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Original Article

Conventional plate and screws in medial opening-wedge high tibial osteotomy: are they sufficiently stable? A retrospective study☆

*Rodrigo Salim**, *Fabricio Fogagnolo*, *Mauricio Martins Perina*, *Ugo Messas Rubio*, *Mauricio Kfuri Junior*

Universidade de São Paulo, Faculdade de Medicina, Hospital das Clínicas, Ribeirão Preto, SP, Brazil

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ABSTRACT

Objective: Opening-wedge osteotomy of the proximal tibia is a widely performed procedure for treating medial gonarthrosis in active patients and in the presence of varus malalignment of the lower limb. The fixation method is controversial, and the use of conventional implants has been abandoned in favor of implants with more modern locking screws. The aim of the present clinical study was to assess the maintenance of the correction achieved in cases wherein fixation was performed using conventional implants.

Methods: This retrospective study included 51 patients who underwent opening-wedge high tibial osteotomy wherein fixation was performed using conventional implants (4.5-mm DCP plate and non-locking screws). Radiological findings regarding patellar height, tibial slope, and varus correction postoperatively and after consolidation were analyzed to assess the maintenance of the correction achieved by osteotomy.

Results: The mean loss of correction angle, calculated by the difference between the correction angle in the immediate postoperative period and that after consolidation, was $0.92^{\circ} \pm 0.9^{\circ}$. In addition, changes in patellar height determined by the Blackburne–Peel method and in the sagittal slope of the tibial plateau were not significant or clinically relevant.

Conclusions: The use of conventional plates and screws is viable in the fixation of opening-wedge high tibial osteotomy because they provide enough stability to maintain the achieved correction until consolidation, without significant changes.

☆ Work performed in the Universidade de São Paulo, Faculdade de Medicina, Hospital das Clínicas, Departamento de Biomecânica, Medicina e Reabilitação do Aparelho Locomotor, Ribeirão Preto, SP, Brazil.

* *Corresponding author.*
E-mail: rodsalim@gmail.com (R. Salim).

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O sistema convencional de placa e parafusos na osteotomia tibial alta com cunha de abertura medial é suficientemente estável? Um estudo retrospectivo

Palavras-chave:
Estudo retrospectivo
Osteotomia
Joelho
Osteoartrite

RESUMO

Objetivo: A osteotomia com cunha de abertura da tíbia proximal é um procedimento amplamente realizado para o tratamento da gonartrose medial em pacientes ativos e na presença de mau alinhamento em varo do membro inferior. O método de fixação é controverso e o uso de implantes convencionais foi substituído pelo uso de implantes com parafusos de bloqueio mais modernos. O objetivo do presente estudo clínico foi avaliar a manutenção da correção realizada nos casos em que a fixação foi realizada com implantes convencionais.
Métodos: Este estudo retrospectivo incluiu 51 pacientes submetidos a osteotomia tibial alta com cunha de abertura em que a fixação foi realizada utilizando implantes convencionais (placa de DCP de 4,5 mm e parafusos não bloqueados). Os achados radiológicos referentes à altura da patela, à inclinação tibial e à correção do varo no pós-operatório imediato e após consolidação foram analisados para avaliar a manutenção da correção obtida pela osteotomia.
Resultados: A perda média de ângulo de correção, calculada pela diferença entre o ângulo de correção no pós-operatório imediato e após a consolidação, foi de $0{,}92^{\circ} \pm 0{,}9^{\circ}$. Além disso, alterações na altura patelar, avaliadas pelo método de Blackburne-Peel, e na inclinação sagital do platô tibial não foram significativas ou clinicamente relevantes.
Conclusão: O uso de placas e parafusos convencionais é uma alternativa viável na fixação da osteotomia tibial alta com cunha de abertura, pois proporcionam estabilidade suficiente para manter a correção obtida até a consolidação, sem alterações significativas.

