Return to Sports After High Tibial Osteotomy Using the Opening Wedge Technique*

Retorno ao esporte após osteotomia tibial alta com método de cunha de abertura

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Rev Bras Ortop 2021;56(3):313–319.

Abstract

Objective The present paper evaluates the resuming of physical activities by young, active patients who practiced some sport modality and underwent a high tibial osteotomy (HTO) using the opening wedge technique.

Methods A total of 12 patients submitted to HTO using the opening wedge technique were prospectively analyzed. All patients were not playing sports at that time. Pre- and postoperative Lysholm and International Knee Documentation Committee (IKDC) scores, visual analog scale for pain and performance level were compared. The average follow-up time was of 12 months.

Results One patient resumed sporting activities at a performance level significantly lower compared to the preoperative level, while eight patients returned at a slightly below level, two returned at the same level and one patient returned at a higher level in comparison with the preoperative period.

Conclusion For isolated medial osteoarthrosis treatment, HTO using the opening wedge technique has favorable clinical and functional results, allowing patients to resume their sporting activities.

Keywords
- osteoarthrosis
- osteotomy
- sports
- tibia

* *Study performed at the Sports Traumatology Center, Escola Paulista de Medicina, Universidade Federal de São Paulo, São Paulo, SP, Brazil.*

received
March 7, 2020
accepted
June 1, 2020
published online
September 25, 2020

DOI https://doi.org/10.1055/s-0040-1715514.
ISSN 0102-3616.

Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

Resumo

Objetivo Avaliar o retorno ao esporte em pacientes jovens e ativos praticantes de alguma modalidade esportiva submetidos a osteotomia tibial alta (OTA) com o método de cunha de abertura.

Métodos Foram analisados prospectivamente 12 pacientes submetidos ao procedimento de OTA utilizando-se método de cunha de abertura. Todos os pacientes estavam afastados do esporte. Foram utilizados os escores Lysholm, questionário International Knee Documentation Committee (IKDC, na sigla em inglês), escala analógica de dor e nível de retorno em comparação ao período pré-operatório. O tempo médio de seguimento foi de 12 meses.

Resultados Um paciente retornou ao esporte em nível muito abaixo do pré-operatório, oito pacientes retornaram em nível pouco abaixo, dois pacientes retornaram no mesmo nível e um paciente retornou em nível acima.

Conclusão A OTA com uso do método de cunha de adição como forma de tratamento para osteoartrose medial isolada demonstra resultados clínicos e funcionais favoráveis e permite o retorno ao esporte.

Palavras-chave

- osteoartrose
- osteotomia
- esportes
- tíbia

Introduction

The number of young adults with knee osteoarthritis (OA) has been increasing; however, their age and functional activity are incompatible with a total knee arthroplasty (TKA).[1–4] Over 25% of people < 70 years old have knee OA, and this figure is expected to exponentially increase in the future. Sports and recreational activities are very important for these subjects and OA limits such practice.[5]

Unicompartmental OA (UCOA) mainly involves the medial femorotibial compartment in varying degrees, according to the radiographic criteria defined by Ahlback. Predominant symptoms are pain that worsens under load and a progressive angular deformity.

The different therapeutic methods for UCOA include high tibial osteotomy (HTO), which is indicated for physiologically young patients (< 60 years old) with isolated medial OA, preserved range of motion (ROM), no ligament instability, minimum patellofemoral symptoms, and failed conservative treatment. Relative contraindications for HTO include age > 65 years old, advanced OA, three-compartment OA, inflammatory arthritis, decreased ROM (< 120°), smoking, obesity (body mass index [BMI] > 30), and contracture in flexion > 5°.[5]

There are three main types of HTO: with an opening wedge, with a subtraction wedge and the cupuliform procedure. The opening wedge technique has several advantages over the closing wedge method, such as greater precision and ease of correction in both the coronal and sagittal planes; in addition, it does not require a fibular osteotomy or an approach to the proximal tibiofibular joint (which protects the fibular nerve), sparing the bone stock and facilitating a conversion to TKA. The disadvantages of the opening wedge technique include the creation of a bone defect (which, depending on its size, may need a bone graft), risk of pseudarthrosis, potential loss of correction due to synthetic collapse, and a longer period of time in which load is not allowed; moreover, this procedure requires greater attention to the tibial slope.[3,4,6–8]

