High tibial osteotomies – is it still a reasonable option in treatment of osteoarthritis?

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Received: 3 September 2017
Revised: 1 October 2017
Accepted: 15 October 2017
Published: 6 January 2022

The Egyptian Orthopaedic Journal 2021, 56:262–267

Background
High tibial osteotomies (HTO) and unicompartmental knee arthroplasties are performed for the treatment of isolated unicompartmental osteoarthritis (OA) of the knee. Before the development of knee arthroplasties, HTO was the most common operative treatment option for knee OA.
Patients and methods
This work was a prospective study on 27 patients with medial compartmental OA who had been admitted to El-Menoufia University Hospital in the period from 2009 to 2013.
Results
The average age of the patients was 43 years. The average opening height of the osteotomy was 10.8 mm. There were no cases of secondary loss of correction. No patients needed to be treated by a secondary autograft because of delayed bone healing. One patient was reoperated a few days after the first intervention because of overcorrection.
Conclusion
Open-wedge HTO with the use of optimal surgical techniques (biplanar metaphyseal osteotomy) and the fixation with the internal plate fixator TomoFix has proved to be successful in treatment of unicompartmental gonarthrosis, even without bone grafts or bone substitute material. The complication rate is small, and full weight-bearing is achieved quickly with good medium-term results.

Keywords:
osteoarthritis, osteotomy, tibia

Egypt Orthop J 56:262–267

1110-1148

Introduction

Knee osteoarthritis (OA) is more common in women and older people. Apart from ageing, much evidence mostly from North American and European cohorts, indicates that obesity or heavy occupational physical activities are clear risk factors for symptomatic knee OA. A systematic review indicated that the main factors consistently associated with knee OA were obesity, previous knee trauma, hand OA, female sex and older age [1]. In young adults, knee OA is most commonly the result of a previous injury to the knee [2].

High tibial osteotomies (HTO) and unicompartmental knee arthroplasties are performed for the treatment of isolated unicompartmental OA of the knee. Before the development of knee arthroplasties, HTO was the most common operative treatment option for knee OA [3]. Over the past two decades, the incidence of osteotomies has decreased, but symptomatic, radiologically mild or moderate knee OA is still commonly regarded as an indication of HTO in young and active patients [4].

Results of HTO are reported to be good, but they tend to deteriorate with time, and patients may subsequently undergo TKA [5]. However, most of the previous results for HTOs are reported from a single-center or surgeon series, which limits their power of evidence. There is a paucity of larger, registry-based studies to report results of HTO in widespread use.

HTO alters the anatomy and biomechanics of the knee. The most common changes are ligamental imbalance, patellar tendon length alteration, scar formation, and possible rotational deformities [6]. All these factors may make a subsequent TKA procedure more difficult, but most of the previous studies show no adverse effects on the results of subsequent TKA [7]. However, these previously published studies have very limited cohort sizes. Only one is a register-based study, which reports that a TKA after an osteotomy has almost a threefold higher early revision rate when compared with a primary TKA [8].

 DOI: 10.4103/eoj.eoj_59_21

HTO is viewed as a feasible alternative in cases of isolated medial compartmental knee OA as a way to maintain function, relieve pain, and gain time when the articular cartilage is not completely worn and in relatively young patients, who do not want to modify their activity levels. In addition, HTO can be effective in delaying the need for TKA [7].

Because of the popularization of TKA, the overall role of HTO in the treatment of knee OA has decreased since Jackson (1958) introduced this procedure. However, in the 1990s, in sports medicine, the role of correction of varus alignment in the treatment of ligamentous injuries and imbalance of the knee led to a reappreciation of osteotomy [9].

The most common radiological classification is probably the Kellgren–Lawrence classification (Kellgren and Lawrence, 1957) (Table 1). Another commonly used radiological staging is the Ahlbäck classification (Ahlback, 1968). A common weakness of radiological classifications is that they can only be used to grade the radiological severity of OA; they do not provide information about symptoms or functional outcome, and their role in choosing between treatment strategies is very limited. Radiological classifications are observer dependent and reproducibility is relatively poor; therefore, visual-based classifications are prone to bias [10].

