Opening wedge high tibial osteotomy in varus osteoarthritis of the knee without bone graft

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Background
The aim of this study was to evaluate the efficacy and short-term results of medial opening wedge high tibial osteotomy with the use of a wedge toothed plate in patients with medial compartment osteoarthrosis.
Patients and methods
This study was conducted from April 2010 and September 2012 and included 16 knees of seven female patients and nine male patients. Their average age was 40 years (range: 28–52 years), and they were treated with medial opening wedge high tibial osteotomy for varus knees with early medial compartment osteoarthrosis. The osteotomy sites were fixed with a wedge toothed plate without bone graft. The mean follow-up period was 11.4 months (range: 6–15 months).
Results
The average union time was 15 weeks (range: 8–24 weeks). The mean preoperative and postoperative Lysholm scores were 54.1 (range: 30–60) and 82 (range: 67–95), respectively. The mean preoperative femorotibial angle was 3.5° in varus malalignment (range: 3° valgus to 9° varus). It was 7.3° valgus postoperatively. The mean correction of the mechanical axis was 10.7°. There was loss of correction in one patient and needed revision. Four (25%) cases had delayed union.
Conclusion
Medial opening wedge osteotomy with the use of a wedge toothed plate had advantages of easy application and maintenance of correction in the early follow-up period without bone graft application. Consolidation is obtained without interfering with the rehabilitation period.

Keywords:
bone graft, knee, opening wedge, varus

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Introduction

Opening wedge high tibial osteotomy (HTO) is a reasonable treatment for unicompartmental medial osteoarthritis with varus deformity in young, active patients [1–3]. It improve transfer of a weight-bearing load from an affected medial compartment to lateral compartment of the knee, relieves symptoms, increases healing of damaged cartilage [4], and slows the progression of arthrosis in a knee with varus alignment [5,6]. Overcorrection and undercorrection of the deformity have poor clinical results [6–8], and it is important to achieve and maintain accurate correction of limb alignment until complete healing. The causes of loss of fixation are owing to lack of fixation and instability [8–10]. Optimal corrections was defined to be 8° of anatomic valgus [11], between 3° and 6° of mechanical valgus [3], when the weight-bearing line (WBL) passed through a point between 62 and 66% [12], or 62.5% [6,13] of the tibial plateau width. Introduction of the plate fixator for HTO [14], the open-wedge technique, became more secure owing to higher stability of the osteosynthesis [15,16]. Many surgical techniques have been described since the first description by Jackson [17], such as dome osteotomy [17,18], medial opening wedge [19], lateral closure wedge [20], and Ilizarov [21]. Medial opening wedge HTO above the tubercle had few complications [22,23], in comparison with other methods, and is seen as a correction technique of greater precision [3]. Its advantages include the following: (i) lack of need for lateral dissection and/or osteotomy of the fibula, thereby diminishing the risk of praxis of the common fibular nerve; (ii) provision of limb stretching, given that in arthrosis there is diminution of the joint space, with relative shortening; (iii) the results from angular correction are superior to those from using a lateral closure wedge; and (iv) provision of proximal tibial correction that is more anatomical.

Patients and methods

Sixteen patients were treated by medial opening wedge high osteotomy fixed with wedge toothed plate the for treatment of genu varus deformity and pain owing to osteoarthritis of medial compartment of the knee or varus deformity causing chronic ligament instability of knee between April 2010 and September 2012 at Zagazig University Hospital and Health Insurance Hospital. Nine patients were men and seven were women. The age ranged from 28 to 52 years. The mean follow-up period was 11.4 months (range: 6–15 months) (Table 1). Patient selections with varus malalignment symptoms with overloading in the medial compartment of the knee from osteoarthritis or knee instability due to chronic ligaments injury. Varus malalignment was considered when the tibiofemeoral mechanical axis passed through the medial tibial plateau or when the tibiofemoral mechanical angle was more than 3° compared with the opposite side. The range of motion of the knee joint had to be at least 100° from full extension and to flexion. Patients older than 60 years, adolescents with radiological open growth plates or infection of the knee joint, varus malalignment more than 15°, flexion deformity more than 15°, and grade III Ahlback were excluded. The radiological documentation included standard knee radiographs, a weight-bearing anteroposterior view, and a lateral view. The WBL was found by drawing a line from the centre of the femoral head to the centre of the ankle mortise. The horizontal distance from the WBL to the medial edge of the tibial plateau was then divided by the width of the tibial plateau. Thus, a WBL ratio of less than 0.5 indicated varus angulation with the load shifted medially, whereas a value of greater than 0.5 denoted valgus angulations with the load shifted toward the lateral compartment. The osteotomy opening size ranged from 8 to 14 mm in an attempt to shift the mechanical axis to the Fujisawa point (62% of the tibial plateau located on the lateral side) [6].

