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ORIGINAL STUDY

High tibial valgus osteotomy using the Tomofix plate – Medium-term results in young patients

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Proximal tibial valgus osteotomy is one of the treatment options for painful medial compartment osteoarthrosis and varus deformity of the knee in a young patient . We report our experience with medial opening wedge tibial osteotomy using the Tomofix plate in 46 patients (50 knees). The mean age was 39.5 years (range 30-49). All were male. Mean duration of follow-up was 60 months (36-72 months).

There were no non-unions of the osteotomy site and the medial open-wedge healed without any need for bone graft or bone substitutes. There was functional improvement, as seen from the Oxford and Knee Society scores. Preoperative average knee flexion was 110° (range, 90 -125°) which remained unchanged. The mean preoperative tibio-femoral angle (mechanical) was 7° varus (range, 5°-10°) ; the postoperative angle was 6° valgus (range 5°-8°). One knee was revised to total knee replacement after two years and was considered a failure.

The Tomofix plate provided immediate stability, satisfactory healing of the osteotomy site without the need for bone graft or bone substitutes, and good functional results in young patients with isolated medial compartment degenerative disease.

Keywords : high tibial osteotomy ; medial opening wedge ; Tomofix plate ; closing wedge osteotomy ; varus malalignment ; medial compartment arthrosis.

INTRODUCTION

High tibial osteotomy (HTO) remains an important surgical option for the treatment of unicompartmental knee arthrosis associated with varus malalignment. Despite some reports of good results with knee replacement in younger and active patients (9) many surgeons indeed continue to question the durability of prosthetic joints in young patients. Osteotomy tends to preserve the native knee joint, allows return to high level of activities and does not compromise later total knee replacement.

Although the incidence of proximal tibial valgus osteotomy for osteoarthrosis has decreased because of advances in total knee arthroplasty (*32*), there is still a need for this operation in the young, high-demand patient with medial compartment osteoarthritis.

It can be a technically demanding procedure with the potential for intraoperative and postoperative complications (*33*). It can also make subsequent total knee replacement technically more difficult although still yielding results comparable to those patients who have not had a previous osteotomy (*2,13,26*).

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There have been various techniques described to realign the proximal tibia into valgus : opening and closing wedge and dome osteotomy. For these, varying methods of fixation have been used, including staples, plates, external fixation, and plaster. For multiplanar deformity or where significant lengthening is needed, Ilizarov's technique may be required (*7*).

Medial opening wedge is an appealing alternative to the lateral closing wedge osteotomy. The fixation can be achieved either by an external or an internal fixation device. One fixation device is the Tomofix plate (Tomofix, Synthes GmbH, Switzerland). This works as a bridging internal fixator with the principle of a locking compression plate (LCP) ; It provides a stable fixation of the osteotomy without bone graft or bone substitutes (*28*).

We report our experience with medial opening wedge tibial osteotomy using the Tomofix plate.

MATERIALS AND METHODS

The results of 50 consecutive high tibial osteotomies in 46 patients, performed by the senior author, were evaluated. All the patients had medial compartment degenerative arthritis with varus deformity of the knee.

Contraindication to the operation was lateral or patellofemoral compartment disease/symptoms, fixed flexion deformity more than 15°, stiffness (active flexion less than 90°), subluxation, inflammatory arthritis, previous lateral meniscectomy and age above 60. Age in itself was not an absolute contraindication but we preferred to operate on active patients below the age of 60.

This is a prospective study with follow-up at regular intervals. All the patients were male with an average age of 39.5 years (range 30-49). The patients were assessed on the basis of pre- and post-operative Oxford and Knee Society score, range of motion, radiological evidence of healing of the osteotomy site and alignment of the knee. Mechanical tibio-femoral angle was measured, pre and post operatively.

Pre-operatively, all the patients had long leg films to measure the tibio-femoral angle and determine the degree of correction required (fig 1). The amount of correction is dependent upon the severity of degenerative changes in the medial compartment and the degree of varus deformity. Jakob and Murphy (*21*) modified the overcorrection recommendation, made by Fujisawa *et al* (*12*), based on the amount of cartilage space remaining on the medial side. Fujisawa *et al* had suggested that best results from HTO were obtained when the mechanical axis line passed through the 30% to 40% lateral tibial

Fig. 1. — Preoperative weight bearing long leg alignment film with lines marking the weight bearing axis and mechanical tibiofemoral angle.