The technique was introduced by Jackson et al.[9] in 1961, but it only became popular in 1965, when Coventry[10] promoted it for treating medial OA with varus deformity. Since then, there have been countless advances in the technique, fixation, and selection of patients, leading to reduced complications and better outcomes.[3,4,6–8]

High tibial osteotomy aims to decrease the load in the involved compartment and transfer it to the healthy compartment, correcting the angular deformity and promoting symptomatic improvement of the affected knee.[1–3,7,8]

Because of the excellent HTO survival rates[11–19] and the potential TKA risks, such as loosening, material wear or periprosthetic fractures in subjects practicing high impact activities,[20] HTO is recommended for young adults. Johnstone suggested that young patients submitted to osteotomy may resume their work and sports activities. On the other hand, the rate of return to sports in patients undergoing TKA is of only 20%.[5]

Even though the HTO technique is well-described, few studies analyze the level of return to sports and the clinical outcome after the opening wedge procedure in young adults with UCOA.[2,3,22]

The present study aims to evaluate the resuming of physical activities by young, active patients who practiced some sport modality and underwent an HTO procedure using the opening wedge technique. Subjects were assessed using the Lysholm and International Knee Documentation Committee (IKDC) scores, visual analog scale for pain (VAS) and a comparison between pre- and postoperative sports performance level.

Material and Methods

The present study was performed at the Sports Traumatology Center from July 2017 to January 2018, under the approval of the institutional Research Ethics Committee

Sample Description

A total of 12 patients were assessed, including 2 women and 10 men, with a mean age of 34.3 years old (range, 30 to 44 years old) and an average BMI of 28.8 kg/m^2 (range, 24.4 to 33.7 kg/m^2). Preoperative ROM ranged from 90° to 132° (mean value, 108.3°) and the mechanical axis of the affected lower limb ranged from 6.4° in varus to 2° in valgus, with an average value of 3.4 ± 2.2° in varus.

Six subjects were street runners (lengths ranging from 5 to 21 kilometers), four were field soccer players, one was a handball player and one practiced mixed martial arts (MMA).

Adult patients aged 20 to 55 years old, with OA grade II to III according to the Ahlback criteria, BMI < 35, ROM > 90° and who were not practicing sports for at least 3 months were included in the study.

The following patients were excluded: those with a history of surgery on the affected knee; subjects with bicompartmental or tricompartmental arthrosis, varus deformity > 15°, symptomatic ligament instability, diabetes, inflammatory arthritis, and smokers.

Description of the Procedures

All patients underwent a previous clinical treatment for at least 6 months before surgery. All of them underwent an HTO procedure according to the wedge opening technique, using a wedge plate Puddu,[23] and they were submitted to the same rehabilitation protocol.

Preoperative planning employed long panoramic radiographs, analyzing mechanical and anatomical axes to calculate the size of the required wedge according to the noyes and Dugdale method.[24,25]

High tibial osteotomy was performed following the concept, in which the load axis of the lower limb is kept in a neutral position and an hypercorrection of ~ 2° to 5° in valgus is performed; as such, the mechanical axis passes laterally to the center of the knee joint, ideally between the middle and lateral portion of the lateral condyle (62%), and slightly lateral to the lateral intercondylar eminence.[3,24]

Opening wedges of up to 15 mm were made. Up to 10 mm, a plate spacer was used alone; between 10 and 15 mm, an autologous tricortical graft from the ipsilateral iliac crest was added.

Load bearing was allowed only after radiographic consolidation of the fracture. All subjects answered questionnaires before surgery and at 6 weeks, 3 months, 6 months, and 12 months postoperatively. The IKDC and Lysholm scores assessed the return to sports, daily activities, clinical parameters, and personal satisfaction from each patient. In addition, VAS was analyzed before surgery and 6 months after the procedure.

Using long panoramic anteroposterior radiographs, the anatomical axis (femorotibial axis) and the mechanical axis of the lower limb were recorded pre- and postoperatively, as well as the arthrosis degree according to the Ahlback criteria.

Patients were asked about their performance level when resuming sports, with the following answers: they did not return to sports; they returned at a significant lower level in comparison with the preoperative period; they returned at a slightly lower level compared with the preoperative period; they returned at the same level compared with the preoperative period; and they returned at a higher level in comparison with the preoperative period.

