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Comparison Between Results of High Tibial Osteotomy Above and Below Tibial Tubercle in Relation to Future Total Knee Arthroplasty

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ABSTRACT

This prospective study included 50 patients with medial compartment osteoarthritis and varus knees. Twenty-five patients had high tibial closed wedge osteotomy above the tibial tubercle (TT) (group I), and the other 25 had the osteotomy just below it (group II). The two groups were matched. The osteotomies in both groups were fixed with plates and screws. All patients were followed up radiographically and clinically for more than 12 months. Clinical and radiographic results of both groups are comparable. Regarding factors that will affect future knee arthroplasty (TKA), osteotomies below TT are more advantageous. That is because soft tissues and bony changes of the knees in group II are minimal, and the issue of slower union rates can be diminished by using rigid plate fixation.

High tibial osteotomy (HTO) is a surgical procedure used to treat early medial compartment knee osteoarthritis. It is a highly effective procedure in relieving pain, correcting deformity, and improving function. HTO is usually performed on younger and more active patients, aiming at unloading the diseased cartilage and delaying total knee arthroplasty (TKA) [1]. According to long-term studies [2–5], TKA is required in more than 25% of knees 10 years after HTO. Therefore, HTO should not increase the difficulties of any future procedures especially TKA. It can be performed using a variety of techniques with varying clinical results [6–9]. Depending on the osteotomy technique, outcomes such as patellar height changes, lateral truncation, reduced proximal tibial bone stock, altered joint line, hardware and medial displacement of the tibial axis play a role in the reduced success of any subsequent TKA [10–13]. The results of TKA after HTO are conflicting. Some studies have reported inferior results when compared with primary TKA [11–13] and others have found no or little differences [10,14,15]. Most studies [11,12,14–16] have not provided enough information about the effect of the type of HTO on subsequent TKA, while some [17,18] have reported that the results are equal in patients undergoing TKA after opening and closing wedge HTO.

However, the most frequently used HTO technique is closed wedge osteotomy that is performed proximal to the tibial tubercle [19–21]. Many disadvantages have been reported for this type of osteotomies, mainly patellar height changes, reduced bone stock of the proximal tibia and peroneal nerve palsy [22,23]. The incidence of peroneal nerve injury is reported between 3.3 and 11.9% [23], and most authors agree that the most important cause of nerve injury is iatrogenic damage to the peroneal nerve, in particular with the inclusion and location of the fibular osteotomy [23,24]. Studies comparing the functional and radiological outcomes of closed wedge osteotomies above and below tibial tubercle are extremely rare [7,8,25]. These later studies have demonstrated comparable results of both techniques. However, some disadvantages especially patella infera and reduced proximal tibial bone stock were avoided in patients undergoing osteotomies below tibial tubercle. The present study aimed to determine whether there are any differences in the clinical and radiological outcomes between closed wedge HTO above and below tibial tubercle with special interest to factors that will affect future TKA.

Patients and Methods

Between March 2007 and July 2011, a prospective study on 50 patients with medial compartment osteoarthritis and varus knees had been treated with closed wedge upper tibial osteotomy by or under supervision of the senior author. Approval by the Ethics Committee of the University Hospitals was obtained for the study, and the patients gave their informed consent. Twenty-five patients had the osteotomy above the tibial tubercle (TT) (group I), and the other 25 patients had the osteotomy just below it (group II). We alternated consecutive patients as they presented to our clinic. The two groups were matched with regards age, gender, obesity, angular deformity, degree of knee osteoarthritis and clinical evaluation score. For the first group with osteotomy above the (TT), patients' age range was from 42 to 58 years

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Table 1
Patients Characteristics and Length of Follow-Up.

Patients characteristics		Osteotomy above tibial tubercle (group I)	Osteotomy below tibial tubercle (group II)
Number of patients		25	25
Gender	Male	13	12
	Female	12	13
Age (years)		47 (42–58)	48 (41–59)
Degree of osteoarthritis	Grade 1	9 (36%)	8 (32%)
	Grade 2	13 (52%)	14 (56%)
	Grade 3	3 (12%)	3 (12%)
Pre-operative varus deformity		12 (5–14)	11 (6–15)
Weight of patients		75 (71–85)	77 (70–83)
Follow-up period (months)		27.4 (12–34)	29.1 (12–36)

with a mean of 47. There were 12 females and 13 males. The mean varus deformity before operation was 12° (5–14°). The average weight of patients was 75 kg (range 71–85). For the second group with osteotomy below the TT, patients' age range was from 41 to 59 years with a mean of 48. There were 13 females and 12 males. The mean varus deformity before surgery was 11° (6–15°). The average weight of patients was 77 kg (range 70–83). The indication for surgery was age less than 60 years, an active life style, and pain with osteoarthritis limited to the medial compartment.