Fig. 2. — Intra-operative marking of the mechanical axis line using diathermy cord.

plateau region, with the inner edge marking 0% and the outer edge 100% of the lateral tibial plateau.

On the operating table, a diathermy lead was used to mark out the mechanical axis of the lower limb from the centre of the femoral head to the mid-point of the tibial plafond measured between the medial articular aspect of the lateral malleolus and the lateral articular aspect of medial malleolus (fig 2).

Operative technique

A transverse skin incision was made over the proximal tibia. A subcutaneous pocket was created, using blunt dissection, above and below the incision to accommodate the Tomofix plate. The Pes anserinus tendons and medial collateral ligament were identified and the upper edge of the Pes was marked with the electrocautery. The medial collateral was released by retracting it posteriorly with a Hohmann retractor ; this, we feel, is an important step in achieving adequate correction. At the anterior end of the incision, the patellar tendon and tibial tuberosity were identified and the site of the ascending limb of the osteotomy marked with an electrocautery. A guide wire was driven into the proximal tibia, under image intensifier, to mark the site of the horizontal limb of the osteotomy. This is roughly at the metaphyseal/diaphyseal junction, at the superior margin of the Pes tendons. The wire was aimed laterally towards the upper third of the proximal tibiofibular joint. While placing the wire, it is important to check that there is enough tibial segment proximally to allow for insertion of three parallel screws through the horizontal limb and the first proximal screw through the longitudinal limb of the T-shaped plate. A power saw was then used to perform the horizontal osteotomy, along the line of the guide wire. The saw blade was stopped just short of the lateral tibial cortex. A narrow saw blade was then used to make the ascending osteotomy at the site already marked. Chisels were used to break any intact bridges of bone and open the osteotomy site by stacking them on each other ; care was taken to retain an intact lateral cortex. The chisels were then removed and an angle distractor was inserted into the osteotomy site. The osteotomy was distracted and correction was continued until the mechanical axis of the limb was at the new corrected level. This was checked

Fig. 3. — Angle distraction device opening the osteotomy site. New corrected level is seen.

Fig. 4. — Laminar spreader holding the osteotomy in the corrected position.

Fig. 5. — Application of plate and insertion of proximal screws.

using the diathermy lead under image intensifier control (fig 3). Once the required correction was achieved, a laminar spreader was used to hold it in place (fig 4) while a Tomofix plate was applied to the medial aspect of the proximal tibia. The plate was slid under the skin, in the subcutaneous pocket created earlier. The longitudinal limb was inserted first followed by the proximal horizontal portion. The plate was temporarily held in place with K-wires passed through the screw holes. Proximal locking screws were then inserted (fig 5). A lag screw was inserted into the first plate hole distal to the osteotomy. The purpose of this was to compress the lateral hinge by pulling the distal osteotomy segment towards the plate. During this process, the osteotomy gap was watched for any loss of correction. The distal locking screws were then inserted (fig 6). A bicortical locking screw was inserted at the site of the lag screw. No form of bone graft or bone substitutes was used to fill in the gap left by the open wedge medially. A final check of the alignment was made and the wound was closed.

Post-operatively, long leg radiographs were taken to check the alignment (fig 7). The patients were allowed to weight bear as tolerated and started on physiotherapy for knee range of motion. They were followed up as out patients with serial clinical and radiographic assessment.

Statistical methods

We defined failure as the decision to revise high tibial osteotomy to a total knee replacement. The probability of failure was estimated using the Kaplan Meier Survivorship method (6). In order to analyse the pre and post differences we used the Wilcoxon signed- rank test with the significance level set at < 0.05.