Statistical analysis used the Spearman correlation coefficient to measure the degree of relationship between all quantitative variables at all times: ROM, anatomical axis, VAS, healing time, Lysholm score, IKDC score and BMI.

The Mann-Whitney test compared the degree of arthrosis for some quantitative variables: preoperative anatomical axis, VAS gain, Lysholm score, IKDC score, and healing time. Results were expressed as mean and standard deviation (SD).

Results

Radiographic healing time ranged from 7 to 11 weeks (mean, 9.16 weeks). This value was correlated with the symptoms of the patients and the time in which partial progressive load bearing was allowed.

The mean Lysholm score was 83.8 ± 8.2 points, ranging from 70 to 94 points ($p < 0.05$). In this evaluation, 7 patients (58.33%) had good results and 5 subjects (41.66%) presented regular results.

After standardization in percentage, the average IKDC questionnaire score was 75.8 ± 9.8, with values ranging from 62 to 84% ($p < 0.05$).

One patient presented delayed healing, requiring a new procedure to place an autologous graft 6 months after the index surgery. This patient progressed satisfactorily 1 year after the first procedure.

One patient resumed sporting activities at a performance level significantly lower compared with the preoperative level, while eight patients returned at a slightly below level, two returned at the same level and one patient returned at a higher level in comparison with the preoperative period.

Both ROM and VAS presented significant statistical differences between pre- and postoperative values. The mean VAS decreased from 6.83 to 3.53, whereas the mean ROM increased from 108.33° to 123.92° ($p < 0.001$) (►**Table 1**).

The Spearman correlation assessed the degree of relationship between all quantitative variables at all times. A correlation test validated these findings, which were expressed as a percentage. In this scale, values between 0 and 20% indicate a bad correlation; from 20 to 40%, a very bad correlation; from 40 to 60%, a regular correlation; from 60 to 80%, a good correlation; and from 80 to 100%, an excellent correlation.

This analysis (►**Table 2**) showed some statistically significant correlations: between the preoperative

Table 1 Comparison between pre- and postoperative findings

Finding		Mean	Median	Standard Deviation	Q1	Q3	*n*	CI	*p* value
Range of motion	Pre-	108.33	105.0	12.64	101.5	115.0	12	7.15	<0.001
	Post-	123.92	124.0	7.49	119.5	130.0	12	4.24	
Anatomical axis	Pre-	−3.32	−3.9	2.75	−5.4	−2.0	12	1.56	<0.001
	Post-	6.38	6.5	1.89	4.8	8.0	12	1.07	
Visual analog scale for pain	Pre-	6.83	6.4	1.12	6.0	7.9	12	0.64	<0.001
	Post-	3.53	3.4	0.77	3.1	4.1	12	0.44	

Abbreviations: CI, Confidence interval; post-, postoperative; pre-, preoperative.

anatomical axis and the Lysholm score of + 65.4%, indicating that the greater the preoperative deformity, the better the subjective Lysholm score; between the preoperative anatomical axis and a VAS score gain of + 48.5%; between the preoperative anatomical axis and an IKDC score of + 48.5%. In addition, there was an inversely proportional correlation between the preoperative anatomical axis and ROM gain value of 42.4%, indicating that the greater the preoperative deformity, the lower the ROM gain ($p < 0.001$).

Other correlations that deserve being highlighted were between BMI and an IKDC score of - 58.8% and between preoperative ROM and an IKDC score of + 60.8.

The Mann-Whitney test concluded that there was no statistically significant difference between the degrees of arthrosis for the variables analyzed: preoperative anatomical axis, VAS gain, Lysholm score, IKDC score and healing time (►**Table 3**).

Discussion

There are several questions about outcomes and the effective ability of patients undergoing HTO to resume sporting, daily living and recreational activities with no limitations or pain.