Introduction

Proximal tibial osteotomy is a widely performed surgical procedure for the treatment of unicompartimental knee arthrosis associated with the malalignment of the mechanical axis of the limb (varus), particularly in relatively young and active patients. The procedure allows arthroplasty to be delayed for more than 10 years in approximately 80% of patients.[1,2] Medial opening wedge high tibial osteotomy has become increasingly popular in recent years because it is an easy technique that allows fine adjustments to the desired correction during the surgical procedure[3] and does not require a surgical approach to the fibula or superior tibiofibular articulation. However, this type of procedure results in a small bone contact surface at the osteotomy site that is often limited to the apex of osteotomy, which increases the chance of fixation failure and loss of correction.[4] For this reason, several authors have stressed the importance of preserving the integrity of the cortex opposite the base of the osteotomy wedge as a means of preventing secondary deformities, and there are descriptions of surgical strategies for this purpose.[5] Biomechanical and clinical studies have emphasized the importance of the implant used in the fixation of opening wedge osteotomies, in addition to the geometry of the osteotomy, and novel implants have been developed with the aim of increasing stability.[6,7] Some implants have wedges or blocks of varying sizes that are placed so as to support the cortex of the opening wedge, and others use locking screws that create angular stability relative to the plates.[8] In developing countries, it is sometimes difficult to obtain the most modern and expensive implants for the fixation of osteotomies, and conventional implants that theoretically would not be the first choice are used as an alternative. This retrospective study reports a series of cases of high tibial osteotomy performed using the medial opening wedge technique, wherein the fixations were performed using conventional DCP (Synthes, Paoli, USA) plates and investigates the efficacy of these implants in the maintenance of the achieved correction until union of the osteotomy site.

Methods

The present study was retrospectively conducted by assessing radiological findings and medical records of patients who underwent medial opening wedge high tibial osteotomy, wherein the fixation was performed with a 4.5-mm DCP plate, between 2000 and 2013 in a teaching hospital of Ribeirão Preto Medical School of the University of São Paulo. The included patients were older than 18 years of age and exhibited localized pain and functional limitations as a result of arthrosis in the medial compartment of the knee associated with the malalignment of the mechanical axis of the lower limb (varus). Patients with less than two years of clinical follow-up, those who were younger than 18 years old, and those who had rheumatologic conditions and flexion contracture of more than 15° were excluded. Of the total of 51 patients (51 knees), 31 were men and 20 were women. The mean age of the

patients was 48.8 years (range, 18–62 years). All procedures were performed by one of the hospital's senior surgeons or under their supervision. The study was approved by the Ethics Committee in Medical Research. Radiographic assessment was performed preoperatively and in every follow-up visit at 4, 8, 16 and 52 weeks postoperatively, by means of a standing anteroposterior (AP) weight bearing view and a regular lateral view. Full length panoramic views were obtained at the initial assessment preoperatively and at the 52-weeks-mark. For anteroposterior radiographs, the patients stood with the patellae centered over the femoral condyles and feet straight ahead to attain a true anteroposterior image and to control for effects of foot rotation on measures of lower extremity alignment. The X-ray beam was centered on the knee at a distance of 2.5 meters and beam exposure was determined based on each patient's leg mass. Knee arthrosis was classified according to the modified Ahlbäck classification.[9]

Surgical technique

The patients underwent ligament examination under anesthesia and were placed in the supine position on the radiolucent table, with a pneumatic tourniquet on the thigh. All patients had undergone diagnostic arthroscopy to assess the state of the lateral compartment of the knee and treatment of unstable chondral or meniscal lesions. Anteromedial incisions (of approximately 8 cm) were made lengthwise in the knee skin, and the proximal limit was located 1–2 cm distally from the joint line. The crural fascia and pes anserinus tendons were elevated and retracted posteriorly. The medial collateral ligament was completely released from its tibial insertion in all cases. A Hohmann-type retractor, which was posteriorly placed to the tibia, protected the neurovascular structures. The design and cut of the osteotomy was followed according to the technique described by Staubli.[8] Under image intensification, the first osteotomy in the coronal plane was performed posteriorly to the anterior tibial tuberosity in an oblique manner. It started 1 cm proximally to the patellar ligament insertion and extended distally and posteriorly until the second axial component of the osteotomy was met. In a profile view, the two lines of osteotomy formed an obtuse angle. Guidewires were obliquely inserted to guide the medial opening wedge axial tibial osteotomy, the cut of which started at the medial cortex of the tibia 4 cm from the joint line and extended to the projection of the head of the fibula in the anteroposterior view. This cut was designed to end at a point located 2 cm from the joint line and 1 cm from the lateral cortex of the tibia, which was preserved (incomplete osteotomy). The osteotomy was performed with an oscillating saw and broad osteotomes, and the wedge was performed to achieve the desired correction. A blade retractor was posteriorly placed in the medial cortex of the tibia for this purpose. The axis was corrected with the aid of the cautery cord, extended from the center of the femoral head to the center of the ankle to reproduce the mechanical axis of the limb. The Fujisawa point was used as a reference for the correction limit, thus eliminating the need of preoperative planning of the amount of angular correction.[8,10] The fixation of the osteotomy was subsequently performed using a 4.5-mm DCP plate with four or five holes. Spongious screws (6.5 mm) and cortical screws (4.5 mm) were used in the metaphysis and diaphysis, respectively. The fixation was supplemented in all cases with a 6.5-mm spongious and partially threaded screw that crossed the osteotomy, inserted through the lateral cortex proximally to the apex of the osteotomy and extending to the medial plateau, as described by Paccola.[5] Fig. 1 shows the radiographs of a patient who underwent surgery with the described technique. After fixation, bone grafting with autologous bone extracted from the patient's iliac crest was usually performed in cases in which the opening of the medial cortex in the osteotomy site was larger than 1 cm (arbitrarily defined in institution's routine) or at the discretion of the senior surgeon. In the remaining patients, the gap was filled with absorbable gelatin sponge (Gelfoam®,