Patients and methods

This work is a prospective study of 27 patients with medial compartmental OA who had been admitted to El-Menofyia University Hospital in the period from 2009 to 2013. The study was approved by the institutional ethics committee in the Orthopedic Department of Orthopaedic Surgery, EL Menofyia university, Egypt. All cases that fulfilled the inclusion criteria had been treated by HTO.

Table 1 Kellgren–Lawrence classification of knee osteoarthritis

Grades	Radiological findings
I	Doubtful narrowing of the joint space, possible osteophytes
II	Small osteophytes, possible narrowing of the joint
III	Multiple, moderately sized osteophytes, definite joint space narrowing, some sclerotic areas, possible deformation of bone ends
IV	Multiple large osteophytes, severe joint space narrowing, marked sclerosis, and definite deformity of bone ends

Criteria of inclusion

Patients included in this study met the following criteria: selecting the ideal patient is crucial in achieving good results with HTO for medial knee OA. The list of characteristics for the ideal HTO patient, according the International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine, is isolated medial joint line pain, age 40–60 years, BMI less than 30, high-demand activity but no running or jumping, varus malalignment less than 15°, metaphyseal varus of tibia more than 5°, full range of movement, normal lateral and patellofemoral compartments, no defect of the posteromedial tibia, normal ligament balance, nonsmoker, and some level of pain tolerance [11]. The possibility to return to a sporting activity can also be an important consideration in the decision-making process for treatment of knee OA [12].

Preoperative planning of the correction

Deformity analysis and the planning of the correction on the basis of the full-leg weight-bearing radiograph are carried out either digitally or are drawn on paper. The principles for planning are the same for either method; however, the magnification factor of the radiograph should, if necessary, be taken into account. The extent of the opening required for the osteotomy can now be measured (in mm) on the medial tibial cortex [13–15]. Fujisawa *et al.* [16] were able to demonstrate that the best results following valgization displacement osteotomy were achieved if the mechanical axis postoperatively intersects the joint line at about 62% of the medial/lateral width of the tibial head. Agneskirchner *et al.* [17] were able to confirm this by biomechanical experiments. The 62% point, which lies slightly lateral to the intercondylar eminence, is accordingly marked on the knee baseline.

Surgical concept

The intervention is carried out in the supine position. A knee bench and a footrest are attached to the operating table. The full leg including the iliac crest is draped free for possible bone-graft harvesting and for intraoperative control of the axis of the leg from the center of the hip to the center of the ankle. The intervention itself is performed with knee flexion of 45°, with the foot resting on the operating table. Tourniquet is normally not required; optionally, a sterile tourniquet may be used. Because an image intensifier is required in controlling the surgery, this should be positioned on the opposite side of the table.

At first, always, arthroscopy is carried out to evaluate the condition of the cartilage and the menisci, especially within the lateral compartment. When indicated, this includes resection of the medial meniscus and smoothening of the cartilage or even the ablation of anterior and sometimes medial plateau osteophytes to overcome the extension deficit.

The skin and soft-tissue conditions have to be free of irritation, and the surgical approach needs to take into account preexisting surgical scars. We prefer skin incision of 6–8 cm from the insertion of the pes anserinus dorsocranially upward toward the posteromedial corner of the tibial head, but longitudinal incisions are also possible. After transaction of the subcutis, the tendons of the pes anserinus are retracted posteriorly and distally by a hook. The distal fibers of the superficial medial collateral ligament are carefully detached and the rear edge of the tibia displayed.

Employing image intensifier monitoring of the anteroposterior plane, two 3.0-mm Lancet tipped K-wires, which mark the height and direction of the horizontal osteotomy, are placed exactly parallel to the articular surface. The anteroposterior K-wire marks the center of the joint and is introduced parallel to the tibial slope. The point to be aimed at is the proximal end of the tibiofibular joint. The wires end exactly at the edge of the lateral tibial cortex. For the correct depth of the cut, 10 mm is subtracted from the total depth of transection as measured on the image intensifier.