The literature reports excellent to good outcomes from HTO with an opening wedge for UCOA and poor alignment

Table 2 Variables correlation

			Range of Motion			Anatomical Axis			Analog Visual Scale for Pain			Healing time	Lysholm Score	IKDC Score
			Pre-	Post-	Gain	Pre-	Post-	Gain	Pre-	Post-	Gain			
Range of motion	Post-	Corr	76.50%											
		p-value	0.004											
	Gain	Corr	−67.00%	−19.70%										
		p-value	0.017	0.539										
	Pre-	Corr	57.90%	58.00%	−42.40%									
		p-value	0.049	0.048	0.169									
Anatomical axis	Post-	Corr	21.40%	11.30%	−8.70%	35%								
		p-value	0.503	0.727	0.789	0.264								
	Gain	Corr	−56.10%	−74.50%	32.70%	−87.90%	−4.60%							
		p-value	0.058	0.005	0.299	<0.001	0.888							
	Pre-	Corr	7.80%	−3.40%	−19.80%	−32.50%	4.40%	21.20%						
		p	0.810	0.917	0.538	0.303	0.892	0.506						
Visual analog scale for pain	Post-	Corr	7.20%	−7.80%	−20.90%	3.20%	−43.80%	−1.20%	17.20%					
		p-value	0.824	0.811	0.514	0.922	0.155	0.97	0.594					
	Gain	Corr	0.90%	−6.10%	−5.30%	48.50%	−3.90%	−27.50%	−87.90%	15.70%				
		p-value	0.978	0.874	0.869	0.110	0.905	0.388	< 0.001	0.626				
Healing time		Corr	50.80%	61.20%	−37.60%	34.40%	−47.50%	−58.30%	−19.90%	24.60%	19.60%			
		p-value	0.092	0.035	0.228	0.274	0.119	0.047	0.536	0.441	0.541			
Lysholm score		Corr	64.60%	52.80%	−52.90%	65.40%	11.10%	−67.40%	9.80%	33.70%	9.00%	30.80%		
		p-value	0.023	0.077	0.077	0.021	0.731	0.016	0.763	0.284	0.781	0.331		
IKDC score		Corr	60.80%	53.40%	−23.80%	43.90%	45.60%	−36.40%	44.90%	−3.70%	−32.00%	−6.50%	54.90%	
		p-value	0.036	0.074	0.456	0.153	0.136	0.244	0.144	0.909	0.311	0.842	0.064	
Body mass index		Corr	−39.20%	−45.20%	−12.00%	−52.20%	−51.90%	34.60%	7.10%	14.20%	−5.10%	12.70%	−12.00%	−68.80%
		p-value	0.208	0.140	0.709	0.082	0.084	0.271	0.827	0.659	0.875	0.693	0.711	0.044

Abbreviations: Corr, Correlation; IKDC, International Knee Documentation Committee; post-, postoperative; pre-, preoperative.

Table 3 Arthrosis grade comparison

Arthrosis Grade (Ahlback)		Mean	Median	Standard Deviation	Q1	Q3	*n*	CI	*p-value*
Preoperative anatomical axis	Grade II	−2.80	−2.2	3.55	−6.2	−1.2	5	3.11	0.808
	Grade III	−3.69	−4.2	2.25	−4.8	−3.5	7	1.67	
Pain gain	Grade II	−3.48	−4.0	0.98	−4.0	−3.0	5	0.86	0.935
	Grade III	−3.17	−3.2	1.34	−4.2	−2.5	7	0.99	
Lysholm score	Grade II	82.00	82.0	9.27	76.0	90.0	5	8.13	0.624
	Grade III	85.14	88.0	8.07	80.0	90.0	7	5.98	
IKDC score	Grade II	78.40	80.0	5.18	74.0	82.0	5	4.54	0.414
	Grade III	74.00	76.0	8.16	69.0	79.0	7	6.05	
Healing time	Grade II	9.40	10.0	1.34	8.0	10.0	5	1.18	0.618
	Grade III	9.00	9.0	1.29	8.5	9.5	7	0.96	

Abbreviations: CI, Confidence interval; IKDC, International Knee Documentation Committee.

treatment: Hernigou et al.[13] described 81% of excellent or good results after 10 years of follow-up with 53 patients. Aglietti et al.[26] performed a clinical follow-up of 61 patients for up to 21 years after HTO and observed that 79% of them had no pain or presented mild pain in the operated knee.

Regarding post-HTO sports practice, some previous studies have shown good outcomes and high rates of return. Salzmann et al.[22] noted that 90.9% of patients were participating in sports and recreational activities, compared with 87.9% before surgery. The Lysholm score and VAS increased significantly, from 42.4 to 69.6 and from 6.9 to 2.9, respectively ($p < 0.01$).