Surgical technique

Arthroscopy was performed before HTO to treat meniscal and chondral lesions.

Skin incision started distal to the joint line and ends 4–5 cmcm distal to the tibial tuberosity. The superficial medial ligament is subperiosteally elevated and retracted around the posterior edge of the tibia. A guide wire is passed from the medial tibial cortex starting from a point that usually corresponds to a bow in the proximal tibia aiming at the lateral tibial cortex at the level of tip of the fibular head. In knees with short proximal fragment for fixation (short distance between the joint line and tibial tuberosity), the anterior third of the cut can be modified to be more slanting to pass proximal to the tibial tuberosity. Opening of the osteotomy was done without force with the aid of bone spreader to avoid fracture of the lateral tibial plateau. All osteotomies were done without bone graft or bone substitutes. Internal fixation was done using four-holes toothed plate that offers osteotomy opening sizes of 8, 10, 12, and 14 mm (Table 2). Wound closure was done without a suction drain with anatomical closure of the pes anserinus and soft tissues to preserve the fracture haematoma in the osteotomy gap. Lateral cortical fracture is a severe complication that can occur during the surgery, decreasing axial resistance (47%) and rotational resistance (54%) of the osteotomy [24].

Table 1 Patient's data and results

Age (years)	Sex	Pathology	Wedge size	Union time/weeks	Follow-up/ms	Complications	Results
36	Male	Medial OA compartment	14	14	6	–	Excellent
41	Female	Malunited medial tibial plateau	10	13	9	–	Excellent
52	Male	Medial OA compartment	12	20	11	Delay union	Good
28	Female	Malunited medial tibial plateau	8	15	14	–	Excellent
33	Male	Medial OA compartment	12	12	12	–	Excellent
45	Female	Malunited medial tibial plateau	10	18	10	Delay union	Good
50	Female	Medial OA compartment	8	14	15	–	Excellent
38	Male	Medial OA compartment	14	16	12	–	Excellent
39	Female	Medial OA compartment	12	20	14	Delay union	Good
42	Male	Malunited medial tibial plateau	10	10	13	–	Excellent
49	Female	Malunited medial tibial plateau	12	24	12	Loss of fixation	Failure
47	Male	Medial OA compartment	14	8	8	–	Excellent
35	Male	Malunited medial tibial plateau	8	12	9	–	Excellent
29	Female	Medial OA compartment	14	18	11	Delay union	Good
31	Male	Medial OA compartment	12	16	14	–	Excellent
38	Male	Medial OA compartment	8	10	12	–	Excellent
39.6	–	–	–	15	11.4	–	–

OA, osteoarthritis.

Table 2 Osteotomy opening size and number of patients

8 mm	4
10 mm	3
12 mm	5
14 mm	4
Total	16

It occurs when the lateral tibial cortex is perforated or cut by the chisel. This complication occurs when opening the osteotomy wedge with the anterior and posterior cortex intact, which is detected by subluxation of the osteotomy. If it occurs, it is necessary to add a lateral fixation (screw or hook) at the apex of the opening wedge, to increase the stability of the osteotomy [25].

Follow-up

Patients were kept nonweight bearing with mobilization in bed till removal of stitches to decrease the postoperative oedema and enhance good soft tissue healing. Low-molecular-weight heparin was given in high-risk patients as prophylaxis against deep venous thrombosis. Partial weight bearing with crutches was allowed. Isometric quadriceps and active ankle exercises were begun immediately after surgery. Active exercises, patellar mobilization, and straight-leg raises were started on the first postoperative day. Partial weight-bearing was allowed at 6 weeks, and full weight-bearing at eight to 12 weeks postoperatively. Patients were reviewed monthly for clinical and radiologic assessments till union and then at 6 months. Repeated radiographs were assessd for bone union as mature trabecular continuity observed in both the anteroposterior and the lateral radiographs. Clinical assessment was performed using Lysholm score and recorded results at 6 months and at the last follow-up (Fig. 1).

Statistical analysis

The following statistical methods were used for analysis of results of the present study. Data were checked, entered, and analyzed using SPSS, version 19 (SPSS Inc., Chicago, Illinois, USA) in Windows 7 for data processing and statistic.

The statistical analysis is illustrated in Fig. 2 and Tables 3–9.