RESULTS

The mean follow-up was 60 months (36-72 months). There were no non-unions at the osteotomy site. The mean preoperative Oxford knee score was 48 (range 38-54). This improved to a mean score of 22 (range 17-31) at final follow-up. The mean Knee Society score improved from the preoperative mean of 38 (range 30-55) to 82 points (range 45-92) at final follow-up. The mean func-

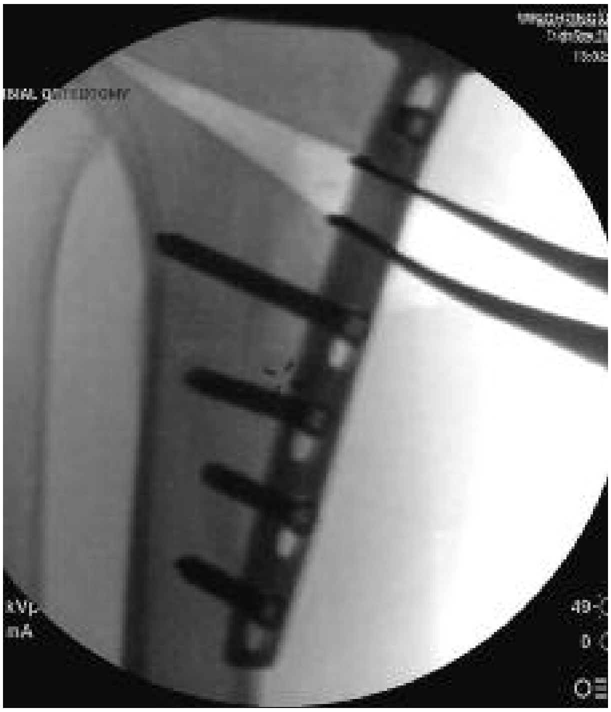

Fig. 6. — Distal screw insertion completing the application of Tomofix plate.

Fig. 7. — Postoperative weight bearing long leg alignment film with lines marking the change in weight bearing axis and mechanical tibiofemoral angle. Tomofix plate can be seen *in situ.*

tional score was 35 (range 25-55) preoperatively and 75 points (range 50-95) at follow-up. These changes were statistically significant ($p < .05$). The preoperative average knee flexion was 110° (range 90°-125°) which remained unchanged at final follow-up. The mean tibio-femoral angle was 7° varus (range 5°-10°) preoperatively and 6° valgus (range 5-8) at follow-up. One of the patients had revision to total knee replacement. He was a 49-year-old male with severe medial compartment osteoarthritis and an above knee amputation on the contralateral side. He continued to have pain after the high tibial osteotomy and had conversion to total knee replacement two years later.

With conversion to total knee replacement as the end point, using the Kaplan Meier survivorship analysis, our cumulative survival rate for the high tibial osteotomy at the end of 5 years was 98% (fig 8).

One patient had post-operative DVT. Two patients had post-operative cellulitis in the operated leg, which settled down with intravenous followed by oral antibiotics. There were no deep infections.

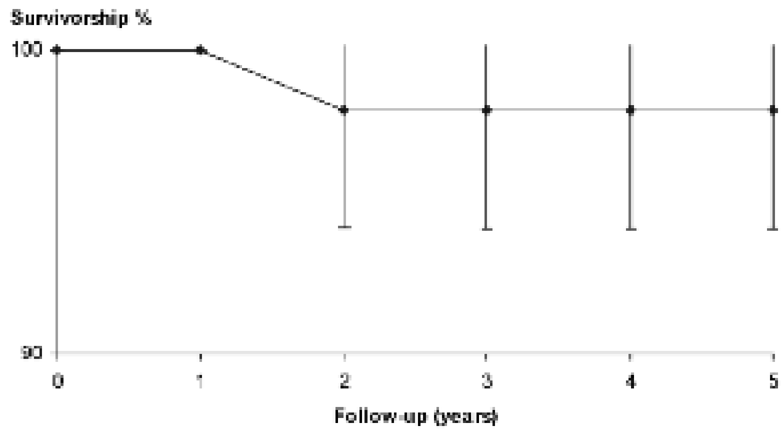

Fig. 8. — Survivorship analysis using the Kaplan-Meier survivorship curve

DISCUSSION

A painful osteoarthritic knee in a young patient presents a challenging therapeutic scenario. The goal of management in these patients is symptomatic relief with return to normal activity level and extension of the lifetime of the natural knee joint. Surgical options include arthroscopic debridement, realignment osteotomy, unicompartmental arthroplasty and total knee arthroplasty. Although total knee replacement has been shown to be effective in young patients, the main concern is the potential adverse effect of high joint forces on the polyethylene articular surface (*5,30*). The wear debris, generated over many years, carries the risk of causing aseptic loosening (*10,17*). Due to the potential for numerous revision operations in the course of a lifetime, total knee replacement has generally been reserved for older patients (*3, 11,29*). The data from Mayo clinic showed 10-year survivorship in patients 55 years or younger to be 83% whereas the same survivorship in patients older than 70 was 94% (*27*). High tibial osteotomy is a procedure which has been accepted in the treatment of medial compartment osteoarthrosis in the presence of varus malalignment, particularly in young and active patients.

