excessive discrepancy ratio between ligament preservation group and ligament excision group.

	Preservation group	Excision group	
LLD, mm	**Mean ± SD**	**Mean ± SD**	**p-value**
Preoperative	-5.1 ± 3.8	-5.2 ± 6.2	0.92
Postoperative	0.6 ± 3.4	3.6 ± 7.3	< 0.05
Excessive LLD ratio	**Mean ± SD**	**Mean ± SD**	**p-value**
More than 5mm	2 / 30 (6.7 %)	9 / 30 (30.0 %)	< 0.05
More than 10mm	0 / 30 (0.0 %)	5 / 30 (16.7 %)	< 0.05
Absolute LLD, mm	**Mean ± SD**	**Mean ± SD**	**p-value**
Preoperative	5.2 ± 3.7	6.3 ± 5.0	0.32
Postoperative	2.9 ± 1.8	5.4 ± 6.0	< 0.05
Excessive absolute LLD ratio	**Mean ± SD**	**Mean ± SD**	**p-value**
More than 5mm	3 / 30 (10.0 %)	10 / 30 (33.3 %)	< 0.05
More than 10mm	0 / 30(0.0 %)	5 / 30 (16.7 %)	< 0.05

LLD: leg length discrepancy; SD: standard deviation.

Table 3. Comparison of femoral offset difference and excessive difference ratio between ligament preservation group and ligament excision group.

	Preservation group	Excision group	
FO difference, mm	**Mean ± SD**	**Mean ± SD**	**p-value**
Preoperative	0.7 ± 4.2	0.3 ± 5.5	0.70
Postoperative	-1.1 ± 4.9	1.4 ± 5.6	0.07
Excessive FO difference ratio	**Mean ± SD**	**Mean ± SD**	**p-value**
More than 5mm	2 / 30 (6.7 %)	8 / 30 (26.7 %)	< 0.05
More than 10mm	0 / 30 (0.0 %)	2 / 30 (6.7 %)	0.15
Absolute FO difference, mm	**Mean ± SD**	**Mean ± SD**	**p-value**
Preoperative	3.5 ± 2.4	4.1 ± 3.7	0.48
Postoperative	4.1 ± 2.8	4.6 ± 3.4	0.52
Excessive absolute FO difference ratio	**Mean ± SD**	**Mean ± SD**	**p-value**
More than 5mm	6 / 30 (20.0 %)	12 / 30 (40.0 %)	0.09
More than 10mm	1 / 30 (3.3 %)	2 / 30 (6.7 %)	0.56

FO: femoral offset; SD: standard deviation.

DISCUSSION

The main finding of the present study is that patients who underwent THA with ligament preservation showed significantly smaller postoperative LLD compared with those after THA with the ligament excision procedure. In addition, the rate of excessive LLD and FO difference following THA was significantly smaller in the preservation group than in the excision group. The absolute LLD also showed significant suppression in the ligament preservation group. These results confirmed our prior hypothesis. This study is the first to assess the effect of preservation of hip capsular ligament on the postoperative LLD and FO in THA in the supine position. Our result suggested that the preservation of hip capsular ligaments improves the LLD and FO difference and contributes to patient satisfaction following THA.

Slightly increased leg length and offset contain the proper soft tissue tension and decrease the risk of dislocation.[4,16] However, excessive LLD leads to various complaints such as lower back pain, abnormal gait, decreased walking distance and nerve palsies,[6,7] and more than 10 mm LLD decreases patient satisfaction.[17] In addition, more than 5mm FO increases soft tissue tension, diminished pain relief [9] and linear wear.[18] Therefore, restoring normal leg length and offset without overlengthening is important to obtain adequate soft tissue tension and patient satisfaction.[19,20] In the present study, the rate of more than 5mm and 10mm LLD was significantly smaller in the preservation group than in the excision group, and the rate of more than 5mm FO difference was smaller in ligament preservation group.

The hip capsular ligaments were important components for stability of the joint, and iliofemoral ligament and pubofemoral ligament especially control the external rotation mobility.[21] Van Arkel et al. suggested that the anterior ligament with its straight line of action directly contributes to restraining hip laxity following THA, compared to the posterior ligament which requires wrapping tightly around the surface of the femoral head.[22] Myers et al. showed that excision of the iliofemoral ligament resulted in increased external rotation and anterior translation of femoral head in all flexion angles compared to the intact state.[23] In the present study, the preserved iliofemoral ligament and pubofemoral ligament seemed to improve joint stability, positively influence intraoperative evaluation of joint laxity, and contribute to restoring native hip biomechanics.

Our study has some limitations. First, intraoperative joint laxity was evaluated by 1 senior surgeon. The evaluation of intraoperative joint stability require the high experience of joint surgery,[3] thus senior surgeon is required for proper procedure. Second, we only measured leg length and offset radiographically. The slight difference of hip position can cause substantial errors in the radiographic measurement of leg length and offset, so further study using Computed Tomography scans is desired. Third, our study did not evaluate clinical outcomes. The evaluation of clinical scores and patient satisfaction is required in the future.

CONCLUSION

In conclusion, the preservation of the vertical band of the iliofemoral ligament and pubofemoral ligament contribute to restoring the native leg length and offset following THA.

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SPINE

NO SIGNIFICANT EFFECT OF 3D MODELLING ON SURGICAL PLANNING IN SPINAL DEFORMITIES

NENHUM EFEITO SIGNIFICATIVO DA MODELAGEM 3D NO PLANEJAMENTO CIRÚRGICO EM DEFORMIDADES DA COLUNA VERTEBRAL

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ABSTRACT

Objective: To evaluate the effect of 3d printed models on surgical pre-operative planning of complex spinal deformities. Methods: In our study, five orthopedic surgeons made surgical planning of 5 patients with severe spinal deformity in three conditions: X-ray with computer tomography (X-ray-CT), 3D-computed tomography (3dCT), and 3d printed spine models. Operation plans were examined according to the level and number of instrumentations, osteotomy level, and time required for decision-making. Results: X-ray-CT, 3dCT, and 3d modeling methods were compared, and no statistically significant difference was observed in the number of screws and osteotomy score to be used in operation. The time required for decision ranking is 3d Model, 3d CT, and Xray-CT. Conclusions: 3d printed models do not influence the operative plan significantly; however, it reduces surgical planning time at pre-op duration, and those models gave some opportunities to practice with implants on a patient's 3d spine model. ***Level of Evidence III; Diagnostic Studies - Investigating a Diagnostic Test.***

Keywords: Biomedical Engineering. Image-Guided Surgery. Orthopedic Surgery. Simulation. Biomechanics.

RESUMO

Objetivo: Avaliar o efeito de modelos 3D impressos no planejamento pré-operatório cirúrgico de deformidades complexas da coluna vertebral. Métodos: Em nosso estudo, 5 cirurgiões ortopédicos fizeram o planejamento cirúrgico de 5 pacientes com deformidade espinhal grave em três condições: raio-X com tomografia computadorizada (raio X-CT), tomografia computadorizada com reconstrução 3D (3dCT) e modelo de coluna vertebral impressa (modelo 3d). Os planos de operação foram examinados de acordo com o nível e número de instrumentos, nível de osteotomia e tempo necessário para a tomada de decisão. Resultados: Foram comparados os métodos de modelagem de raio X-CT, 3dCT e modelo 3d e nenhuma diferença estatisticamente significativa foi observada no número de parafusos e escore de osteotomia a serem utilizados na operação. O ranking do tempo necessário para a tomada de decisão foi de modelo 3d, 3d CT e raio X-CT. Conclusões: Os modelos impressos em 3d não influenciam significativamente o plano operatório, porém reduzem o tempo de planejamento cirúrgico no pré-operatório e esses modelos deram algumas oportunidades de praticar com implantes no modelo de coluna 3d do paciente. ***Nível de evidência III; Estudos de Diagnóstico - Investigando um Teste de Diagnóstico.***

Descritores: *Engenharia Biomédica. Cirurgia Guiada por Imagem. Cirurgia Ortopédica. Simulação. Biomecânica.*

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INTRODUCTION

In complex spinal deformities, preoperative surgical planning and preparation are vital for fruitful treatment of the problem. The correction procedure is often very challenging as unexpected pedicle absence and vertebral rotations can be discovered intraoperatively, posing great risk of neurovascular lesions during the operation.[1] With advances in both medical imaging and computer programming, two dimensional axial images can be processed in to other reformatted views (sagittal and coronal) and three-dimensional (3D) virtual models that represent a patients' own anatomy.[2]

Three-dimensional print models for orthopedic conditions can improve understanding of anatomy and pathology by way of tactile and visual experience for both the surgeon and patient to complement images displayed on a computer monitor.[3] There are studies

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The study was conducted at Dokuz Eylul University Hospital, Konak, Turkey.
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in literature on many fields such as complex neoplasm and cardiac anomaly surgeries, deformity, fracture or spinal deformities with promising results for almost all of them, especially in reducing the operation period.[3-14]
However, careful review of the literature revealed no study on the effectiveness of 3D printed models on pre-operative planning. So, the present study was conducted to search the effects of 3D models on preoperative planning of complex spinal deformities with special reference to the level of instrumentations and osteotomies.

MATERIALS AND METHODS

Five patients (1 male and 4 females) who underwent operation for their severe spinal deformities between 2010-2015 were included in the study. All patients had severe scoliosis, kyphosis or kyphoscoliosis deformity. Preoperational X-rays and CT images were obtained from the archives. Ethics committee Approval Number; 2015/11-06.
3D CT's were produced as follows: spines were scanned using computer tomography (Somatom Definition Flash; Siemens Healthcare) with a spatial resolution of 0.3 mm. Data were reconstructed out of the axial plane with a slice thickness of 0.6 mm, matrix size of 512 9 512, and a field of view of 154 mm 9 154 mm.
For 3D printing, soft tissues were erased just to get spine itself. Two freeform surfaces were represented by triangular tessellation and exported as STL (stereolithography) files, respectively. The STL files of both the collecting system and the Spine model outer shape were checked for anatomical correctness and then imported to Geomagic Studio 12.0 (Geomagic Inc. US) (Figure 1). Surface modification was done on 3D spine model and then imported to Cura 2.0 (Ultimaker, The Nertherlands) to print the spine model with a 3D printer (Ultimaker 2 Extended, The Netherlands)
Three different sets (X-ray - CT, 3D CT and 3D Model) were prepared for each patient. This means, a total of 15 sets were ready for five patients. Then five surgeons who were at least 20 years of experience in spinal surgery were included in the study. Fifteen sets were presented randomly presented to these surgeons and they were asked to make surgical planning for deformity correction and mark the level osteotomy and screws. Additionally, time required for decision making was also noted. 3D model of a patient is displayed in (Figure 2).
The results were analyzed by Friedman test.

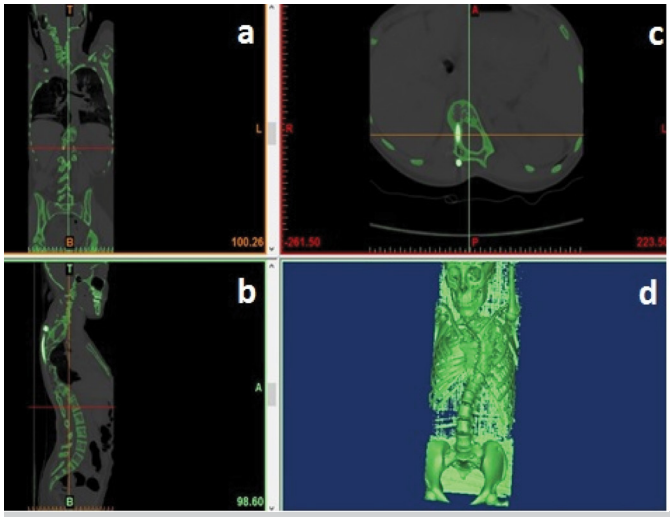

Figure 1. Workflow for getting 3D model of the spine on a software (Mimics 17). CT imaging data of a human spine as acquired (a) frontal view and (b) sagital view. (c) The collecting system is used as the inner mold. Image segmentation for each slice to get the best solution for each spine. (d) CT images were constructed to the 3D model.

RESULTS

Surgical plannings of five surgeons for five patients with severe vertebral deformity were analyzed in terms of level and number of instrumentations, level of osteotomy and time required for decision making.
Compared to X-ray CT, 3D CT and 3D modeling methods, no statistically significant difference was observed regarding the distribution of the number of screws to be used in the operation. The statistical distribution of the number of screws is (p=0.072) (Table 1).
The results of statistical evaluation of the number of osteotomies to be performed in the operation turned out to be similar to those of X-ray - CT, 3D CT and 3D model. (p=0.803).
Time required for surgical planning with regard to the methods is statistically different (p<0,001) (Table 2). According to multiple comparison tests, while required time in X-Ray is longer than in 3D CT and 3D model and it is statistically significant; time-length in 3D CT is longer than in 3D model, which is also statistically significant.

DISCUSSION

In orthopedic procedures, surgeons have to mentally integrate all preoperative two-dimensional images and formulate a 3D surgical plan. This preoperative planning is particularly difficult in areas that have complex anatomy and severe deformity.[2] 3D

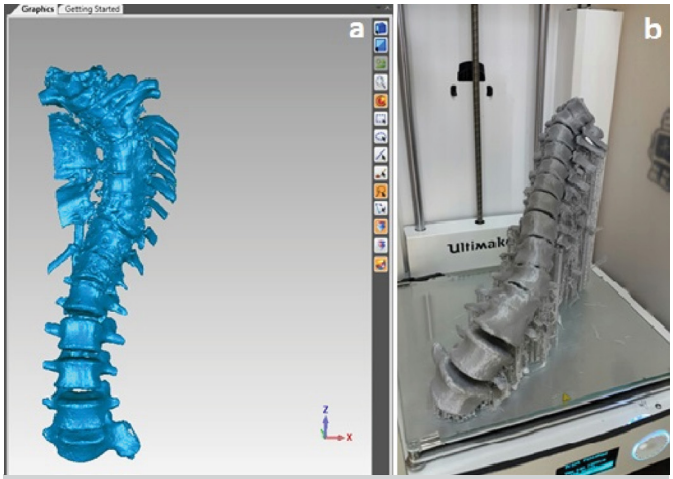

Figure 2. Workflow for building a 3D spine model. (a) The surface modification of the spine model is done by the software (Geomagic 12.0) to ease the 3D printing. (b) spine model is 3D printed with an ultimaker PLA material to obtain 3D surgical evaluation spine model for complex spinal deformities.