Faschingbauer et al.[21] analyzed the rate of return to work and sports in 51 patients submitted to HTO. According to these authors, 92.3% of the patients returned to sports in similar performance levels compared with the preoperative period; in addition, they observed a shift from high impact to low impact activities, and they noticed a decrease in the duration and amount of sports activity.

Hoorntje et al.[27] conducted a systematic review on this subject, which revealed an 82% rate of return to sport in studies with sound methodology and low risk of bias (totaling 11 studies). They also reported a survival rate of 87 to 99% at 5 years and of 66 to 84% at 10 years after HTO. The studies differed considerably in terms of sports activity assessment (level of practice).

In another systematic review, Ekhtiari et al.[28] analyze the return to work and sports activities after HTO. This review included 11 studies, totaling 250 patients with a mean age of 46.2 years old. The opening wedge was the most used technique. After the procedure, 87.2% of the patients returned to sports, with 78.6% resuming their activities in equal or higher levels. Among competitive athletes, 54% returned to competitions. Approximately 90% of the patients who returned to work and sports activities did so within 1 year. In addition, 7% underwent TKA after an average period of 6.7 years. Several methods were used to measure the level of physical activity.

Bastard et al.[29] retrospectively analyzed 30 patients for a mean follow-up period of 1.3 years and observed that all subjects returned to sports within 1 year, including 73.3% at the same preoperative performance level and 23.3% at higher levels.

W-Dahl et al.[30] followed-up 79 HTO patients for 10 years. After this period, 25 subjects underwent TKA. These authors concluded that HTO is an excellent solution for young patients with OA who present moderate degeneration over time, providing the possibility of physical activity and quality of life. Two years after HTO, patients increased their physical activity, and more than half of them participated in sports such as golf, dance, walking and water aerobics. After 10 years, almost half were still involved in the same activities.

Our study corroborates these findings and demonstrates that opening wedge HTO has good functional outcomes. The anatomical axis was satisfactorily corrected from $3.31 \pm 1.2°$ in varus for an average value of 6.38 ± 1.8 degrees in valgus. One patient did not present overcorrection, with an alignment to 3.6 degrees in valgus. This patient had the worst functional outcomes, with a Lysholm score of 70 and an IKDC score of 62%. The importance of proper preoperative planning, anatomical and mechanical axis calculation and wedge size determination must be highlighted, since these factors will have a direct impact on the outcome.

In a specific analysis, the Lysholm and IKDC scores were significant, with 7 patients (58.33%) presenting a good Lysholm score and a mean percentual IKDC 75.8 ± 9.8 ($p < 0.05$) at an 84% index.

There was a significant improvement in ROM gain and VAS. The present study reinforces the use of HTO with an opening wedge with good outcomes and potentially resuming activities in levels which are close to the preoperative ones.

The present study has some limitations: small sample; lack of control group; short follow-up time, possibly interfering with the level of return to sports; and lack of training periodicity, intensity, and volume assessment. These are preliminary findings and we plan to add more patients to our research for further evaluation to achieve more significant statistical results.

Conclusion

Open wedge HTO as treatment for isolated medial osteoarthrosis demonstrates favorable clinical and functional outcomes, allowing the patient to resume sports activities.

Declarations

– The present study was approved by the Ethics Committee from UNIFESP.
– All study participants signed an informed consent form.
– All analyzed material/data is included in the article.
– Financial support.

There was no financial support. All costs for collection, analysis, data interpretation, and manuscript writing were provided exclusively by the authors.

Authors Contribution

Nicolini A. P. was responsible for conception and design, acquisition of study patients, data analysis and interpretation, manuscript writing, and final approval of the submitted version.

Christiano E. S. was responsible for conception and design, logistical support, manuscript writing, and final approval of the submitted version.

Cohen M. was responsible for conception and design, writing of the manuscript, statistical expertise, technical support, and final approval of the submitted version.

Abdallah R. J. was responsible for conception and design, manuscript writing, and final approval of the submitted version.

Carvalho R. T. was responsible for conception and design, data analysis and interpretation, critical review, acquisition of the study patients, manuscript writing, and final approval of the submitted version.

Conflict of Interests

The authors have no conflict of interests to declare.

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