Historically, osteotomy of the proximal tibia has been used for correction of angular deformities in the setting of tibia vara conditions such as Blount disease, rickets, poliomyelitis and posttraumatic conditions. Jackson was first to report performing a high tibial osteotomy for osteoarthritis of the knee (*19,20*). This concept was subsequently adopted by Coventry and Insall (*8,18*) who popularised the lateral closing wedge type osteotomy. Potential problems of lateral closing wedge osteotomy include patella infera, need for fibular osteotomy or release of the proximal tibiofibular joint, risk of damage to the common peroneal nerve and difficulty in biplanar correction. Larger corrections may cause marked shortening of the leg and increased offset of the proximal tibia compromising later placement of the tibial component of TKR (*23*).

Patient selection is critical to the success of knee osteotomy (*16*). The decision between joint replacement and high tibial osteotomy is based on disease distribution, patient age and activity level. Isolated medial compartment disease in a physiologically young and high-demand individual, is most appropriate for a high tibial osteotomy whereas the same condition in a physiologically old, low-demand patient is appropriate for either uni or total knee replacement. Although good results have been reported for total knee replacement in young active patients, wear and loosening are the main concerns in this group of patients (*9*). Unicompartmental knee replacement is also vulnerable to premature wear and loosening when subjected to high physical demands.

The technique of medial opening wedge osteotomy has several advantages : biplanar, and precise angular correction can be achieved with a single saw cut. The open wedge does not require bone graft or graft substitutes for healing ; there is less extensive surgical dissection and dissection is away from the peroneal nerve/ proximal fibula.

This procedure has however been less popular mainly because of the inability of the implants to withstand axial and torsional forces in the proximal tibia. Several implant-related complications have been reported, including fixation failure (*4,25*). Another cause of possible failure is if the osteotomy is made above the tibial tuberosity, little room is left for proximal tibial fixation. A modified cut has been proposed in which transverse cut is combined with a second ascending cut behind the tibial tuberosity (*22*) ; with this technique, more room is left for proximal fixation and a buttress is created which provides stability in the sagittal and transverse planes.

The Tomofix plate is based on the principle of locking compression ; this increases the stiffness of the construct and avoids the need for rigid application of the plate against bone. The plate has a combination screw hole which can be used for compression.

The plate provides immediate stability which has been shown by a biomechanical study by Agneskirchner *et al* (*1*) : the Tomofix plate resisted more force, in single load-to-failure, and more loading cycles, in cyclical load-to-failure tests.

High tibial osteotomy has somewhat declined in popularity because of the improved design, metallurgy and results of modern total knee replacements. The technical difficulty of proximal tibial osteotomy is also a deterrent and so are the potential complications which include intra-articular fracture, under or over correction and difficulty in fixation with subsequent delayed/non union of the osteotomy site.

There is also the potential of making subsequent total knee replacements technically difficult to perform. While a total knee replacement following high tibial ostoetomy may be technically more demanding, studies suggest that the clinical results of primary total knee arthroplasty in knees with and without a previous high tibial osteotomy are not substantially different (*14,24*).

There are other studies that show poor results of total knee replacement following high tibial osteotomy (*15,31*). Some of the poor results are due to the technique of osteotomy which is one of the reasons we choose to perform an open-wedge biplanar ostetotomy. A modification of this can be used, in large corrections or in cases with preoperative patella infera. The vertical limb of the osteotomy is cut distally instead of proximally, therefore allowing the tibial tuberosity to stay with the proximal fragment.

Proximal tibial osteotomy does not preclude later total knee arthroplasty and should be part of the gamut of surgical options available for younger patients

Our study shows that Tomofix plate fixation in high tibial osteotomy gives immediate stability, good deformity correction and allows early rehabilitation. The osteotomy gap does not require bone graft or its substitutes. The medium-term functional results are encouraging. Longer-term follow-up is however needed to establish its effectiveness in deferring joint replacement surgery in this demanding group of patients.

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