Table 1. Comparison of Instrumentation Levels with 3 Different Methods.

Instrumentation Level	Mean	Median(Min-Max)
X-ray - CT	11,4	13 (3-9)
3D CT	11,0	12 (3-20)
3D Model	9,9	11 (0-15)

*p=0,072.

Table 2. Comparison of time required for surgical planning levels with 3 Different Methods.

Time required for surgical planning	Mean	Median (Min-Max)
X-ray - CT	4,9	5,0 (2,0-10,0)
3D CT	3,5	3,2 (1,3-7,0)
3D model	2,2	2,0 (1,0-4,0)

p<0,001. Friedman test.

modeling seems to overcome these problems. Careful review of the literature revealed a number of studies on application of 3D modeling in orthopedics.[2-7,9]

Because of referring a new method of diagnosis and treatment, these are generally expert opinion articles. In the experience of bone fractures, pediatric deformities and complex spinal deformity, 3D modeling reported an incredible improvement. However, there was no statistical evaluation in those articles.

3D modeling is thought to facilitate the perception of the existing pathology, and it is obvious that experienced surgeons and orthopedic residents will benefit most from it. Bizzotto et al. 2015, examined different fracture models by experienced surgeons and residents. They observed a clear improvement in both groups, but it was not mentioned whether there was a difference between the groups.[5]

Considering the production process, it is more logical to use 3D modeling in specific cases rather than its routine usage. Wang et al., made preoperative planning of complex spinal disorders with 3D modeling can be cited as a successful application of that.[6]

Real size spinal models allow determination of deformity corrective interventions in the preoperative period. Martijn van Dijk et al., determined osteotomy and resection levels by using real size implants and had a chance to test custom-made implants in-vitro environment.[9]

In the literature, there are two articles published on this subject and they are about high tibial osteotomy and cubitus varus surgeries. Perez-Mananes et al., applied 3D modeling to high-tibial osteotomy surgery and they determined that it shortened the surgery time, reduced the use of scopy and decreased the margin of error.[4]

Takeyasu and colleagues treated supracondylar fractures of the cubitus varus deformities with custom-made surgical templates and three-dimensional corrective osteotomy with the use of a custom-made surgical template that is designed and produced on the basis of computer simulation is a feasible and useful treatment option for cubitus varus deformity.[7]

Review of the literature revealed several studies concerning complex spinal problems.[9-14] In most of these studies, the authors had prepared templates in order to perform more accurate osteotomies or instrumentation and reduce the operation period.[9-14] However, none of these studies focused on the contribution od 3D models on preoperative decision making as compared to conventional methods such as x rays, CT or 3D CT. We designed our study on the basis of this gap in the literature and aimed at determining a supporting method for the decision-making process of daily practices of surgeons dealing with spinal deformities.

This can be interpreted that 3D models can lead to fundamental changes under some conditions. It is obvious that this change is important given the financial size of the intervention, the risks of complications that may arise from the operation, especially the psychosocial status of the patient with a surgical intervention.

In the present study, the level of the osteotomy and instrumentation were not affected by 3D CT or 3D model ($p=0,803$ and 0,072 respectively). So, conventional x rays and CT seems enough for surgical decision making.

In our study, required time for surgical planning were 4.9 minutes with Xray-CT, 3.5 minutes with 3D CT and 2.2 minutes with 3D model and that difference was statistically significant. Rapid preoperative planning with 3D models can be the result of having detailed knowledge by examining the model in concrete. On the other hand, although statistically significant ($p<0,001$) in realty, three or four minutes have no importance especially in nonemergency surgeries, such as correction of spinal surgeries. Moreover, considering the production process of a spine model with the existing technology, the practical usability of 3D modeling is debatable.

CONCLUSION

In conclusion, the results of the present study indicate that 3D printed models do not influence the operative plan significantly. On the other hand, it is probable that surgeons may feel more confident with 3D models. We also conclude that larger series with different groups of patients may allow more strict conclusions.

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OSTEOMETABOLIC

SELF-MANAGEMENT PROGRAM (PARQVE) IMPROVES QUALITY OF LIFE IN SEVERE KNEE OSTEOARTHRITIS

PROGRAMA DE AUTOGESTÃO (PARQVE) MELHORA A QUALIDADE DE VIDA NA OSTEOARTRITE GRAVE DO JOELHO

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ABSTRACT

Objective: To evaluate the effects of the self-management program PARQVE in patients with severe knee osteoarthritis (KOA). Methods: Prospective randomized controlled clinical trial with 65 grade IV Kelgren & Lawrence (K&L) KOA patients who were allocated into groups: Control (CG) and Intervention (IG). Both groups received usual care. IG also participated in two days of multi-professional interventions about OA (causes and treatment) and received the program's DVD and book. Standing X-rays were obtained at inclusion and Ahlback's classification was registered. Western Ontario and McMaster Universities Index (WOMAC), Numerical Rating Scale (NRS), Lequesne, weight, and body mass index (BMI) were obtained at inclusion, and after 6, 12 and 24 months. Results: Groups were similar at baseline, despite higher WOMAC stiffness scores and a greater number of Ahlback's grade 4 and 5 in the IG. Only the IG improved WOMAC and total functions ($p<0.001$) during the study period above 12%, but did not reach the minimal clinically important difference of 20%. Best results were in one year. Non-significant improvements were observed without changes in body composition ($P>0.05$). Conclusions: Patients with severe KOA have mild to moderate function and quality of life improvement due to self-management program (PARQVE). ***Level of Evidence I; Therapeutic Studies; Prospective Randomized Controlled Trial.***

Keywords: Osteoarthritis, knee. Education. Clinical trial. Minimal clinically important difference. Quality of life. Patient education as topic. Treatment outcome.

RESUMO

Objetivo: Avaliar os efeitos do programa de autocuidado PARQVE em pacientes com osteoartrite grave de joelho (OAJ). Métodos: Ensaio clínico prospectivo randomizado controlado com 65 pacientes Kelgren & Lawrence (K&L) grau IV que foram alocados nos grupos: Controle (GC) e Intervenção (GI). Ambos os grupos receberam cuidados habituais. O IG também participou de dois dias de intervenções multiprofissionais sobre OA (causas e tratamento) e seus membros receberam o DVD e o livro do programa. Raios-X em pé foram obtidos na inclusão e a classificação de Ahlback foi registrada. Western Ontario e McMaster Universities Index (WOMAC), Escala de classificação numérica (ECN), Lequesne, peso e índice de massa corporal (IMC) foram obtidos na inclusão, e aos 6, 12 e 24 meses. Resultados: Os grupos eram semelhantes no início do estudo, apesar de maiores escores de rigidez WOMAC e um número maior de pacientes de Ahlback grau 4 e 5 no GI. Apenas o GI melhorou em WOMAC e função total ($p <0,001$) acima de 12% durante o período de estudo. Os melhores resultados foram após um ano. Melhorias não significativas foram observadas na composição corporal ($P> 0,05$). Conclusões: Pacientes com OAJ grave apresentam melhora leve a moderada de função e qualidade de vida pelo programa de autogerenciamento (PARQVE). ***Nível de Evidência I; Estudos Terapêuticos; Estudo Clínico Prospectivo e Randomizado.***

Descritores: *Osteoartrite do joelho. Educação. Ensaio clínico. Diferença mínima clinicamente importante. Qualidade de vida. Educação de pacientes como assunto. Resultado do tratamento.*

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INTRODUCTION

Osteoarthritis (OA) is considered a serious disease because it affects 240 million people worldwide, limiting mobility, disabling normal activity and increasing risk of cardiovascular disease, diabetes, hypertension and death. OA has no cure and yet, according to experts, all patients should receive education to be active, exercise and manage their weight.[1]

In the Department de Ortopedia e Traumatologia - Hospital das Clínicas - Faculdade de Medicina da Universidade de São Paulo (DOT-HC-FMUSP), a series of studies were made in order to develop

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a self-management program for patients with knee OA (KOA) called PARQVE (Project Arthritis Recovering Quality of Life by Education).[2–9] Initially, patients were included with all degrees of knee OA[2,3,8,9] and although not using all coping tools added to the program through the years, the impression of results were bleak since only 10% of patients improved significantly, far away from reported results.[10] In order to verify the effectiveness of two days of self-management-program on OA by a multiprofessional group to patients with KOA, patients with grades I to III Kellgren & Lawrence (K&L)[11] KOA submitted to usual care were compared to patients with the self-management program and usual care finding clinically relevant improvements of function and strength in those who participated in the PARQVE program.[5,6,12] Although we agree that all patients should receive education,[1] K&L grade IV KOA carries a significant diversity of clinical presentations varying from obliteration of the joint space to instability and deformity where diet and exercise will hardly compensate for instability. Ahlback's classification modified by Keyes[13] reflects the anatomic and pathologic progression of medial compartment KOA, and is of value in allowing more accurate comparisons to be made of different methods of treatment. The objective of this study is to verify how much an OA self-management program (PARQVE) can improve quality of life in patients with severe KOA.

MATERIAL AND METHODS

This study is a single-blind, single center, prospective randomized controlled clinical trial that followed the guidelines of the CONSORT statements for randomized controlled trials and nondrug treatments[14] and was performed at the Osteometabolic Group -Department of Orthopedics and Traumatology––Hospital das Clínicas–University of São Paulo. Ethics Committee for Analysis Certificate - CAAE 37436114.6.0000.0068. Clinical Trials registration number: NTC 02335034.
Eligibility criteria included patients 40 years of age or older, with American College of Rheumatology (ACR) clinical and radiological definition of KOA with K&L grade 4, able to understand Western Ontario and McMaster Universities Index (WOMAC)[15] and sign the informed consent. Patients were excluded if missed interventions or if submitted to knee surgery or any other disease or surgery that prevented them from participating in the program.

Randomization

Fifty-four sealed, opaque and non-translucent envelopes containing a card indicating CG or IG were mixed in an urn. The patient retrieved a card from the urn and opened it in front of an assistant of the project. Patients were directed to the subsequent routine.

Interventions

Patients randomized to the intervention group (IG) participated in two saturdays (8:00 to 17:00, two months apart) of interventions including lectures and physical and mental exercises in order to understand the disease and the importance of changing lifestyle and how to accomplish such changes[5] with a group of professionals including orthopedic surgeons, nutritionist, psychologists, physical therapists, physical educators, occupational therapists and social workers. IG participants received written[16] and video (DVD) educational material on the first day of the program, with all material explained in the interventions so they could change lifestyle at home or in community centers and primary and secondary care centers of the city of São Paulo compiled by the social workers of the program.

Usual care/ Follow-up routine

The orthopedic team treated all patients (control - CG and IG) on weekdays for inclusion but on Saturdays for baseline, six, 12- and 24-months evaluations. Interventions were scheduled less than a month after baseline evaluation. At first attendance patients were prescribed analgesics such as paracetamol, codeine and/or dipyrone according to symptoms. Subsidiary exams were requested. If criteria matched, patients were included in a subsequent follow-up. At each visit since the inclusion, the medical team explained the disease and its forms of treatment based on international guidelines[17,18] and prescribed whatever services they considered appropriate including the need to diet and exercise, orthotics, and medications to each patient, including diacerhein. When baseline evaluations were performed all patients were under medications for more than two months.

Outcome Measures

The primary aim of this study was to evaluate the improvement in total WOMAC of the patients at 12 months. Secondarily was to evaluate improvements in WOMAC total at 6 and 24 months, as well as WOMAC pain, stiffness and function, Numerical Rating Scale (NRS), Lequesne algo-functional questionnaire, weight body and mass index (BMI) at six and 12 months, 24 months. At each follow-up evaluation verify if improvement reached minimum clinically important differences (MCID).

Post Hoc Outcomes

Post hoc outcomes at 6, 12 and 24 months were: reduction of at least 5Kg in body weight,[19] NRS pain reduction of 20%,[20] WOMAC pain reduction of 11%,[21] WOMAC function of 20%,[21] WOMAC stiffness of 8%,[21] and WOMAC total improvements of 12% in respect to baseline.[21,22]

Sample Size

The number of patients was calculated to obtain a statistical power of 80% and a significance level of 5%. The standard deviation of a pilot study of 15.8[23] and an expected improvement of 20% estimated a number of 22 per group. Adding 20% per losses a number of 27 per group was selected.

Blinding

Patients were conscious about the group they were randomly assigned. Evaluators were blind to groups.

Statistical analysis

Quantitative personal and clinical characteristics were described according to groups using summary measures (means, standard deviations, medians, minimum and maximum) and compared between groups using the Mann-Whitney test or Student's t-test, the qualitative characteristics were described according to groups and the association with the use of the chi-square test was verified. The WOMAC domains were described according to groups and evaluation moments using summary measures and compared between groups and moments using generalized estimated equations (GEE) with Poisson marginal distribution and identity link function for the other evaluated parameters were assumed normal distribution with identity link function and assumed first order autoregressive correlation matrix between the evaluation moments for all analyses. The analyzes were followed by Bonferroni's multiple comparisons to verify where differences between groups and evaluation moments occurred when significant. The results were illustrated using graphs of mean profiles with the respective 95% confidence intervals. The analyzes were performed using the IBM-SPSS for Windows version 22.0 software and tabulated using the Microsoft-Excel 2010 software, and the tests were performed with a significance level of 5%.