Fig. 1 – Radiographs in anteroposterior (AP) and profile (P) views of an opening wedge osteotomy wherein fixation was performed using a 4.5-mm DCP plate.

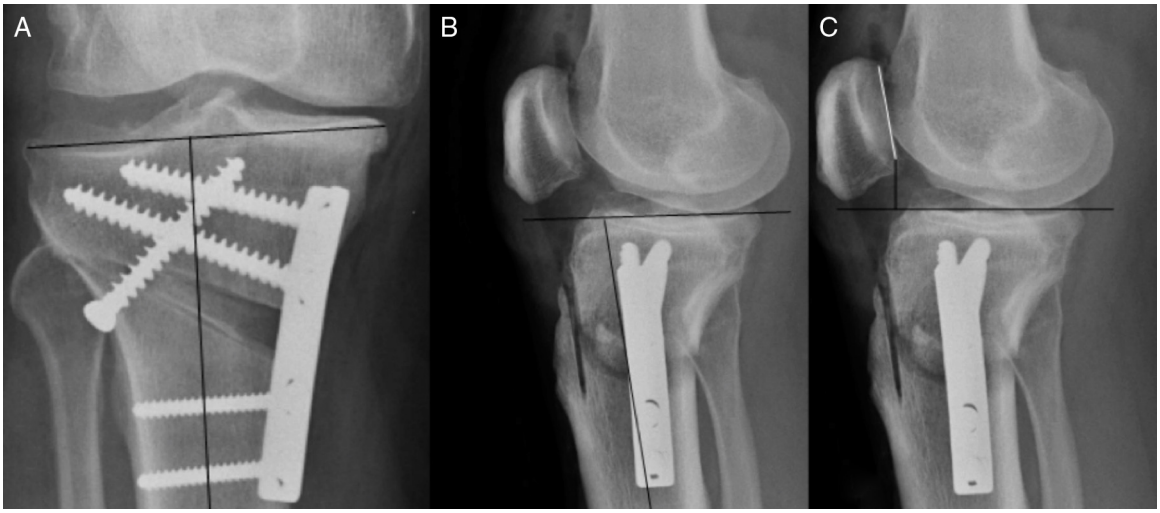

Fig. 2 – Radiographs in anteroposterior (AP) and profile (P) views of an opening wedge osteotomy demonstrating the methods used to make measurements.

Pfizer), and the fragments of spongious bone removed from the osteotomy itself were placed in the projection of the cortex, around the gelatin sponge. Intraoperative radiographic images were obtained in all cases at the end of procedure.

Physiotherapy was started on the first day after the procedure, with exercises to improve the range of movements and isometric exercises to strengthen the gluteal and quadriceps muscles and for active mobilization of the knee. Weight bearing was partially limited for eight weeks and was allowed to increase after the verification of consolidation in radiographs obtained at 4, 8, 16, and 52 weeks postoperatively. No immobilization or orthosis was required.

Radiological assessment

To assess the maintenance of the correction achieved by osteotomy, the angles of the proximal part of the tibia were measured according to the method described by Poignard et al.[11] The values recorded in the radiographs immediately after the procedures were compared with those recorded in the radiographs obtained after consolidation, and the differences were calculated (Fig. 2). Similarly, the patellar height index using the Blackburne-Peel method and the sagittal slope of the joint line (tibial slope) were measured. The differences between these angles allowed us to confirm whether there had been a loss of the correction achieved by the surgical procedure. Union of the osteotomy site progresses over time from lateral to medial and it was judged according to the presence of trabecular bone crossing the initial gap during follow-up AP radiographic assessments.

Statistical analysis

The paired t-test was used to compare patellar height, tibial slope, and varus correction postoperatively and after consolidation because it considers grouped responses, and the assumption of independence between the observations was not adequate. Statistical analysis was performed using SAS® 9.2 software.