Patients were evaluated clinically before and after surgery using the Knee Society Score (KSS) and function score [26]. The preoperative degree of radiological osteoarthritis was assessed according to the Ahlback criteria [27]. The patella height was measured preoperatively and postoperatively using Insall–Salvati index [28]. The severity of the preoperative deformity and degree of postoperative correction were determined using the mechanical axis, and correction loss was evaluated from postoperative through final follow-up radiographs. Radiographs included full-length standing X-rays as well as lateral views of the knee. Preoperative planning included the degree of angulation, the wedge size, and location of the osteotomy based on the preoperative imaging templating. The correction angle was formed by the intersection of a line from the centre of the femoral head to a point at the junction of the medial two-thirds and the lateral one-third of the tibial plateau and a line from the center of the ankle to the previous point of the tibial plateau [29,30]. The goal was to calculate the angular correction necessary to produce 2 to 4° of mechanical or 8 to 10° of anatomical valgus. Post-operative radiological union was defined as the presence of bridging callus on at least two X-ray views [31,32]

All patients received IV antibiotics (ceftriaxone 1 g) 2 hours pre-operatively and every 12 hours post-operatively for 2 days. As a prophylaxis of thrombo-embolism, low molecular weight heparin (enoxaparin 40 mg once a day) was administered subcutaneously on the first post-operative day, and continued for 15 days post-operatively.

A tourniquet was used to create a bloodless field. The fibula was osteotomized at the junction of the middle and distal zone in patients with tibial osteotomy below TT. In patients of group (I) with osteotomy above TT, release of the proximal tibiofibular joint with removal of inner 1/3 of fibular head was performed. Two guide Kirschner wires were inserted under image intensifier, first one below tibial tubercle (for osteotomy below TT) or above tibial TT (for osteotomies above tibial tubercle), and parallel to joint line, while the second wire was inserted at a predetermined angle in oblique direction to meet the first wire in medial cortex. An oscillating saw was used to cut the wedge of bone outlined by the wires. Both osteotomies were incomplete leaving 4–6 mm of the most medial tibial cortex intact. Lateral wedge-shaped bone segment was removed. Osteotomy was completed by gentle valgus strain. The below tibial tubercle osteotomies were fixed with locked plates, while the above tibial tubercle osteotomies were fixed by L-shaped plates. No casts were applied. On the second post-operative day, patients had adjustable hinged knee orthoses and were allowed to do range of motion training and isometric quadriceps strengthening knee exercises. The patients were non-weight bearing walking using two crutches for the first 6 weeks. After 6 weeks, touch weight bearing was advised. Full weight-bearing was allowed when radiographic union occurred. The patients were followed up at 2 weeks for removal of stitches and then every month for clinical and radiographic evaluation until union occurred, and then every 3 months until the end of follow up. Statistical comparisons between preoperative and final follow-up values were performed using the paired-samples t-test using SPSS version 17.0 software (SPSS Inc., Chicago, Illinois, USA). The independent-samples t-test was used to compare (KSS) and function scores. A P-value <0.05 was considered to be significant.

Results

Closed wedge osteotomy was performed on all cases; 25 knees had the osteotomy above the TT (group I), while the other 25 patients had the osteotomy just below it (group II). Locked plates and screws were used in all cases. Patient characteristics, length of follow-up and the degree of preoperative osteoarthritis for the two groups are given in Table 1, and the clinical and radiological results are given in Table 2.

No statistically significant differences were seen between the postoperative final follow-up results for closed wedge osteotomy above and below tibial tubercle in terms of the KSS or function scores (Table 2). There was also no statistically significant difference in the amount of correction achieved by the two techniques (Table 2). Statistically significant differences between the two groups were found, however, in the amount of correction loss at final follow-up, with a significantly smaller correction loss ($P < 0.05$) being seen after osteotomy below tibial tubercle (Table 2). All cases, except one in group II, united at 2–3 months post-operatively (Fig. 1A, B, and C). There was a statistically significant difference between the preoperative and postoperative Insall–Salvati index following closed wedge

Table 2
Clinical and Radiographic Results.

	Osteotomy above tibial tubercle (group I)		Osteotomy below tibial tubercle (group II)	
Results	Pre-operative	Post-operative	Pre-operative	Post-operative
Knee Society Score	61.7 (55–65)	93.6 (80–100)	65.1(55–70)	94.1 (85–100)
Function score	63.5 (55–70)	94.9 (85–100)	67.0 (65–75)	95.2 (85–100)
Mechanical axis	12 (5-14) varus	2.8° valgus (0–4° valgus)	11 (6-15) varus	2.9° valgus (1–5° valgus)
Deformity correction	11.7° (8–14°)		12.1° (7–16°)	
Correction loss immediate Postoperative to final Follow- up	2.4° (0–4°)		1.1° (0–2°)	
Insall–Salvati index	1.00 (0.92–1.07)	0.80 (0.74–0.9)	0.99 (0.9–1.09)	0.96 (0.89–1.04)