RESULTS

Between January and February 2015, 65 patients met the inclusion criteria and agreed to participate. Randomization with envelopes was programmed for 54 patients. The remaining 11 patients were invited

to participate in the program and invited to come at the evaluation days, after randomization was completed. These extra patients came to all evaluations and their data were included (Figure 1). Groups were similar at inclusion despite a greater number of volunteers in the study group (Table 1, Figure 1).

WOMAC total and function were different between groups ($p<0.001$, Table 2, Figure 2), improving from baseline to all other moments in the IG ($p<0.001$, Table 3). WOMAC Pain varied during the study

Table 1. Description of baseline characteristics according to groups and results of statistical tests.

Variable	Group		p
	Control (N = 27)	Intervention (N = 38)	
Age (years)			0,996
Mean ± SD	67.5 10.3	67.5 11.1	
median (min.; max.)	65.5 (46; 86)	69 (34; 88)	
Gender, n (%)			0.378*
Male	9 (30,8)	8 (21,1)	
Female	18 (69,2)	30 (78,9)	
Weight (Kg)			0.261
Mean ± SD	78.4 14.6	82.8 15.4	
median (min.; max.)	78.7 (48.5; 119.7)	82 (50.7; 124.3)	
BMI			0.386
Mean ± SD	31.6 6.1	32.8 5.3	
median (min.; max.)	33 (21.5; 47.3)	32.3 (23.7; 42.7)	
WOMAC pain			0.662**
Mean ± SD	10.5 3.8	11.1 3.9	
median (min.; max.)	12 (4; 15)	11 (5; 18)	
WOMAC stiffness			0.010**
Mean ± SD	4.3 1.2	5.4 1.9	
median (min.; max.)	4 (2; 6)	6 (0; 8)	
WOMAC function			0.242**
Mean ± SD	36.6 10	42.1 9.7	
median (min.; max.)	40.5 (13; 51)	40 (24; 63)	
WOMAC total			0.233**
Mean ± SD	51.4 13.7	58.5 13.7	
median (min.; max.)	55.5 (22; 70)	54 (33; 89)	
NRS			0.194
Mean ± SD	67.4 17.6	74.4 15.6	
median (min.; max.)	67.5 (25; 100)	80 (40; 100)	
Lequesne			0.315
Mean ± SD	14.2 3.6	15.4 3.9	
median (min.; max.)	14.3 (6; 21)	14 (8.5; 21)	
Ahlback Right			0.993**
1	0 (0)	2 (6,3)	
2	1 (4,3)	0 (0)	
3	4 (17,4)	5 (15,6)	
4	11 (47,8)	15 (46,9)	
5	7 (30,4)	10 (31,3)	
Ahlback Left			0.095**
2	1 (4,5)	2 (6,7)	
3	8 (36,4)	2 (6,7)	
4	8 (36,4)	16 (53,3)	
5	5 (22,7)	10 (33,3)	
Worst Ahlback			0.383**
3	4 (17,4)	1 (3,1)	
4	10 (43,5)	17 (53,1)	
5	9 (39,1)	14 (43,8)	

Student T test; ** Mann-Whitney test; * Chi square test.

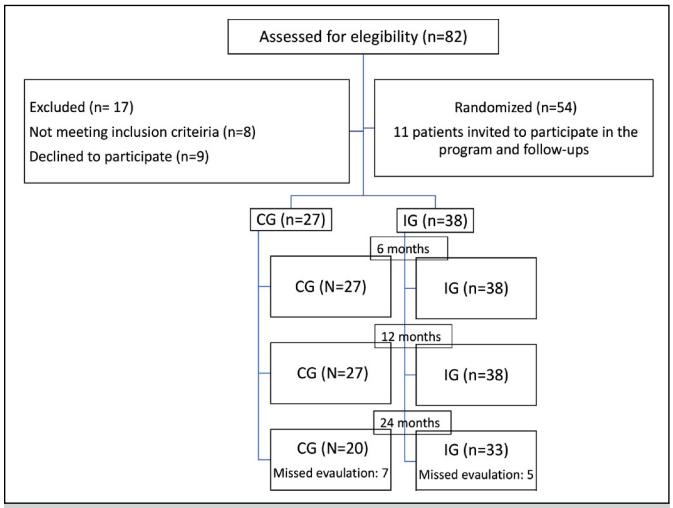

Figure 1. Flowchart.

irrespective of the group ($p=0.049$, Table 2). Despite better IG averages at 12 months, results were not significant ($p>0.05$, Table 3). IG WOMAC pain average results at six and 12 months, reduced 11% and 16%, respectively, reaching MCID of 11%.[21] None of the groups improved function above 20%(MCID).[21] IG stiffness results showed average improvement of 13% in all moments in respect to baseline (MCID of 8%).[21] The sum of WOMAC subsets in the IG led to improvements in WOMAC total above 13% in all moments in respect to baseline (MCID of 12%).[21]

(Table 4) shows that only weight showed a statistically different mean behavior of the groups throughout the evaluation moments (p Interaction = 0.008). In (Table 5 and Figure 3) we can see that the IG weight decreased on average from baseline to the other moments, and in 2 years the weight was on average lower than the other evaluated moments ($p < 0.05$), without significant mean difference between the groups at any time evaluated ($p > 0.05$). One patient in the control group lost more than 5kg whereas eight/38 patients (21%) in the IG lost ≥ 5kg.[19] Among the eight patients they presented grades 3, 4 and 5 of Ahlback. Pain, by NRS, reduced on average 11.4% not reaching the 20% mark.[20] Lequesne results failed to show any difference between groups or during the study period.

DISCUSSION

We were surprised by an actual improvement in patients with grade IV K&L (Grades III to V Ahlback) by the self-sufficiency program (PARQVE).[5] Groups at inclusion were similar with a reasonable amount of grade V Ahlback (with subluxation of the joint). One could say that the intervention group had a higher percentage of grades IV and V Ahlback, and at inclusion average pain and scores were non significantly higher (except for stiffness) in the IG. What we do not know is if they consume less medication and were less willing to be submitted to total knee arthroplasty as has been described.[10]

Yet this group responded with improvements in pain, stiffness, function and quality of life (considering that there is a direct relation between WOMAC total and EQ5D),[24] not as high as those improvements seen in patients with grades I to III K&L,[5] but above minimum clinically important differences (MCID)[21] for total knee replacement. Interestingly almost 20% of the IG reduced at least 5kg. That percentage is superior to those found in the group of patients with K&L I-III submitted to the same program.[5]

Lequesne results were practically unchanged during the study period demonstrating severe commitment of the patients and a

Table 2. Description of the WOMAC domains and the total according to groups and moments of assessment and results of comparative tests.

Variable/Group	Moment				p Group	p Moment	p Interaction
	Baseline	6 months	12 months	24 months			
WOMAC pain					0.505	0.049	0.237
Control							
mean ± SD	10.5 ± 3.8	10.5 ± 3.6	9.9 ± 3.2	11.3 ± 2.7			
median (min.; max.)	12 (4; 15)	11 (2; 15)	10 (2; 17)	12 (5; 16)			
Intervention							
mean ± SD	11.1 ± 3.9	9.8 ± 3.4	9.3 ± 3.3	10.1 ± 3.3			
median (min.; max.)	11 (5; 18)	9.5 (4; 17)	9 (3; 16)	10 (5; 17)			
WOMAC stiffness					0.436	0.51	0.06
Control							
mean ± SD	4.3 ± 1.2	5.1 ± 1.7	4.2 ± 1.5	4.8 ± 1.4			
median (min.; max.)	4 (2; 6)	6 (0; 8)	5 (1; 7)	5 (1; 8)			
Intervention							
mean ± SD	5.4 ± 1.9	4.7 ± 1.5	4.7 ± 1.7	4.7 ± 1.7			
median (min.; max.)	6 (0; 8)	5 (1; 8)	5 (0; 8)	5 (0; 7)			
WOMAC function					0.612	<0.001	<0.001
Control							
mean ± SD	36.6 ± 10	38.2 ± 10.8	35.9 ± 11.1	38.7 ± 10.8			
median (min.; max.)	40.5 (13; 51)	41 (9; 52)	36 (10; 56)	40 (17; 59)			
Intervention							
mean ± SD	42.1 ± 9.7	35.6 ± 12.7	36.5 ± 12.9	36.7 ± 11.9			
median (min.; max.)	40 (24; 63)	38 (7; 62)	36.5 (10; 65)	37 (14; 64)			
WOMAC total					0.687	<0.001	<0.001
Control							
mean ± SD	51.4 ± 13.7	53.8 ± 15.5	50.1 ± 14.9	54.6 ± 14.1			
median (min.; max.)	55.5 (22; 70)	57.5 (15; 73)	49 (14; 79)	57 (26; 81)			
Intervention							
mean ± SD	58.5 ± 13.7	50.1 ± 16.7	50.6 ± 16.6	51.5 ± 16			
median (min.; max.)	54 (33; 89)	52 (12; 85)	50 (21; 89)	53 (22; 86)			

Generalized Estimated Equations with Poisson distribution and identity function.

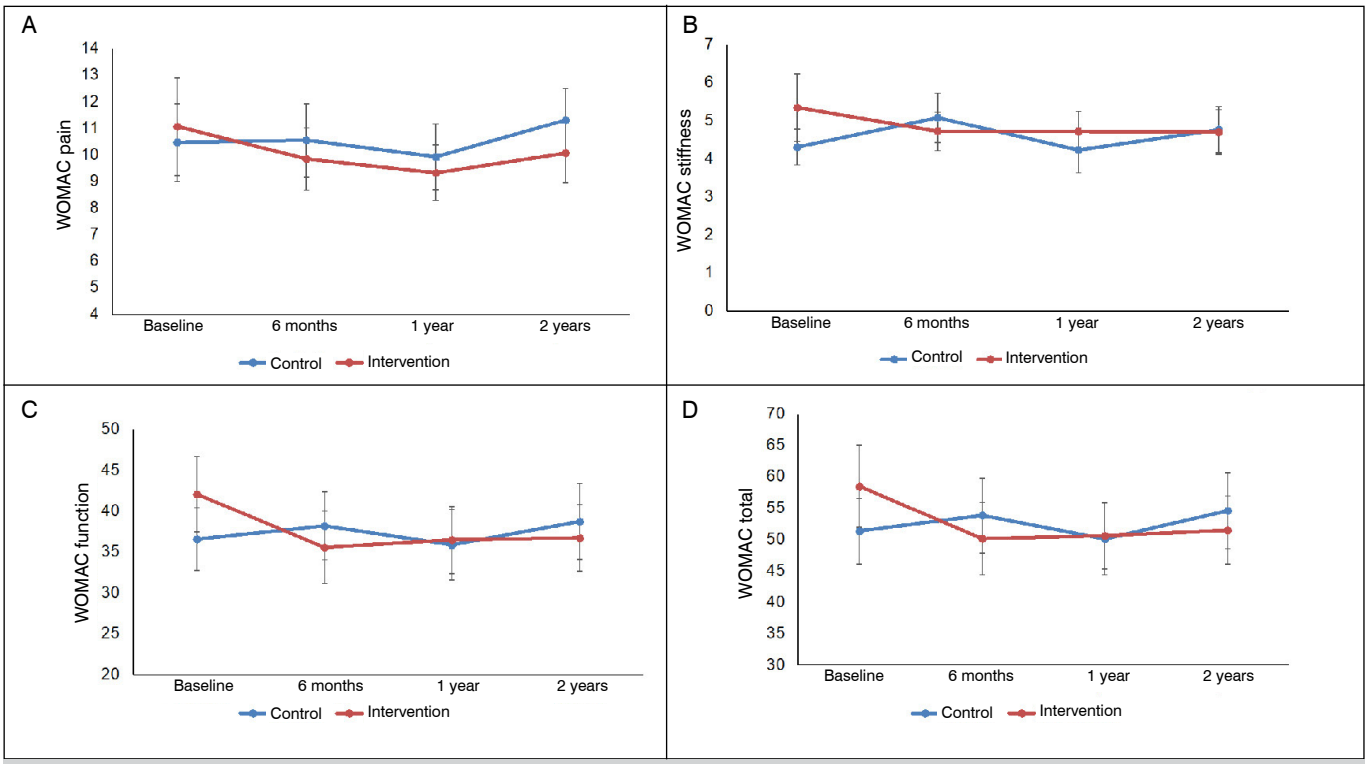

Figure 2. WOMAC pain (A), stiffness (B), function (C) and Total (D) results from control and intervention groups.

Table 3. Result of the comparisons of the WOMAC domains and total between groups or evaluated moments.