Osteotomy

The horizontal osteotomy (always with new saw blades) proceeds below the guiding wires in the posterior two-thirds of the tibia. The anterior ascending osteotomy in the ventral third of the tibia runs upward, cranially, behind the tuberosity and through the entire far cortex, always parallel to the anterior edge of the tibia. The two planes form an angle of ∼110°. During the entire time of sawing, the oscillating saw is flushed continuously. After reaching the designated depth of the osteotomy, flat chisels are carefully inserted into the horizontal osteotomy gap, one after the other, opening it slowly after reaching the preoperatively determined opening, and then the flat chisels are removed, and a bone spreader is inserted intercortically in the far posteromedial corner of the osteotomy.

The leg is extended over a towel roll, and the corrected leg axis is examined clinically and radiologically. While one spreads the osteotomy open, the inclination of the tibial slope in the sagittal plane must be watched carefully. In cases of pure varus correction, it should not be changed. This requires a greater osteotomy gap opening posteriorly than anteriorly, because of the geometry of the metaphyseal tibial. In cases of varus malalignment with additional extension deficit or/and anterior knee instability, a valgization-extension displacement osteotomy of the proximal tibia (i.e. a required reduction of tibial slope, but never less than 0°) could lead to a correction of the axis, and coincidentally, to the diminution of the anterior translation in full extension. In such cases, the asymmetric opening of the gap must then be accentuated. Conversely, a valgization-flexion HTO (i.e., a required increase of tibial slope) allows stabilization of posterolateral knee instability and correction to an extent to be expected in morphologically varus knees. In such cases, the osteotomy is opened rather more anteriorly than posteriorly by the use of special wedges [13].

Internal plate fixator

After one achieves the preoperatively designated correction of the axis, the internal plate fixator with eight unidirectional conical and combi-holes (since 2009, the new-generation plate with identical biomechanical properties is in use) with premounted spacers is inserted through the subcutaneous tunnel, and then the proximal three screws are inserted and locked into the proximal top of the T-shaped plate under image-intensifier control. The next step is to temporarily secure the plate by a lag screw in the first distal hole. This measure pulls the distal segment of the osteotomy toward the plate fixator and simultaneously compresses the lateral cortex bridge. Subsequently, after removal of the premounted spacers, locking screws are inserted monocortically or bicortically in the remaining plate holes from distal to proximal. After tightening all other screws, the lag screw is replaced by a bicortical locking screw. Finally, the bone spreader is removed. In case of an intact bone bridge and good bone contact of the ascending ventral osteotomy, it is possible to refrain from employing autologous spongiosa grafts. For gaps of up to about 20 mm in cases of osteoporotic bone, it is recommended to use autologous bone graft from the iliac crest; in our study, we used bone substitutes. After documentation of the operation results by the image intensifier in both planes, the wound is closed layer by layer.

Postoperative management

Mobilization starts on day 1 postoperatively, with the patient using forearm crutches with partial weight-bearing activity. Incremental weight bearing depends on the level of pain. Generally, it is possible to for the patient to begin full weight-bearing activity without crutches in the fifth postoperative week, which means that by the end of the sixth postoperative week, normal weight-bearing capability should have returned.

The range of motion of the knee joint does not need to be restricted, and there is no need for orthesis.

Until a return to full weight-bearing activity is achieved, medical antithrombotic prophylaxis by low-molecular-weight heparin should be continued.

Radiographic examination of the knee joint and proximal lower limb in both planes is performed on the third postoperative day and 6 weeks after the intervention (a full-leg weight bearing radiograph is made at a later date). By then, the lateral and the anterior bone bridges should show stable bone healing; the gap itself will naturally still be open. It is important to emphasize that full weight-bearing and physical activity do not depend on the completion of bone remodeling within the gap, as this process can take up to a year. In case of complaints, implant removal might be carried out 12–18 months postoperatively [13,18]. In our study, implants are generally removed in ~20% of the patients.