Results

Radiological results

Sixteen patients underwent open wedge medial HTO in this study which united in all patients. Four patients had a delay in union, which resolved by 6–8 months, postoperatively. A loss of fixation occurred in one patient owing to early full weight bearing postoperatively and needed revision, which was considered as failure. There was significant difference between the healing time and the size of the osteotomy opening. There were no infections, loss of knee motion, and nerve or arterial injuries. Full weight bearing was achieved at a mean of 9 weeks (range: 5–12 weeks), postoperatively. Seven (43.8%) knees had osteotomy openings of 10 mm or less, and nine (56.25%) knees had more than 10 mm osteotomy openings. The osteotomy united in all patients at the end of follow-up. Average time to union was 15 weeks (range: 8–24 weeks). By the end of the third month (12 weeks), 62.5% of osteotomies have healed.

Clinical results

Patients were evaluated with Lysholm score at 6, 12, and 24 months postoperatively, and the mean preoperative and postoperative Lysholm scores were 54.1 (range: 30–60) and 82 (range: 67–95), respectively. Postoperative radiological follow-up after 6 weeks, 6 months, and 12 months with good quality radiograph. The mean preoperative femorotibial angle was 3.5° in varus malalignment (range: 3° valgus to 9° varus). It was 7.3° valgus, postoperatively. The mean correction of the mechanical axis was 10.7°, with loss of correction during the follow-up period in one patient and needed revision. Four (25%) cases had delayed union. The lateral cortex was not broken in any patient. All patients were satisfied with the treatment except one patient who needed revision.

Discussion

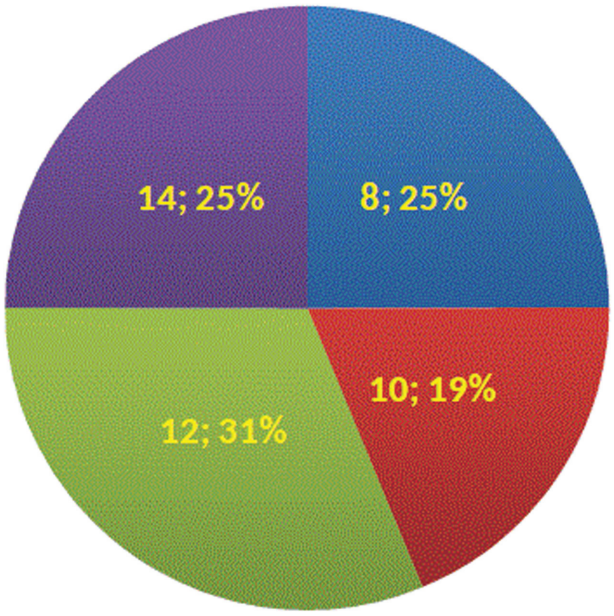
Opening wedge HTO has become popular in recent years because it enables a medial approach, which minimizes the risks of neurovascular lesion and the need for dissection of the soft tissues. It enables the wedge to be opened and closed during the procedure, giving a better end result. Another advantage of this technique is that it enables earlier mobility and immediate weight-bearing, depending on the implant used [26]. Open wedge osteotomy of the medial metaphyseal tibia does not compromise limb length. It enables correction of medial ligamentous laxity and operation on the diseased compartment enabling correction of up to 15° of deformity, but it is less stable than closed wedge osteotomy. Thus, fragment fixation is of critical importance. The procedure is indicated for limbs with a good healthy vascular status, excellent triceps strength, osteoarthritis limited to a single medial compartment, and pain/disability affecting the quality of life. An unstable knee (lateral tibial subluxation of >1 cm) with a

Figure 1

(a) Standing full-length lower limb radiograph. (b) Short film nonweight bearing radiographic knee. (c) Postoperative radiograph with opening wedge osteotomy without graft. (d–f) Follow-up with progress healing.

narrow medial joint space and/or bone loss (2–3 mm), knee flexion contracture (>15°), limited knee flexion (<90°), major knee deformities (>15°) and associated inflammatory arthropathies are contraindications for open wedge osteotomy. Excellent and good results were achieved in 67.5% of patients. Thirty-seven (86.0%) patients reported clinical improvement at 24 months compared with preoperative status. Evaluation of the clinical course following HTO revealed a significant increase in function after 12 and 24, but not at 6 months after surgery. A further increase was found between 12 and 24 months; 67.5% of the study population returned to their predisease sports activity level at 24 months after surgery. Except for one case of intra-articular fracture, no severe intraoperative complications were found. One case of nonunion that demanded additional surgery was observed [27]. In this study, excellent\good results were seen in 93.7%, failure in one (6.3%) patient, and union was delayed in four (25%) patients at the end of follow-up period. The Puddu *et al*. [28] plate was developed as a simple fixation device for the opening-wedge osteotomy and uses two screws proximally and two screws distally. Amendola *et al*. [29] reported on their first 74 consecutive patients over a 2-year period. Their results indicate a 90% satisfaction compared with the 93.8% satisfaction rate in this study. All osteotomies in this series were held by the toothed angled plate plate, with two holes above and below the osteotomy. Intra-articular fracture as an extension of the osteotomy associated with a high osteotomy and too thick an osteotome, and this complication was avoided in comparison with this study by using thin osteotome large-sized proximal fragment. Four failures of fixation

Figure 2



Different wedge sizes in studied group.