Variable	Group/ Moment	Comparisson		Average difference	Standard error	freedom degree	p	CI (95%)	
								Inferior	Superior
WOMAC pain		Baseline -	6 months	0.80	0.48	1	0.603	-0.48	2.07
		Baseline -	12 months	1.33	0.55	1	0.097	-0.13	2.79
		Baseline -	24 months	0.52	0.63	1	>0.999	-1.13	2.17
		6 months -	12 months	0.53	0.40	1	>0.999	-0.51	1.58
		6 months -	24 months	-0.28	0.53	1	>0.999	-1.66	1.11
		12 months -	24 months	-0.81	0.43	1	0.343	-1.93	0.31
WOMAC function	Control	Baseline -	6 months	-1.62	1.03	1	>0.999	-4.85	1.62
		Baseline -	12 months	0.69	1.30	1	>0.999	-3.37	4.75
		Baseline -	24 months	-1.72	1.54	1	>0.999	-6.54	3.10
		6 months -	12 months	2.31	1.03	1	0.701	-0.91	5.52
		6 months -	24 months	-0.11	1.41	1	>0.999	-4.52	4.30
		12 months -	24 months	-2.41	1.13	1	0.908	-5.94	1.11
	Intervention	Baseline -	6 months	9.99	1.34	1	<0.001	5.82	14.17
		Baseline -	12 months	7.95	1.49	1	<0.001	3.30	12.60
		Baseline -	24 months	8.25	1.62	1	<0.001	3.21	13.29
		6 months -	12 months	-2.04	0.89	1	0.583	-4.81	0.72
		6 months -	24 months	-1.74	1.14	1	>0.999	-5.30	1.82
		12 months-	24 months	0.30	0.89	1	>0.999	-2.49	3.09
	Baseline	Control -	Intervention	-7.84	1.87	1	0.001	-13.69	-2.00
	6 months	Control -	Intervention	3.76	1.57	1	0.462	-1.14	8.67
	12 months	Control -	Intervention	-0.59	1.53	1	>0.999	-5.37	4.19
	24 months	Control -	Intervention	2.13	1.65	1	>0.999	-3.03	7.29
WOMAC total	Control	Baseline -	6 months	-2.46	1.21	1	>0.999	-6.25	1.33
		Baseline -	12 months	1.27	1.52	1	>0.999	-3.49	6.03
		Baseline -	24 months	-2.58	1.82	1	>0.999	-8.26	3.09
		6 months -	12 months	3.73	1.21	1	0.055	-0.03	7.50
		6 months -	24 months	-0.12	1.66	1	>0.999	-5.31	5.06
		12 months-	24 months	-3.85	1.32	1	0.100	-7.98	0.28
	Intervention	Baseline -	6 months	12.84	1.56	1	<0.001	7.96	17.72
		Baseline -	12 months	11.01	1.74	1	<0.001	5.58	16.43
		Baseline -	24 months	11.03	1.89	1	<0.001	5.13	16.94
		6 months -	12 months	-1.83	1.04	1	>0.999	-5.07	1.40
		6 months -	24 months	-1,81	1.34	1	>0.999	-5.99	2.38
		12 months-	24 months	0.03	1.04	1	>0.999	-3.23	3.28
	Baseline	Control -	Intervention	-10.26	2.20	1	<0.001	-17.15	-3.38
	6 months	Control -	Intervention	5.04	1.86	1	0.193	-0.79	10.86
	12 months	Control -	Intervention	-0.53	1.81	1	>0.999	-6.17	5.11
	24 months	Control -	Intervention	3.35	1.95	1	>0.999	-2.75	9.46

Bonferroni's multiple comparissons.

Table 4. Description of anthropometric measures (weight and BMI), Numerical Rating Scale (NRS) and Lequesne (algofunctional questionnaires) results according to groups and evaluation moments and results of comparative tests.

Variable/Group	Moment				p_{Group}	p_{Moment}	$p_{Interaction}$
	Baseline	6 months	12 months	24 months			
Weight (Kg)					0.383	0.001	0.008
Control							
mean ± SD	78.4 ± 14.6	78.3 ± 14.6	76.7 ± 12.3	78.5 ± 15.8			
median (min.; max.)	78.7 (48.5; 119.7)	79.4 (50.6; 120.5)	79.1 (51.3; 105.1)	78.3 (57.4; 104.3)			
Intervention							
mean ± SD	82.8 ± 15.4	81.6 ± 15.7	81.6 ± 15	80.9 ± 12.9			
median (min.; max.)	82 (50.7; 124.3)	81.7 (45.7; 120.6)	80.6 (46.3; 119.8)	77.1 (60.1; 111)			
IMC					0.708	0.668	0.717
Control							
mean ± SD	31.6 ± 6.1	31.6 ± 6.3	30.9 ± 5.5	31.5 ± 5.2			
median (min.; max.)	33 (21.5; 47.3)	33.8 (21; 47.7)	33.4 (22; 40.1)	32.6 (24.4; 39.9)			
Intervention							
mean ± SD	32.8 ± 5.3	32.3 ± 5.4	32.4 ± 5.3	32.5 ± 5			
median (min.; max.)	32.3 (23.7; 42.7)	31.6 (22.4; 43.6)	32.4 (22.1; 43.8)	31 (25.8; 44.6)			
NRS					0.393	0.225	0.341
Control							
mean ± SD	67.4 ± 17.6	69.5 ± 20.6	63.9 ± 17.2	65.1 ± 16.1			
median (min.; max.)	67.5 (25; 100)	75.5 (25; 100)	60 (24; 95)	68 (22; 92)			
Intervention							
mean ± SD	74.4 ± 15.6	67.3 ± 20.8	65.9 ± 18.4	67.7 ± 18.8			
median (min.; max.)	80 (40; 100)	68 (10; 96)	62 (20; 97)	74 (22; 97)			
Lequesne					0.627	0.158	0.544
Control							
mean ± SD	14.2 ± 3.6	13.8 ± 3.4	14.3 ± 3.5	14 ± 4.1			
median (min.; max.)	14.3 (6; 21)	15 (5.5; 19)	14.3 (4; 20.5)	14.5 (6; 20)			
Intervention							
mean ± SD	15.4 ± 3.9	13.8 ± 4.2	14.3 ± 3.8	14.3 ± 3.5			
median (min.; max.)	14 (8.5; 21)	13.5 (5.5; 22.5)	14.8 (4.5; 21.5)	14.5 (6.5; 21.5)			

Generalized Estimated Equations with Poisson distribution and identity function.

Table 5. Results of comparisons of Weight (kg) between groups or evaluated moments.

Variable	Group/ Moment	Comparisson		Average difference	Standard error	freedom degree	p	CI (95%)	
								Inferior	Superior
weight	Control	Baseline -	6 months	0.07	0.30	1	>0.999	-0.86	1.01
		Baseline -	12 months	0.01	0.43	1	>0.999	-1.32	1.35
		Baseline -	24 months	0.19	0.66	1	>0.999	-1.89	2.26
		6 months -	12 months	-0.06	0.31	1	>0.999	-1.01	0.90
		6 months -	24 months	0.11	0.59	1	>0.999	-1.74	1.97
		12 months-	24 months	0.17	0.51	1	>0.999	-1.42	1.76
	Intervention	Baseline -	6 months	1.20	0.25	1	<0.001	0.42	1.99
		Baseline -	12 months	1.14	0.35	1	0.031	0.05	2.24
		Baseline -	24 months	2.39	0.44	1	<0.001	1.00	3.78
		6 months -	12 months	-0.06	0.25	1	>0.999	-0.84	0.73
		6 months -	24 months	1.19	0.37	1	0.040	0.02	2.35
		12 months-	24 months	1.25	0.27	1	<0.001	0.39	2.10
	Baseline	Control -	Intervention	-4.34	3.71	1	>0.999	-15.94	7.25
	6 months	Control -	Intervention	-3.22	3.71	1	>0.999	-14.81	8.38
	12 months	Control -	Intervention	-3.21	3.71	1	>0.999	-14.81	8.38
	24 months	Control -	Intervention	-2.14	3.74	1	>0.999	-13.82	9.54

Bonferroni's multiple comparissons.

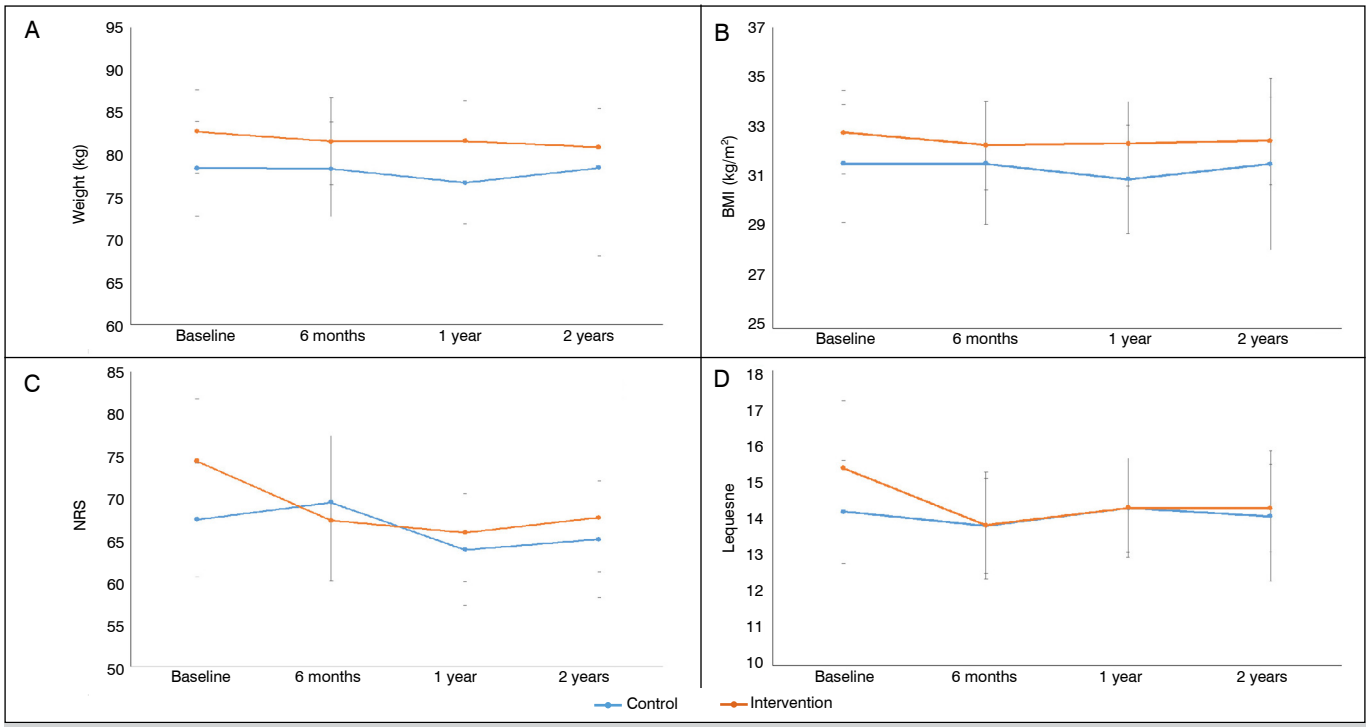

Figure 3. Weight, Body mass index (BMI), numerical rating scale (NRS) and Lequesne results.

lack of sensibility of the scale to show improvements in quality of life in such cases.

There are several limitations to this study: Joining different degrees of OA severity in K&L grades IV; not controlling hours and intensity of exercises performed by the patients; not controlling medications taken by patients; lack of control of satisfaction, diet and if patients were less willing to undergo surgery.[10] Among the strengths are the prospective nature of the study. We do believe that a study separating Ahlback 3 from 4 and from 5 should be performed since the severity of the disease is markedly different.

CONCLUSION

Patients with severe KOA have mild to moderate functional and quality of life improvement by self-management program (PARQVE).

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SERRATUS ANTERIOR MUSCLE FLAP FOR RECONSTRUCTION OF EXTREMITY INJURIES

RETALHO DO MÚSCULO SERRÁTIL ANTERIOR PARA RECONSTRUÇÃO DE LESÕES EM EXTREMIDADES

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ABSTRACT

Objective: To report the use of the serratus anterior free tissue transfer in the treatment of traumatic injuries. Methods: Twenty-six free flaps or serratus pedicled flaps were performed for reconstruction of traumatic extremity injuries. Results: Complete flap survival was recorded in 20 limbs and 3 patients had circulatory complications. Even with the review of vascular anastomoses, partial flap necrosis could not be prevented and required a skin graft after debridement in the necrotic area. Another flap also required reexploration as a result of heavy congestion due to impaired venous return. Superficial wound infection was found in three patients and treated with conservative measures. Regarding the donor area, seroma formation was found in 8 cases; drainage was necessary in 2, and the others were resolved spontaneously. In 2, bruises formed and were later drained. In 1 limb there was long thoracic nerve injury and scapular winging. Conclusion: According to this study, the serratus anterior muscle flap is an excellent tool for treating small complex lesions in the extremities. ***Level of Evidence IV; Case series.***

Keywords: Free Tissue Flaps. Upper Extremity. Hand Injuries.

RESUMO

Objetivo: Relatar o uso da transferência de retalho livre do serrátil anterior no tratamento de lesões traumáticas. Métodos: Vinte e seis retalhos livres ou pediculados do serrátil anterior foram realizados para reconstrução de lesões traumáticas de extremidades. Resultados: A sobrevida completa do retalho foi registrada em 20 membros e 3 pacientes tiveram complicações circulatórias. Mesmo com a revisão das anastomoses vasculares, a necrose parcial do retalho não pôde ser prevenida e exigiu enxerto de pele após desbridamento da área necrótica. Outro retalho também necessitou reexploração em decorrência de forte congestão por dificuldade de retorno venoso. Infecção de ferida superficial foi encontrada em três pacientes, tratados com medidas conservadoras. Em relação à área doadora, a formação de seroma foi encontrada em 8 casos; em 2 foi necessária drenagem e os demais foram resolvidos espontaneamente. Em 2 houve formação de hematomas, que foram drenados. Em um membro havia lesão longa do nervo torácico e deformidade do tipo escapula alada. Conclusão: De acordo com este estudo, o retalho do músculo serrátil anterior é uma excelente ferramenta para o tratamento de lesões complexas e pouco extensas nas extremidades. ***Nível de Evidência IV; Série de casos.***

Descritores: *Retalhos de Tecido Biológico. Extremidade Superior. Traumatismos da Mão.*

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INTRODUCTION

Traumatic wounds of the extremities often result from serious and devastating injuries involving multiple componentes. Adequate coverage for complicated extremity injuries, especially the hands and feet, is a challenging problem, especially when structures such as bones, tendons, nerves and blood vessels are exposed. Several flaps have been described that are useful to cover these lesions.[1,2] Experimental and clinical studies have shown that muscle flaps are ideal in lesions with impaired vascularity and potential infection.[3,4] The serratil muscle present a low risk of surgical complications, with a cosmetic scar in the donor area, without functional deficit, providing adequate quantity and quality of tissue with a consistent vasculo-nervous pedicle of adequate length and easy to be dissected.[5-9] It can be transferred with the latissimus dorsi or scapular flap in very extensive lesions as they originate from a common vascular pedicle,[5,6] it can be incorporated into the last ribs in osteocutaneous losses.[5-7] It has been used in several transfers dynamics to restore thumb opposition, preserving segmental innervation of the long thoracic nerve. As a disadvantage, it may cause some asymmetry of the scapulae, formation of seromas or bruises are common, and blood transfusion may be necessary.[5-7]

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

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Covering the lesion site with appropriate soft tissues is essential for the improvement of the functions of the extremities.[5] An optimum coverage must be stable, durable and capable of withstanding great work demands; it must preserve joint mobility and have an aesthetically acceptable appearance, but always prioritizing function.[2] The objective of this study was to present our experience and evaluate our results with the anterior serratil muscle flap in the reconstruction and recovery of the extremities in selected cases.