Radiological results

Open-wedge osteotomy of the medial proximal meta-epiphyseal tibia without filling material is controversial among surgeons. There is a trend to use filling materials or at least substances that enhance new bone formation in the osteotomy gap. Solid interpositions alone (autologous, heterologous) are not sufficient enough to withstand the dynamic forces [13,19].

The effect of solid interpositions to primary and secondary stability has yet to be established. In a retrospective case series study, reviewing the radiological files of 13 consecutive patients for describing and quantifying the process of osteotomy gap healing without the use of filling material, with gap openings between 4 and 18 mm (average 10 mm), we have seen that ossification of the gap always progressed from the lateral hinge toward the medial side. The average age of the patients was 47 years. The standard radiography evaluation showed in all patients that the angle between surfaces was stable over time, confirming osteotomy stability. Bone healing of the osteotomy gap started at the osteotomy surfaces, so the osteotomy gap was closed from lateral to medial within 6–18 months. Implant removal is therefore not recommended before 12 months.

Fixation stability of open-wedge HTO with T-plate versus the closed-wedge procedure was examined in a series of 42 patients by a randomized clinical trial using radiostereometry by Luites *et al.* [20]. Both gave excellent initial stability and remained stable until bone healing was complete, that is, at 2 years without loss of correction.

Clinical results

This work is a prospective study of 27 patients with medial compartmental OA who had been admitted to El-Menofyia University Hospital in the period from 2009 to 2013. All cases that fulfilled the inclusion criteria had been treated by HTO. The average age of the patients was 43 years. The average opening height of the osteotomy was 10.8 mm. There were no cases of secondary loss of correction. No patients needed to be treated by a secondary autograft because of delayed bone healing. One patient was reoperated a few days after the first intervention because of overcorrection.

In this case, the distal locking screws were removed from the plate fixator, the axis of the leg was corrected, and the long side of the plate was again fixed by bicortical locking screws. The further clinical course was ordinary for this patient. All in all, two cases were affected by late infection together with soft-tissue irritation of the implant bed 4 months postoperatively. After removal of the plate fixator and insertion of antibiotics-impregnated beads, the further clinical course for these patients was free of complications (Figs 1 and 2).

In cooperation with the AO-CID (AO Foundation, Davos), a multicenter retrospective outcome analysis of 538 patients with valgization tibial osteotomy for the years 2004–2006 was compiled (publication 2010). The decisive criterion used was the Oxford Knee Score. This score, which is used to evaluate results for both knee unicondylar sled prosthesis and total knee replacement, prevails in international publications. The 12 questions to be answered by the patient are based on a five-step scale, so that a minimum of 0 and a maximum of 48 points can be reached. The average follow-up period was 3.6 (2.4–4.7) years, the average BMI was 27, and the average opening of the osteotomy was 10 mm. On average, an Oxford score of 40 was achieved, with no significant deviations found within the age groups. Even in the age group of 60-year-old patients, very good medium-term results could be achieved for patients with correct indications. The list of all postoperative complications include one implant breakage; eight with insufficient bone

Figure 1

Anteroposterior view.

Figure 2

Lateral view.

healing diagnosed early, leading to corresponding treatment (reoperation); 11 hematomas; 11 infections; three infected hematomas; and two impaired wound healing.

Recommendations of AO-KNEG 2009 in cases of bone healing delay are as follows: with large gaps or slow bone healing conditions, cancellous bone from the iliac crest should be used, and in a few cases of delayed unions, a computed tomographic scan and the use of cancellous bone in a second surgical intervention is recommended.

We have never had to perform a lateral secondary osteosynthesis. In comparison with the results published for prostheses, the functional results can be regarded as very favorable, and together with the low rate of complications, recommendation in favor of this procedure is justified.

Conclusions

Realignment osteotomy holds a central position within the therapeutic spectrum for early-grade and medium-grade varus medial compartment OA. We might state that open-wedge HTO with the use of optimal surgical techniques (biplanar metaphyseal osteotomy) and the fixation with the internal plate fixator TomoFix has proved to be successful in treatment of unicompartmental gonarthrosis, even without bone grafts or bone substitute material. The complication rate is small, and full weight bearing is achieved quickly, with good medium-term results.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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