Results

Of the 54 patients who underwent surgery during this period, three were lost to the 2-year follow-up and were thus excluded. Therefore, the final sample included 51 patients who underwent opening wedge osteotomy to correct varus deformity in the proximal end of the tibia, with fixation using a 4.5-mm large fragment DCP plate. Autogenous bone grafting harvested from iliac crest was done only in nine cases. Case distribution according to the degree of arthrosis (Ahlbäck classification) is shown in Table 1. In this series of cases, three patients exhibited fixation failure with loosening of implants and loss of correction. They received fixation with fixed-angle plates and progressed with adequate consolidation and correction. One patient had a hematoma in the surgical site that required surgical drainage and that subsequently resolved. At 1 year postoperatively, all osteotomies were consolidated. No cases of infection, thromboembolic events, or neurovascular complications were reported.

Table 2 summarizes the findings of the present study. There was no clinically significant difference in the assessed parameters between the postoperative radiographs and radiographs obtained after the consolidation of the osteotomies. Changes in patellar height determined using the Blackburne-Peel

Table 1 – Distribution of patients according to modified Ahlbäck classification.

Ahlbäck	*n*
1	21
2	12
3	12
4	6

Table 2 – Differences in the three assessed parameters between radiographs obtained immediately after the procedures and those obtained after osteotomy consolidation.

	Mean difference	Standard deviation	Confidence interval (95%)	*p*-Value
Loss of varus correction	0.92	1.34	0.54–1.30	<0.01
Loss of tibial slope	0.27	0.75	0.06–0.49	0.01
Loss of patellar height	0.01	0.06	−0.01–0.03	0.29

method, tibial slope, and tibial correction in the anteroposterior plane were not significant and were within the variability expected for this type of dimension. The difference in the proximal tibial angle was statistically significant. The mean correction loss angle, which was calculated by the difference between the correction angle in the immediate postoperative period and after consolidation, was $0.92^{\circ} \pm 0.9^{\circ}$.

Discussion

The main contribution of the present study was to demonstrate that conventional and less expensive implants may provide adequate stability for a commonly performed procedure in active patients with knee osteoarthritis. Although the number of osteotomies for the treatment of medial gonarthrosis has decreased over the years in favor of arthroplasties, this procedure is still widely performed. It improves symptoms and functional capacity and allows a delay in arthroplasty in a large number of patients.[12] Several factors are associated with the success or failure of osteotomies; however, correction maintenance is undoubtedly important for long-term outcomes.[13] The type of fixation and selected implant have a decisive role in the stability of the fixation. Moreover, the small surface of bone contact in opening wedge osteotomy leads to a higher incidence of complications.[4,14] Nelissen et al.[14] studied fixation using short plates with retractors and reported a higher rate of complications in cases in which more extensive corrections were performed. With the advent of implants with locking screws, which provide angular stability to the plate, the popularity of this type of fixation significantly increased.[8,15,16] Biomechanical studies confirm that implants with locking screws enhance the stability of the fixation of opening wedge osteotomies.[15,17] However, the higher cost of these implants limits their routine use in economically less developed countries. Moreover, important changes may occur in the sagittal plane and patellar height, depending on the osteotomy technique used.[18] Changes in the sagittal slope of the tibial plateau and potential reduction in patellar height after an opening wedge osteotomy in the proximal end of the tibia may lead to significant biomechanical changes that can compromise long-term outcomes.[19]

The main findings of the present study showed that the osteotomy technique and fixation method with conventional plates and screws (which are in theory less stable) used in our hospital provided enough stability to maintain the correction achieved until consolidation because the differences observed in the assessed parameters were not significant. There were no clinically relevant changes in the frontal plane, sagittal plane, or patellar height with the fixation method. The use of a lateral spongious screw crossing the osteotomy may have provided more stability to the fixation. A recent biomechanical study conducted at our hospital showed that the addition of this screw, even in the presence of a gap in the lateral cortex, makes the resistance to the fixation gap comparable to that of an intact lateral cortex.[20]

Although the study had limitations, such as the methodological limitation inherent to a study of cases and the absence of a comparison with other methods of fixation, the differences observed between the measured angles were not clinically or statistically significant, which allowed us to conclude that the conventional plates and screws used with the described technique provided enough stability for this type of fixation. These implants can still be used in the clinical routine, with the advantage of being an affordable solution.

Conclusions

The use of conventional plates and screws is viable in the fixation of opening wedge high tibial osteotomy because they provide enough stability to maintain the correction achieved until consolidation, without significant changes.

Conflicts of interest

The authors declare no conflicts of interest.

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