MATERIALS METHODS

Twenty-six serratus muscle flaps were used to reconstruct the extremities between 1986 and 2014, 16 for the upper limbs and 10 for the lower limbs. The age group was 16 to 66 years old (of which 3 were younger than 18 years old), 20 male and 6 female pacients. Causes of injury included 18 patients with mechanical trauma such as compressions, chains, and rolling machines, 4 patients with electrical and contact thermal burn, 4 crushing injury secondary to a motor vehicle accident. No patients had bony defects and 4 had extensor tendons injuries. In 11 cases, the last four digitations were used; in 12 cases, three digiations; in 3 two digitations. Each digitation averaged was 1.8 cm x 8 cm, varying according to the patient's height. The removal of only the three lower digitations can be performed without changes in the position of the scapula.[10,11] The muscle is easily removed through an incision in the medium axillary line and has a long and reliable vascular pedicle.[12,13] (Figure 1) The patient is placed in the supine position with a support on the back, raising the hemithorax from the operating table. The incision is made along the middle axillary line. The skin and subcutaneous tissue is elevated exposing the muscular layer. The thoraco dorsalis vascular pedicle and the long thoracic nerve are visualized on the muscular layer. The lower digitations of the serratus muscle with its vascular branches are then identified. Marking the amount of muscle that will be used by sectioning the muscle immediately after the vessels and close to the scapula may be usefull. Then, we anchor the sectioned end of the serratus muscle to the chest wall in order to prevent changes in the scapular position. The dissection continues proximally, up to the subscapular artery, depending on the length of the desired pedicle for the case. The pedicle is only detached from the donor area, when the recipient area was completely prepared. Anastomoses, preferably end to side, are performed outside the lesion area. In 3 limbs the skin graft was performed immediately after the flap and in 23 members the flap coverage with skin graft was performed 7 to 10 days after its application, with the confirmation of the flap's survival. The initial aspect of a bulky flap can be resolved by the subsequent atrophy of the denervated muscle, promoting a very acceptable final contour a few weeks after its application. (Figure 2) Microsurgical instruments and with the aid of loupes and a stereoscopic dissecting microscope set at 16x magnification are the fundamental tools used by our staff in this procedure. CAAE: 37913420.8.0000.5373.

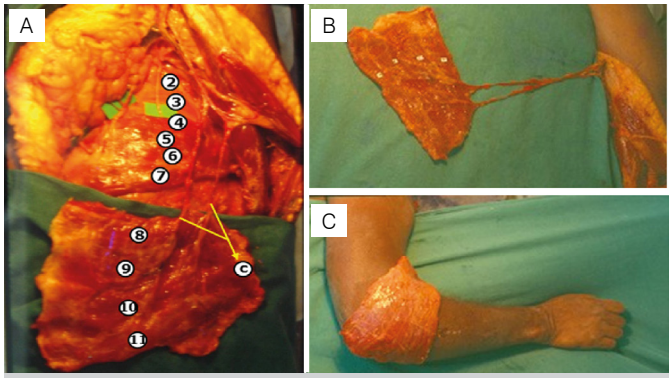

Figure 1. (A) Figure shows 11 digits of the serratil muscle, with two branches of the thoracodorsal artery destined for the anterior serratus muscle. (B and C) The last 4 digits with a long vascular pedicle, reaching the elbow region.

RESULTS

In this study, we used the serratus muscle flap in 26 lesions of the extremities, 16 in the upper limbs and 10 in the lower limbs. Two of them were used as a pedicled flap to cover an area on the arm, one on the elbow, latter associated with ulnar nerve repair. (Figure 3) In three cases it was used as free flaps for the forearm, in two cases associated with fractures of the radius and ulna. (Figure 4) In 11 cases as free flaps for the hand, and in 4 of them for the palm. (Figure 5) We disignated 7 to the dorsal aspect of the hand and wrist. (Figure 2) Only part of the muscle was used to cover the palmar aspect of the hand, with flexor tendon exposure in

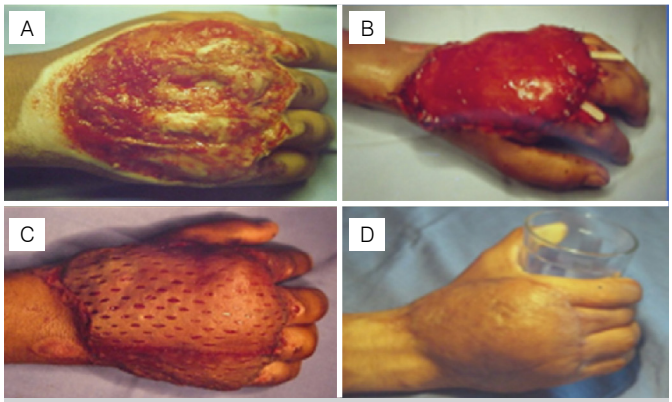

Figure 2. (A) Injury in the back of the wrist and hand. (B) The initial appearance of a bulky flap. (C and D) subsequent atrophy of the denervated muscle, promoting a very acceptable final contour a few weeks after the flap application.

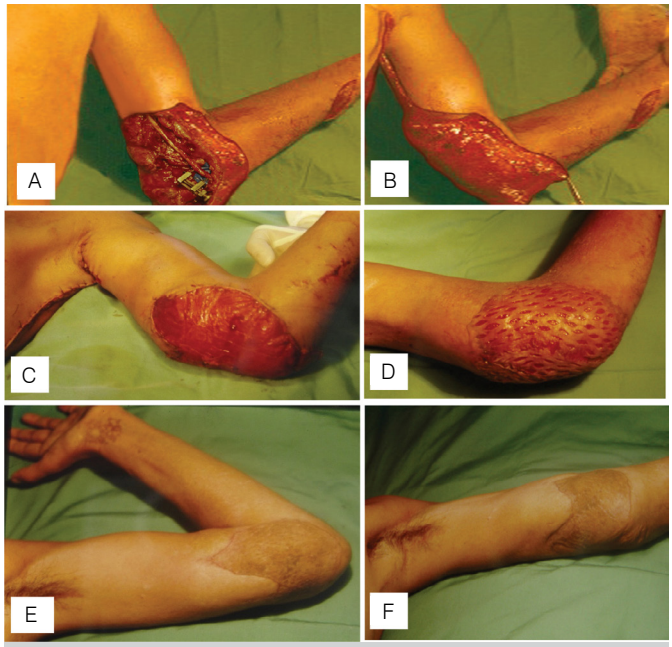

Figure 3. (A) Loss of soft tissue associated with injury to the ulnar nerve. B-pedicled flap of the anterior serratus muscle. (C and D) recent surgery. (E and F) Late postoperative.

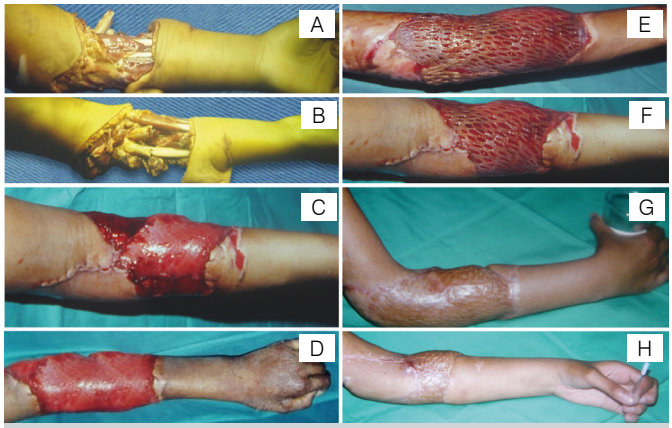

Figure 4. (A, B) injury associated with fracture of the forearm bones. (C,D and E, F) Free flap of the anterior serratus muscle, recent postoperative period. G, H - Late postoperative.

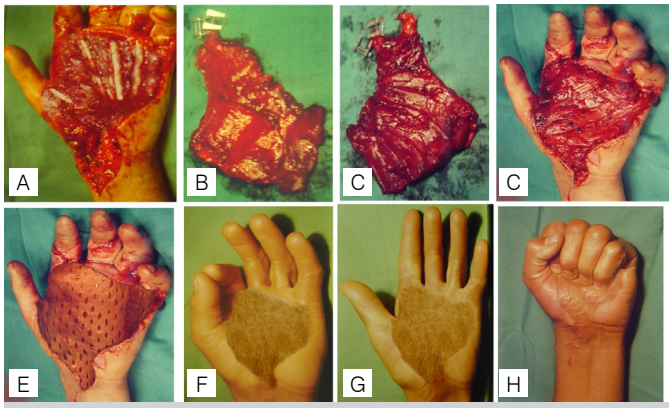

Figure 5. (A) Injury of the palmar surface of the hand with exposure of the flexor tendons. (B, C) Part of the thickness of the muscle, covered by the fascia, in contact with the flexor tendons to prevent their adherence to the musculature, leaving the bloody muscular area facing the surface. (D,E,F,G,H) Recent and late postoperative period.

4 limbs. The portion covered by the fascia in contact with the flexor tendons had the aim to prevent adherences. The bloody muscular area facing the surface was grafted with partial skin. (Figure 5) Regarding the dorsal aspect of the hand, the same procedure was performed. In 3 limbs, we used silicone rod at the same time as the application of the serratus flap. (Figure 2) The serratus flap was used to cover the lower third of the leg in four cases, (Figure 6) for the dorsal aspect of the foot in 3 cases, (Figure 7) 2 for the calcaneus area (Figure 8) and one for the plantar surface of the foot. We considered the immediate good results, when the anastomoses were patent, there was diffuse bleeding of the muscle over the entire length of the flap, good color and normal turgor of the muscle. The result was considered bad, when the muscle remained ischemic, or excessive bleeding. We considered a good late result when, after two weeks, the muscle had a normal appearance, completely integrated with the receiving area, and regular when the part of the necrotic area, after debridement, was able to receive a skin graft. We considered the result to be bad when the flap or part of it was necrotic, requiring its removal and a new procedure for the same purpose. The results obtained were considered good when the patient was able to return to the functions he performed prior to the injury, or a briefly limited functional limitation; regular, when there is a greater limitation, however, the use of the extremity is useful for the patient; bad when the function has not been restored (Table 1).

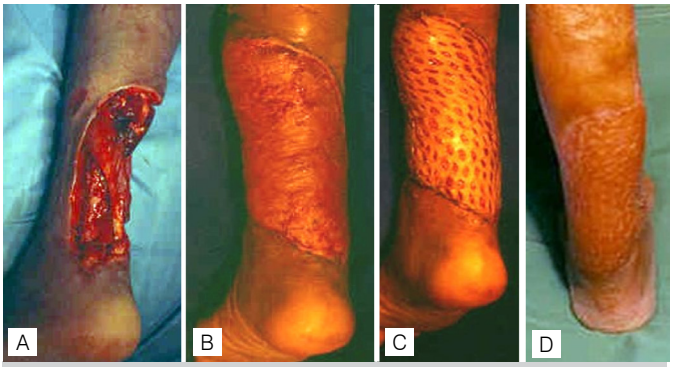

Figure 6. (A) Musculocutaneous loss, transfer of the fibular brevis muscle to replace the Achilles tendon, (B) Free flap of the anterior serratus muscle. (C and D) Recent and late postoperative period.

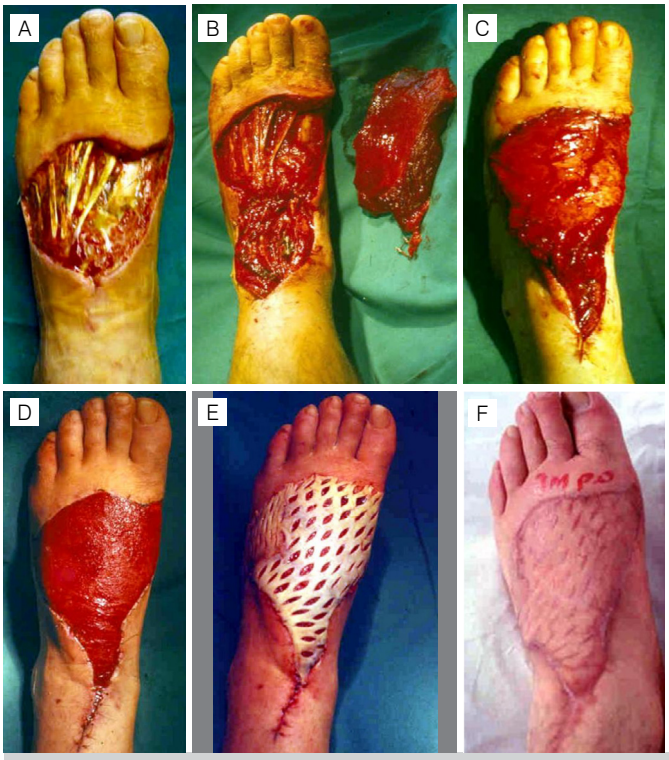

Figure 7. (A) Injury to the dorsum of the foot. (B, C, D) free flap of the anterior serratus muscle. E -Recent postoperative period. (F) - late postoperative.