Table 3 Association between mean ages and wedge size

Wedge size	Age (*N*=16) (mean±SD)	*F*	*P* value
8	37.8±9.2	0.343	0.795
10	42.7±2.1	–	–
12	40.8±9.4	–	–
14	37.5±7.4	–	–

Table 4 Association between sex and wedge size

Wedge size	Sex [*n* (%)]		Total (*N*=16)	χ^2	*P* value
	Male (*n*=9)	Female (*n*=7)			
8	2 (22.2)	2 (28.6)	4 (25.0)	1.3	0.728
10	1 (11.1)	2 (28.6)	3 (18.8)	–	–
12	3 (33.3)	2 (28.6)	5 (31.3)	–	–
14	3 (33.3)	1 (14.3)	4 (25.0)	–	–

Table 5 Association between pathology and wedge size

Wedge size	Pathology [*n* (%)]		χ^2	*P* value
	Medial OA compartment (*n*=10)	Malunited medial tibial plateau (*n*=6)		
8	2 (20.0)	2 (33.3)	8.32	0.039
10	0 (0.0)	3 (50.0)	–	–
12	4 (40.0)	1 (16.7)	–	–
14	4 (40.0)	0 (0.0)	–	–

were reported compared with one case occurred in this study owing to early weight bearing and loss of fixation and need revision. These failures were attributed to early, aggressive weight bearing. The average decrease in the Blackburne–Peel ratio of patella height was 0.17,

Table 6 Association between mean union time/weeks and wedge size

Wedge size	Union time/weeks (*n*=16) (mean±SD)	*F*	*P* value
8	12.8±2.2	1.873	0.188
10	13.7±4	–	–
12	18.4±4.6	–	–
14	14±4.3	–	–

Table 7 Association between mean follow-up/ms and wedge size

Wedge size	Follow-up/ms (*n*=16) (mean±SD)	*F*	*P* value
8	12.5±2.6	2.156	0.146
10	10.7±2.1	–	–
12	12.6±1.3	–	–
14	9.3±2.8	–	–

Table 8 Association between complication and wedge size

Wedge size	Complication [*n* (%)]		χ^2	*P* value
	Delay union (*n*=4)	Loss of fixation (*n*=1)		
8	0 (0.0)	0 (0.0)	0.83	0.659
10	1 (25.0)	0 (0.0)	–	–
12	2 (50.0)	1 (100.0)	–	–
14	1 (25.0)	0 (0.0)	–	–

Table 9 Association between results and wedge size

Wedge size	Results [*n* (%)]			χ^2	*P* value
	Failure (*n*=1)	Good (*n*=4)	Excellent (*n*=11)		
8	0 (0.0)	0 (0.0)	4 (36.4)	12.0	0.002
10	0 (0.0)	1 (25.0)	2 (18.2)	3.0	0.223
12	1 (100.0)	2 (50.0)	2 (18.2)	0.6	0.741
14	0 (0.0)	1 (25.0)	3 (27.3)	5.25	0.072

with two patients developing patella infera, but no correlation with the functional result was found. In this study, four (25%) cases had delayed union, which was treated by prolonged immobilization, whereas one case needed revision after loss of fixation and was considered as failure, and no cases of fracture, nonunion, or peroneal nerve palsy were observed. Patella baja is a recognized complication of opening-wedge osteotomy [30], associated with immobilization following osteotomy. The complication is reduced if early mobilization is allowed, preventing tethering of the patella. Opening wedge HTO can be performed without grafting, and early weight-bearing can occur without an elevated risk of nonunion or loss of secondary correction. Functional results showed that 92% of the patients were satisfied or very satisfied with the procedure. High level of good results were expected

in the first 5 years after a medial high tibial opening wedge osteotomy [31–36].

Conclusion

A medial opening wedge HTO without grafting can be stabilized with a locking plate and can be used to treat medial tibiofemoral knee osteoarthritis in an active individual with genu varum. The reliability of the plate allows for a simpler postoperative recovery with early weight-bearing and primary union, which gets away from the risks related to filling the osteotomy site with bone or an inert substitute. The instrumentation to control the angle of correction must be used carefully to attain the desired angular correction. Conversely, spontaneous and total filling of the osteotomy site is usually achieved with this technique. Despite the routine addition of bone graft as a part of the HTO procedure, this study supports medial opening-wedge HTO without bone graft or bone substitutes, which shortens the operative time and avoids unnecessary donor site morbidity.

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Conflicts of interest

There are no conflicts of interest.

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