Complete flap survival was recorded in 20 limbs, 3 abstracts circulatory problems, even with a revision of vascular anastomose and partial flap necrosis cannot be avoided and required a skin graft after debridement. Another also requires re-exploration as a result of intense congestion due to difficulty in venous return, this has been fully recovered. In two cases, we used the serratus fascia flap. In these there was partial loss in the first case and total loss in the second, due to venous insufficiency. Superficial wound infection occurs in three patients, who were treated with conservative measures. Regarding the donor area, in 8 cases the formation of seroma occurred, in 2 cases drainage was necessary and in the other cases it was resolved spontaneously. In two instances hematoma formation that was drained. In a limb that has 4 digits to cover an extensive lesion on the back of the wrist and hand, there was an injury to the long thoracic nerve and deformity in the scapula lata (Table 2 – A and B).

DISCUSSION

The transfer of the free anterior serratus muscle flap was first described by Takayanagi and Tsukie.[13] They reported two cases of plantar surface coverage, with good results and minimal morbidity at the donor site. The flap's popularity increased after Whitney and al[6] published a series of 100 cases of use of the anterior serratusl muscle free flap, highlighting the low morbidity at the donor site. Derby et al.[12] report that they performed 34 transfers of serratil flaps to cover lesions in several places, blood transfusion was necessary in 24% of cases. The rate of early complications was 21%, consisting of 6% hematomas and 15% seromas. Scar appearance, pain, numbness, strength and mobility of the shoulder were acceptable. Gordon et al[14] analyzed the result in their patients, 50 months postoperatively, inform that the removal of the flap did not affect the strength and mobility of the shoulder, even those who had some scapular deformity did not have difficulty to perform their activities of daily living. In our cases, complete flap survival was recorded in 20 of the 26 limbs, 3 patients had circulatory complications, even with revision of vascular anastomoses, partial necrosis of the flap cannot be avoided requiring skin grafting. Another flap also required re-exploration as a result of intense congestion due to difficulty in venous return, this was fully recovered. In two cases, we used the serratil fascia flap. In these, there was partial loss in the first case and total loss in the second, due to venous insufficiency, so we prefer to associate a muscular portion about one centimeter thick to facilitate the venous return. In cases of use of the only fascia, or even when associated with a very thin muscular portion, the venous return can be compromised and complications occur. Superficial wound infection occurred in three patients, who were treated with conservative measures. Regarding the donor area, in 8 cases there was a seroma formation, in two cases drainage was necessary. In the others, it was resolved spontaneously. Hematoma formation occurred in two limbs that was drained. In a case where we removed four digits to cover an extensive lesion on the back of the wrist and hand, there was an injury to the long thoracic nerve and deformity in the scapula lata. Blood transfusion was not necessary in the cases that are part of this study. Ronswel et al.[9] in an anatomical study showed that at least one branch of the thoracodorsal artery for serratus is present in 99% of the cases and in 24% registered two branches of the thoracodorsal artery for the serratil muscle.[9] In the 26 members that are part of this study, in only 5 (23%), more than one branch of the thoracodorsal artery was registered for the serratil muscle.

There are few reports of the use of this flap to cover the palm of the hand. Gordon et al.[14] report the experience in 34 cases of covering lesions in the hand with the anterior serratusl flap, in 11 to cover the palm of the hand. Our results are in line with the statement by Gordon et al.,[14] that no type of flap is more suitable for covering the palm of the hand. Other muscle flaps are more bulky, and fasciocutaneous

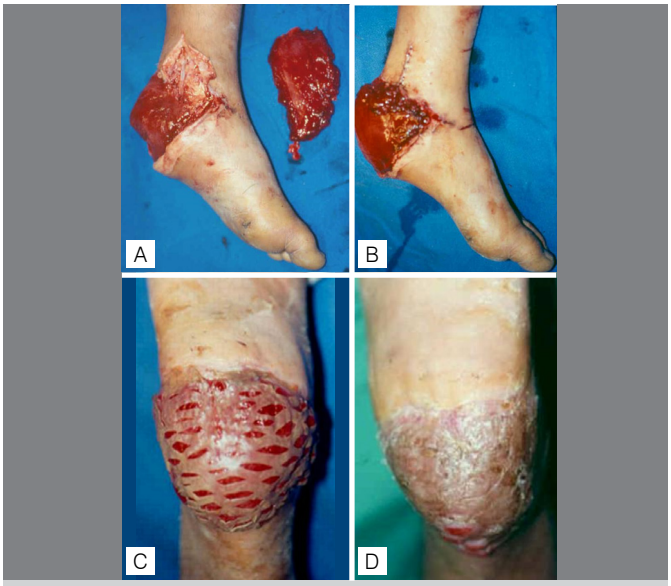

Figure 8. (A) Injury in the calcaneal region. (B) flap of the anterior serratus muscle. (C and D) Recent and late postoperative

Table 2. Complications associated with flaps.

Anastomosis Reexploration	4 of 26 cases	15,38%
Total Flap Necrosis	1 of 26 cases	3,85
Partial Flap Nerosis	4 of 26 cases	15,38%

Table 3. Complications related to the donor area.

Nerve Injury	1 of 26 cases	2,6%
Seroma	8 of 26 cases	21%
Bruise	2 of 26 cases	5,2%
Superficial Infection	3 of 26 cases	7,8%
Osteomyelitis	0 of 26 cases	0%

Table 1. Distribution of lesions according to affected segment, associated lesions, simultaneous surgeries and immediate and late results.

Affected Segment	Number of Lesions	Associated Lesions	Simultaneous Surgeries	Immediate Results	Late Results
Arm and Elbow	2	Ulnar Nerve Lesion (1)	Ulnar Nerve Neurorrhaphy	Good (2)	Good (2)
Forearm	3	Radio and Ulna fracture (2); Tendon Injury (2)	Osteosynthesis (2)	Good (2) Regular (1)	Good (3)
Wrist and Hand (Palmar)	4	Tendon injury (2); Digial Nerve Injury (3)	External Fixation (1)	Good (4)	Good (4)
Wrist and Hand (Dorsal)	7	Tendon injury (5); Digial Nerve Injury (3)	Tendon spacer (3), tendon transfer (2); skin graft (2)	Good (4) Regular (1) Bad (2)	Good (5) Bad (2)
Lower third of the leg	4	Achilles Tendon Injury (1); Sural Nerve Injury (1)	Osteosynthesis(1) External Fixation (1)	Good (3) Regular (1)	Good (4)
Foot (Dorsal)	3	Tendon injury (2); Nerve Injury (1)	Tenodesis (1)	Good (2) Regukar (1)	Good (1)
Foot (Plantar)	1	-	Skin Graft (1)	Good (1)	Good (1)
Calcaneus	2	Fracture	-	Good (2)	Good (2)

flaps have little adherence and subcutaneous mobility makes it difficult to grasp. Unlike these authors in the four cases we operate, we do not transfer serratus to the palm of the hand, with all its thickness, we prefer it with partial thickness, which in addition to a smaller volume, allows us to place the surface portion covered by loose, less adherent areolar tissue, in contact with the exposed flexor tendons, facilitating their sliding to perform digital flexion. (Figure 5) Gordon et al.[14] believe that plantar reconstruction requires a stable and adherent flap, similar to the palmar surface of the hand. We used the serratil flap to cover the calcaneal region in two cases and the plantar region in one case. Logan et al.[5] used the serratil flap in 15 patients, In six additional procedures were performed in the same act as the flap. In two as a functional flap to restore the opposing of the thumb, both patients recovered the opposition of the thumb between 12 and 18 months postoperatively. They also report another case that used the serratil flap, simultaneously with the politiziation of index finger. In another, a tendon graft was performed at the same time as the flap. Gordon et al.,[14] reported a case in which they used the serratus flap, simultaneously with the transplantation of the second toe. In this study, we do not use the serratil flap as a functional flap.

Lin and Yazar[15] performed 24 serratil flaps, including ribs in 22 patients for osteocutaneous reconstruction of the extremities in single-stage procedures. Two patients underwent bilateral costal arch flaps associated with the anterior serratus for bilateral tibial and fibular exposed fractures. In nine cases, the latissimus dorsi muscle was also included in the flap. In 17 limbs, two ribs were included in the flap. Two members included three ribs. In five limbs, only one costal arch was included in the flap. They report that in 21 members the flaps survived. They report that 11 of the 24 members had morbidity in the donor area; these included pneumothorax (one patient), pleural fibrosis (one patient), chest wall deformities (two patients) and chronic chest pain (10 patients). Some patients had more than one morbidity at the donor site. Kurokawa et al.[16] report a case of reconstruction of loss of soft tissues on the dorsal surface of the foot, with bone loss of four metatarsals, using free osteomyocutaneous flap of the seratil muscle associated with costal arches reconstructed osteocutaneous loss, inform that the structure of the foot arches was rebuilt using the curvature of the costal arches. Long-term follow-up has shown good results, the patient can walk and run without support.

Trignano et al.[17] report a series of 12 reconstructions, associating the latissimus dorsi, serratil and ribs, indicating this procedure, in case of bone loss, associated with extensive soft tissue injuries. The flaps survived, however, 6 patients (50%) had postoperative complications. They consider that, in fact, this procedure has a very high percentage of complications, being an alternative option to amputation. Lin et al.[18] performing this same procedure had complications, in 6 of 9 patients 66.7%, and Kim and Blackwell [19] in 14 of 29 patients (48%).

Elia et al.[20] treated 47 patients with osteocutaneous loss, the latissimus dorsi muscle flap associated with ribs were used in 13 limbs. The latissimus dorsi flap associated with the serratil muscle flap and ribs in 25 members as a free flap, in nine as a pedicled flap. In cases of association only of the latissimus dorsal, the eighth and tenth ribs were incorporated into the flap. In cases where serratus was also included, they used the fifth and seventh ribs, inform that they prefer to remove intercalated ribs, in order to preserve the stability of the chest.[20] Yamamoto et al.[21] prefer the removal of the last ribs that are floating and do not alter the dynamics of the rib cage. In this study we used the anterior seratil muscle flap exclusively for traumatic injuries not very extensive in the extremities, we do not use this flap associated with ribs, or as a functional flap innervated by the long thoracic to restore the function of paralyzed hand muscles. We also do not associate the latissimus dorsal and paraescapular muscle flap that originates from a common vascular pedicle. In two cases, we used the serratil muscle flap to cover a lesion on the arm, another on the elbow, by dissecting the vascular pedicle to its origin in the axillary artery, so it was possible to cover these lesions just by transposing the flap, without the need performing microvascular anastomoses. (Figure 3)

CONCLUSION

According to this study, the serratus anterior muscle flap is an excellent tool for treating complex lesions that are not very extensive in the extremities. The dimensions of the vascular pedicle length allow microanastomoses to be performed in vessels distant from the recipient area.

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PEDIATRIC

TELEHEALTH FOR CHILDREN AND ADOLESCENTS WITH PHYSICAL DISABILITIES DURING THE COVID-19 PANDEMIC

TELEATENDIMENTO A CRIANÇAS E ADOLESCENTES COM DEFICIÊNCIAS FÍSICAS DURANTE A PANDEMIA COVID-19

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ABSTRACT

Children and adolescents with physical disabilities have motor and social-emotional challenges that interfere with their health-related quality of life and put them at greater risk of developing secondary conditions. Moreover, services that provide them therapies are more likely to be restricted, especially for the low-income population. There must be broader actions towards health promotion, offering not only means for physical habilitation and rehabilitation but for social and emotional improvements as well. This goal is attainable by adaptive sports and recreational activities where physical conditioning is accompanied by an improvement in self-esteem and social benefits. With the COVID-19 pandemic and social isolation, children and adolescents with physical disabilities were even further deprived of assistance. Our aim was to report the efforts of a non-governmental sports organization in maintaining physical and psychological care through virtual consultations and to analyze the perceptions of those affected by the process. ***Level of evidence IV; case series.***

Keywords: Telemedicine. Disabled Persons. Child Health. Adolescent. COVID-19. Organization, Non-Governmental.

RESUMO

Crianças e adolescentes com deficiência física apresentam desafios motores e socioemocionais que interferem na qualidade de vida relacionada à saúde e os colocam em maior risco de desenvolver doenças secundárias. Além disso, estão mais sujeitos a restrições de serviços adequados que ofereçam terapias, principalmente para a população de baixa renda social. Torna-se necessário oferecer ações voltadas para a promoção da saúde em um sentido mais amplo, oferecendo não só meios de habilitação e reabilitação física, mas também de ganhos sociais e emocionais. Este objetivo pode ser atingido com esportes adaptados e atividades recreativas nos quais o condicionamento físico é acompanhado por ganhos em autoestima e benefícios sociais. Com a pandemia de COVID-19 e o isolamento social, crianças e adolescentes com deficiência física ficaram ainda mais privados de assistência. Relatamos aqui o esforço de uma organização não-governamental esportiva em manter o atendimento físico e psicológico por meio de consultas virtuais, e avaliamos as percepções das partes interessadas no processo. ***Nível de evidência IV; série de casos.***

Descritores: *Telemedicina. Pessoas com Deficiência. Saúde da Criança. Adolescentes. COVID-19. Organização não Governamental.*

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INTRODUCTION

Children and adolescents with physical disabilities have a myriad of challenges throughout their lives that may hinder interactions with others and the environment. Motor impairment in this age group interferes with psychosocial health and health-related quality of life and impairs their full development into adulthood. Due to mobility restraints and lack of proper facilities they lead a more sedentary lifestyle and are at risk of secondary chronic conditions. Interventions promoting physical activity and sports participation among children and adolescents with disabilities should be stimulated as a means to improve health and wellbeing in this population.

A large group of neurological and musculoskeletal conditions results in motor disabilities and are heterogeneous in etiology, severity and associated impairments. In spite of that, health should not be defined as a medical issue only. As of 2011, the World Health Organization (WHO) proposed a more comprehensive concept of health with the publication of the International Classification of Health, Disability and Function (ICF)[1] and depicted body function

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The study was conducted at Universidade de São Paulo, Faculty of Medicine, Hospital das Clínicas, Institute of Orthopedics and Traumatology, HC-FMUSP, Sao Paulo, SP, Brazil and at Instituto Remo Meu Rumo, Non-Governmental Sports Organization, Sao Paulo, SP, Brazil.
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and structure, activity and participation as the three dimensions of health. Participation is defined in the ICF as 'involvement in a life situation' and is an essential aspect of children and adolescents' health, development, and wellbeing.[1] In this way, it is just as important treating individuals concerning their illness or impairment as it is promoting participation in activities and settings that provide an appropriate level of challenge, social engagement, belonging, and autonomy so young people with disabilities reach their full potential throughout their life.[2]

The most prevalent chronic condition that causes disability in childhood is cerebral palsy (CP) and much has been published on the benefits for children and adolescents with CP engaging in physical activity and sports programs. Rosenbaum and Gorter pointed out that children and adolescents with disabilities are often "deprived" of opportunities to practice a skill and develop their potential without expecting "normality".[3] They emphasize that the six "f"s - function, family, fitness, fun, friends and future - are relevant key elements for a child with CP to develop a sense of achievement.

Furthermore, mobility restraints interfere greatly with many aspects of these youngsters' lives including school attendance and education, ultimately leading to less employment opportunities.[4] Young people with physical disabilities and their families are at a higher risk of being at an economic disadvantage.[4] Thus, in addition to activity limitation and participation restrictions, they have less access to health services. There must be actions towards health promotion in a broader sense offering not only means for physical habilitation and rehabilitation but for social and emotional gains as well. This goal is attainable by adaptive sports and recreational activities where physical conditioning is accompanied by an improvement in self-esteem and social benefits. Rowing is one of the most complete sports. Because it is an aerobic sport, it provides caloric burning and gains in muscle strength combined with a consequent global postural alignment, given the use of several muscle chains whilst rowing. Adapted rowing presents children and young people with physical disabilities the opportunity not only to engage in an activity that brings health benefits, but also for personal development, discipline and socialization.

Instituto Remo Meu Rumo (IRMR) is a Brazilian non-profit organization established in 2013 that provides rowing and canoeing to children and adolescents with physical disabilities on a regular basis. Among participants' conditions are CP but also myelomeningocele, Down syndrome, spinal cord injury, autism spectrum disorder, among others, including typical development children, in a truly inclusive environment. An interdisciplinary health care team of physical educators, physical therapists, a psychologist and a social worker have a daily routine to improve function and prepare children and adolescents with disabilities for rowing and canoeing and all the beneficial effects of this activity.[5]

The need for social distancing in order to avoid the dissemination of the coronavirus infectious disease 2019 (COVID-19) resulted in the suspension of IRMR activities and also school activities[6-8] leading to physical, psychological and social damage to this population, a situation which is already considered a secondary effect of the pandemic.[8] According to WHO, in relation to social distancing, adolescents and their families should be encouraged to count on sports and carry on with positivity and, in the face of setbacks, maintain routines, discourage bad habits, maintain calm, stress control and resilience when confronting COVID-19 and its consequences.[9] This was approved by the Ethics Committee for Analysis of Research Projects (CAPPesq) (number CAAE: 00995518.0.0000.0065)

TELEHEALTH

As an immediate strategy by switching to remote assistance, IRMR was able to maintain activities through the work of its multidisciplinary team, minimizing the effects of social isolation during the COVID-19 pandemic. This was especially important for this population considering their vulnerability in the face of isolation situations.[4] In order to keep the NGO's participants active and happy, a series of instructional videos with proposed activities was delivered via the social media platform WhatsApp. The content of the videos included physical, psychological, and cultural cues as a measure to improve resilience when coping with this unique situation. Recommendations were addressed to participants and also their families with topics such as exercise, posture, emotional balance, quality of sleep and reading.

Additional advice aiming to help participants adapt to this new scenario[10] was in the form of a booklet called "Guide to Good Practices - COVID-19", which was developed in digital format. This served not only as a guide to individual measures for prevention of the spread of the coronavirus, but also about quality of life within the current social demands, such as economic instability and the emergence of eventual financial impact challenges.[11]

After 4 months of remote assistance, a cross-sectional survey was developed utilizing an internet-based application to assess client satisfaction about the multidisciplinary instructional videos (Table 1). The survey consisted of nine multiple-choice questions and one open question. Through that, it was possible to appraise participants and their caregivers' perception of the service provided by the team, enabling better decision-making in order to improve services. Out of 104 participants receiving assistance, 81 answered the survey. The median age of the respondents was 13.43 years (ranged 9 to 19), 37% were female and 67% were Caucasian. The social media platform initially chosen by the participants was WhatsApp at 66%, Zoom 18% and other social media 16%. When asked about forming groups

Table 1. Telehealth and telerehabilitation in a sports non-governmental organization for children and adolescents with physical disabilities during quarantine of coronavirus infectious disease 2019 (COVID-19) pandemic.

Variables	Physical disabilities participants (n=81)
Socio demographic	
Age, years	13.43 (9-19)
Female sex	30 (37)
Caucasians	54 (67)
Telehealth	(n=81)
Social Media Platform Preferred	
Whatsapp	53 (66)
Zoom	14 (17)
Other social media	14 (17)
Preference to group virtual visit	65 (80)
Adherence to instructional videos	62 (76)
1 to 3/week	44 (70)
≥ 4/week	18 (30)
Perception of activities as enjoyable	53 (85)
Telerehabilitation	(n=37)
Perception from the Physical Therapy Team	
Virtual visit assiduity	31 (84)
Technical difficulties	10 (27)
No help from household members during visit	13 (35)
Decrease in pain	32 (86)
Perception from participant or caregiver	
Readiness to perform activities	31 (84)
More independence in ADLs	26 (70)
Mood improvement	29 (78)
Sense of worthwhileness	33 (90)

Results are presented in n (%), median (minimum-maximum values). ADL (Activities of Daily Living).

<< SUMÁRIO

according to affinity and age to attend online visits for physiotherapy, physical education, social work and psychology, 80% agreed with this proposal since they were feeling lonely and 20% did not agree because they were busy with other tasks, such as schoolwork. After videos were sent, the majority of the participants (76%) reported they were able to perform what was proposed in the instructional videos. Of those participants that were performing the activities (n=62), 34% reported they were doing it once a week, 36% two to three times, 8% four to five times and 1%, 6 times. The participants were asked if they felt better with the help offered in the IRMR videos and 83% of those who carried out the activities said "yes" (Table 1).

In the open question about what participants thought to be most beneficial to them in online health services, answers revealed that the majority of children and adolescents were grateful for the team's commitment and suggested for more incentives to adhere to activities, and asked for advice about family issues, schoolwork, motivation, resilience and positivism during the COVID-19 quarantine. A few families displayed anguish and seemed overwhelmed with the housework, financial difficulties and the psychological burden on their children and adolescents due to social isolation.

TELEREHABILITATION

One of the important goals when managing children and adolescents with motor disabilities, in physiotherapy treatments, is gaining autonomy when performing daily tasks. Interestingly, telehealth and telerehabilitation have improved convenience delivering care in familiar environments. On the therapist's side, it became an opportunity to understand the patient's home lives and settings, particularly relevant during the COVID-19 pandemic quarantine/lockdown. In our experience, several objects available in the participants' homes could be used, such as broomsticks, chairs, beds, carpets, walls, balls, pillows and plastic bottles, allowing therapies without the need for further expenses on the part of the families during this pandemic. There was a clear demonstration of creativity, effort and synergy between the IRMR team and the participants when performing the therapy.

Another positive effect of virtual physiotherapy care was making it possible for family members to be more involved in the therapy being delivered. A survey involving stakeholders of the telerehabilitation program at IRMR was conducted. From the physiotherapist perception, out of the 37 participants who assiduously attended physiotherapy virtual visits, 27% reported technical difficulties or the lack of someone to assist them, keeping in mind that 35% of the participants were alone during the appointments. When there was somebody at the house, at least 49% of the participants received direct help from them. Participants reported an 11% decrease in pain from the beginning to the end of the activities, and even in those where the pain persisted, there was a perception of analgesia in about 10% according to the analog visual scale. During the virtual visits, there was an average of 7 different therapeutic interventions per appointment, such as massage therapy, analgesia, recreational circuits, strengthening exercises for upper and lower limbs and stretching among other techniques. There was no complication during visits. Everyone received some type of guidance at the end of the appointments, such as continuing the activities during free time, reinforcing the need for engagement to obtain better results. Virtual physical therapy assistance from the perspective of participants or caregivers was evaluated in a survey: 83% of participants reported they carried out activities spontaneously, on their own initiative, not perceiving activities as boring; 70% declared greater independence on a daily basis; 78% showed a better mood after the start of activities; 70% reported more will after the start of activities; 67% described carrying out everyday tasks as being easier; 77% informed lower levels of pain after starting activities and 90% of those who carried out the activities considered the online visits worthwhile (Table 1).

Telehealth and telerehabilitation, in our experience, was an important initiative that ultimately benefited children with impairments and challenges, and their families during quarantine. It is imperative to continue to find new ways forward on developing solutions for better care to people in social isolation. Even after the COVID-19 pandemic, a hybrid form of assistance would be of great benefit to a large number of individuals that have less access to health care. Actions such as those could be implemented in the public health system improving the care of children and adolescents with physical disabilities and increasing the health-related quality of life for pediatric chronic conditions populations and their caregivers. Future multicenter and multidisciplinary studies will be necessary to clarify these issues and challenges in a large population.

CONCLUSION

This was an innovative and relevant initiative and remotely assisting people with disabilities has proven to be very effective in giving the patients assisted a perception of continued, lowering barriers of isolation, minimizing contagion for patients and healthcare workers, diminishing physical inactivity and the risks of chronic diseases, until their return to full social life after the COVID-19 pandemic quarantine/lockdown.

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TREATMENT OF QUADRICEPS TENDON RUPTURE IN HEMODIALYSIS PATIENTS: A 2020 UPDATE

TRATAMENTO DA RUPTURA DO TENDÃO DO QUADRÍCEPS EM HEMODIALISADOS: UMA ATUALIZAÇÃO EM 2020

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ABSTRACT

Quadriceps tendon tears are uncommon injuries often associated with chronic diseases, including end-stage renal disease (ESRD). The role of secondary hyperparathyroidism as a predisposing factor for tendon tears in this group of patients is well documented, and the weakening of the tendon-bone junction is part of this context. The treatment of choice for quadriceps tendon ruptures in patients with ESRD is surgery, which should be performed as soon as possible. There are several surgical techniques to be used, but the lack of comparative studies does not allow us to conclude which one is the best option. More recent publications have preferred the association of techniques, with emphasis on the use of autologous tendon grafts as a reinforcement tool, which is the author's procedure of choice. Recent studies reported the use of biological agents to stimulate healing and allografts, but the information seems preliminary to be routinely recommended. ***Level of evidence II; Obsevation of therapeutic studies.***

Keywords: Quadriceps muscle. Hemodialysis. Hyperparathyroidism.

RESUMO

As rupturas do tendão do quadríceps são lesões incomuns, frequentemente associadas a doenças crônicas, incluindo a doença renal em estágio de falência funcional. O papel do hiperparatireoidismo secundário como fator predisponente para rupturas tendinosas nesse grupo de pacientes está bem documentado, e o enfraquecimento da junção tendão-osso faz parte desse contexto. O tratamento de escolha para rupturas do tendão do quadríceps em pacientes com falência renal é a cirurgia, e deve ser realizado o mais rápido possível. Existem várias técnicas cirúrgicas a serem utilizadas, mas a falta de estudos comparativos não nos permite concluir qual é a melhor opção. Publicações mais recentes têm preferido a associação de técnicas, com destaque para o uso de enxerto tendíneo autólogo como ferramenta de reforço, procedimento de escolha do autor. Estudos recentes relatam o uso de agentes biológicos para estimular a cicatrização e aloenxertos, mas as informações parecem preliminares para serem rotineiramente recomendadas. ***Nível de Evidência II; Observação de estudos terapêuticos.***

Descritores: *Músculo quadríceps. Hemodiálise. Hiperparatireoidismo.*

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INTRODUCTION

The rupture of a quadriceps tendon is considered an uncommon injury, predominating in middle-aged males.[1,2,3] However, an increased incidence of this condition especially in younger patients is associated with the presence of comorbidities such as diabetes mellitus, gout, rheumatoid arthritis and end-stage renal disease (ESRD), among others.[4-7] Of note, in the presence of associated diseases, quadriceps ruptures can occur with low-intensity trauma as the underlying condition weakens the tendon and facilitates its rupture (6,8). Also, there are several reports in the literature of bilateral ruptures of the quadriceps tendon in patients with associated diseases, particularly ESRD.[2,5,7-10]

Once occurred, the quadriceps rupture imposes a strong negative impact on the individual's gait capacity, commonly manifesting with pain at the injury site and the inability to actively extend the knee.[1,11-13] Considering the poor healing capacity of the tendon, especially when there is a retraction of the stump and previous changes in its structure, the appropriate treatment is early surgical repair, and the literature broadly supports this approach.[9,14,15]However, different approaches are described for this purpose without a clear definition as to which one is the most adequate.[14-16] This article aims to present a literature review on the surgical treatment of quadriceps ruptures in patients with ESRD, pointing out the options for operative techniques and highlighting those most frequently used in the last decade.

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

The study was conducted at Hospital Universitário Antonio Pedro, Faculty of Medicine at the Universidade Federal Fluminense, Rio de Janeiro, RJ, Brazil.
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END-STAGE RENAL DISEASE

End-stage renal disease (ESRD) is a prevalent condition worldwide, being a significant cause of morbidity and mortality in the population. Its incidence has grown in recent years, generating a severe impact on public health policies, especially in developing countries.[17]
The United States Renal Data System (USRDS) publishes annual epidemiological data on kidney disease in that country, guiding researchers from the most diverse areas and facilitating the implementation of public policies by the government agencies. In 2017, 124,500 new cases of ESRD were reported totaling 746,557 prevalent cases at the end of the year (growth of 2.6% compared to 2016). The leading listed causes of ESRD were diabetes mellitus, hypertension, glomerulonephritis, and polycystic kidney disease. Currently, the overall mortality rate for patients with ESRD in the United States is 134/1000 patient /year, with 165/1000 patients/year for dialysis and 29/1000 patients/ year for transplant.[18]

PATHOPHYSIOLOGY OF TENDON RUPTURE

A rupture of the quadriceps tendon results from an indirect force, when a vigorous contraction of the anterior thigh muscles is exerted on the flexed knee with the foot resting on the ground (eccentric contraction).[11,14] The following functional disability is evident as a consequence of local inflammatory response, the formation of a tendon gap (Figure 1) and deficit in the active knee extension. The vast majority of quadriceps tendon ruptures occur in men with a mean age of 60 years, and, also previously mentioned, there is a frequent association between ruptures of this tendon and the presence of comorbidities.[11,14,16]
Several chronic diseases are capable of producing long-term changes in the tendon structure, resulting in its weakening and predisposing it to rupture.[6,8,11] In this scenario, forces that do not exceed the physiological demands can cause discontinuity in the midsubstance of the tendon or avulsions at the enthesis (spontaneous ruptures).[2,5,7,19] Among the possible mechanisms of intrinsic tendon injury, we can mention altered proteoglycan metabolism, hypovascularization, decreased collagen production, the formation of intrasubstantial calcifications and chronic inflammation.[8,11] However, in patients with ESRD, the leading risk factor for rupture is secondary hyperparathyroidism.[5,9,19]

HYPERPARATHYROIDISM AND TENDON RUPTURE

The first article reporting a ruptured quadriceps tendon in a patient with hyperparathyroidism secondary to chronic kidney disease was published in the early 1960s,[20] and since then numerous studies have reassured this association.[5,9,19,21-25] The increase in parathormone levels results in the stimulation of osteoclastic activity, which promotes bone resorption in order to balance serum calcium. Since resorption occurs diffusely in the skeleton, the areas of tendon insertion are not spared, resulting in weakness of the tendon-bone junction. Accordingly, most of the quadriceps tendon ruptures in patients with ESRD are located at this point.[26,27] In addition, some studies suggest that tendon rupture is more frequent in patients with a long period of hemodialysis treatment, probably due to chronic biochemical changes that culminate in degenerative injuries to the tendon and its insertion.[21,24]

SURGICAL TECHNIQUES

Direct repair

In ruptures of the quadriceps tendon that occur above its insertion, it is possible to perform a direct repair by approaching and suturing the tendon stumps. The first report of simultaneous bilateral rupture of the quadriceps tendon was published in 1949, when the authors described the treatment of an obese 67-year-old patient who underwent simple sutures of both injuries.[28] They used silk interrupted sutures to perform the tenorraphy, taking advantage of the 2 cm stump that remained attached to the patella, obtaining a satisfactory final result. Currently, the simple suture technique does not find a reliable support in the literature. A 2017 systematic review involving a total of 44 patients showed that this procedure was adopted in only 22% of them.[16] Other authors consider that previous tendon degeneration, especially in patients with ESRD, requires additional procedures to strengthen the suture. The strengthening can be done with local tenoplasty following the techniques of Scuderi and Codivilla,[6,14] sometimes associated with the use of cerclage wire around the patella.[6]

Transosseous repair

Since the first report of a quadriceps tendon rupture associated with hyperparathyroidism and chronic kidney disease by Preston and Adicoff in 1962,[20] the transosseous suture technique has been the most used treatment for the disorder,[1,14,16] As the majority of quadriceps injuries in this group of individuals occur at the tendon insertion, there is no distal stump for the direct suture to be safely performed (Figure 2).[13] The preferred procedure to circumvent this difficulty has been to reinsert the tendon at the upper pole of the patella.[7,10,29] In the transosseous suture technique, resistant non-absorbable sutures are initially braided in the proximal stump of the tendon. This step can be completed according to the surgeon's preference, but the Krackow type of suture has been the most used procedure.[4,7,30] Longitudinal drill holes are made in the patella, allowing the suture ends to be passed distally and tied with the

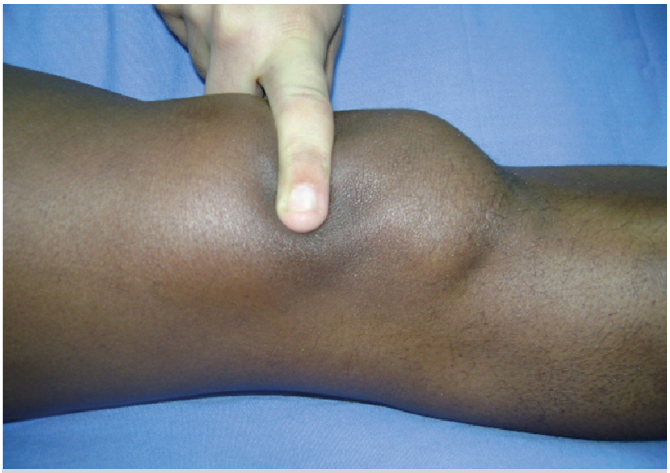

Figure 1. Palpable gap above superior pole of patella.

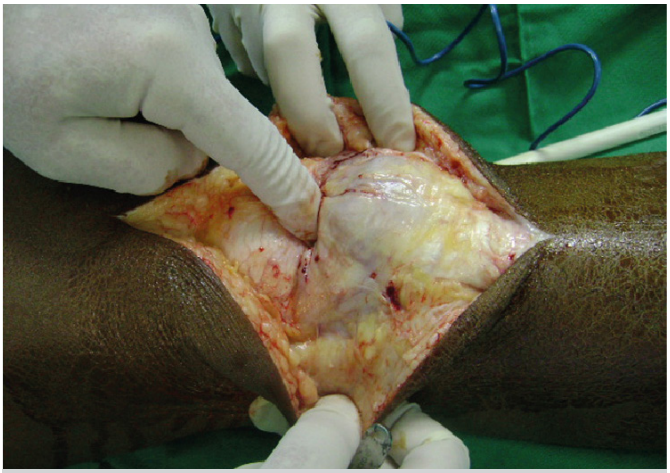

Figure 2. Intraoperative aspect of rupture.

necessary tension to bring the stump closer to its insertion point.[13] To promote healing of the tendon-bone junction, old ruptures or that associated with tissue degeneration may require additional reinforcement as previously described for the direct repair technique.[1]

Suture anchor repair

In 2002, Richards and Barber published a technical note regarding two cases of ruptured quadriceps tendons treated with sutures anchors in the patella. It was the first report of this technique in the English literature, and the authors argue that the higher resistance of the suture would allow a more aggressive rehabilitation program.[31] In the suture anchor technique, small threaded devices are implanted in the upper pole of the patella. Resistant non-absorbable suture wires attached to these devices are tied to the proximal stump of the tendon and tensioned, approaching it in a way similar to that described for the transosseous suture technique.[19,30] The suture anchor repair is not the procedure most frequently used, but the number of published studies regarding this technique has grown substantially in the last decade.[19,30,32] Although there are no comparative clinical studies,[14] the advantages attributed to anchor repair are the shorter operative time, easier access to the implant site, preservation of the patella and higher mechanical resistance.[31] Despite this, a biomechanical study concluded that the transosseous suture is more resistant and cheaper than the suture anchor repair.[32]

Autologous tendon reinforcement

Recent studies have shown concern in obtaining more resistant repairs when treating quadriceps tendon ruptures, especially when there are signs of tendon degeneration.[13,33] This situation is particularly frequent in patients with ESRD, and the eventual delay in rupture diagnosis can create additional difficulty for satisfactory results when more straightforward techniques are used.[9,15] To address this common problem, several authors have advocated the use of autologous tendon grafts to reinforce the suture.[9,13,15,33] After the initial repair employing one of the above-mentioned techniques, the graft is transfixed through the extensor apparatus, at points above and below the lesion. The graft is then sutured to the transfixing points, creating a protective wrap that prevents excessive tension at the repair site.[13,15] Most studies indicate the use of semitendinosus tendon graft for this purpose.[13,15,33] In 2014, we published our own experience on a series of patients with ESRD and quadriceps tendon rupture. Of the 11 operated knees, six were treated with transosseous repair associated with autologous semitendinosus reinforcement,[13] which is our preferred technique (Figures 3 and 4).

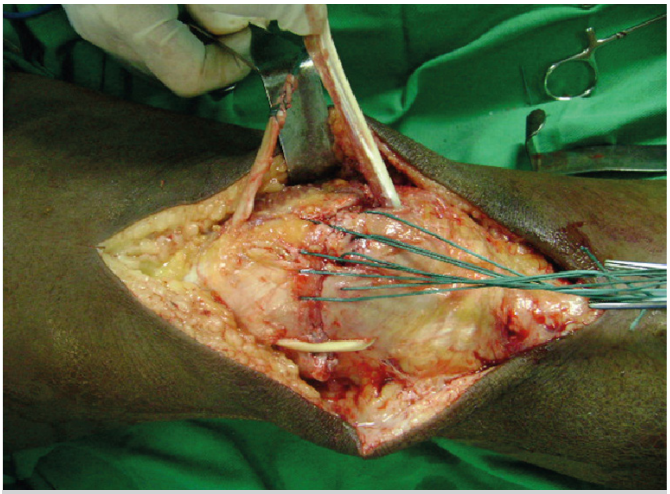

Figure 3. Transosseous suture and autologous semitendinosus graft augmentation.

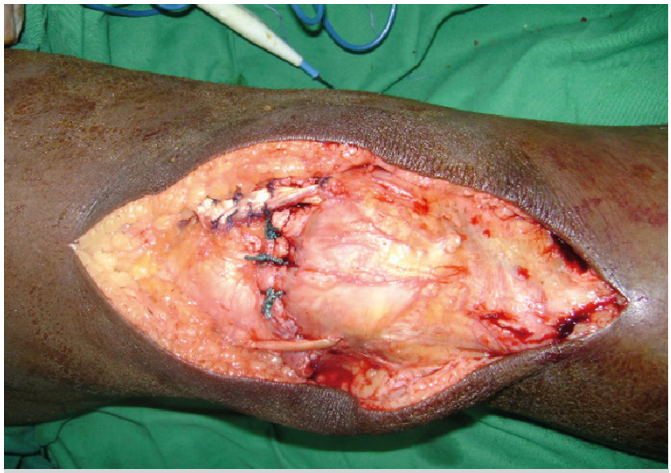

Figure 4. Final construction.

However, it is noteworthy that there are other graft possibilities. Alternatives such as the gracilis muscle tendon, fascia lata or the combination of different tendons have also been described.[1,9]

Special situations

In cases of multiple recurrences of rupture or chronic ruptures with significant retraction of the tendon stump, some salvage procedures have been proposed.[12,34] In 2015, Rehman et al. reported the case of a 61-year-old patient who had suffered the third rupture of the right quadriceps tendon.[34] His comorbidities were arterial hypertension and glaucoma; both controlled with medication. In the surgical procedure, the tendon was elongated and repaired with the Codivilla's technique, and reinforced with grafts from the semitendinosus and gracilis. On the upper surface of the repair, they added a fragment of Prolene mesh fixed with sutures and bathed the site with platelet-rich plasma. Describing a satisfactory result after one year, the authors drew attention to the possible utility of platelet-rich plasma. Its properties to stimulate the release of growth factors and recruit repair cells can play an essential role in the healing of soft tissues.

More recently, Lamberti et al. reported the case of a 51-year-old patient with ESRD and chronic rupture of the left quadriceps tendon.[12] The patient had been on a hemodialysis program for eight years, and her rupture had evolved for 16 months. Due to the substantial retraction and poor quality of the tendon, they opted for reconstruction using an entire extensor mechanism allograft. In the surgery, the original patella was removed, and the graft's anterior tibial tuberosity was fixed to the proximal third of the tibia with a screw and cerclage. The quadriceps and patellar tendons of the graft were tensioned and sutured to the respective remnants, with the knee in full extension. After a 4-year follow-up and assisted rehabilitation, the patient was able to achieve a satisfactory function. As advantages of the allograft, the authors mentioned the creation of a framework for fibrous invasion and the preservation of donor sites of autologous grafts. However, they remembered that the possibility of immune reaction and disease transmission are still disadvantages of this method.

CONCLUSIONS

Patients with quadriceps tendon tears are best treated with surgery, including the ESRD ones. There are several techniques to be used, but which is the best one is still a matter of controversy. Recent publications have reported a preference for the combination of techniques, with a particular enthusiasm on the use of autologous tendon grafts, which is the author's choice. Biological agents and structural allografts are also mentioned as options, but new studies should confirm their routine application.

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