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ORIGINAL ARTICLE

Open-wedge High Tibial Osteotomy for Treatment of Varus Knee in Adults Combined With Arthroscopic Evaluation

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Abstract

Background: **Varus knee in adults is fairly common and considered the most predisposing factor for early medial compartment osteoarthritis of the knee joint.**

Patients and methods: **Fifteen patients underwent a medial open-wedge high tibial osteotomy combined with arthroscopic evaluation for medial compartment osteoarthritis or intra-articular pathology lesions. Measurements included the mechanical axis of the lower limb, hip−knee−ankle angle, posterior tibial slope angle, and medial proximal tibial angle. Clinical evaluation was applied with the Lysholm knee scoring scale and Knee Injury and Osteoarthritis Outcome Score.**

Results: **There were remarkable differences between the mean of preoperative and postoperative measurements at all angles, including the preoperative mean varus angle of 10.5° (range, 7°−14°), the postoperative mean correction angle 13° (range, 10°−17°), the preoperative mean posterior tibial slope 8.5° (range, 7°−10°), and the postoperative mean posterior tibial slope 8.8° (range, 7°−10°). A pathologic intra-articular lesion was detected in 13 of 15 patients during arthroscopic evaluation. Lysholm knee scoring scale was 68.8 preoperative and 93.7 postoperative. Each subscale of Knee Injury and Osteoarthritis Outcome Score was calculated independently, resulting in an improvement of 30−40%.**

Conclusion: **For patients with varus knee, medial unicompartmental knee osteoarthritis, intra-articular lesion, medial open-wedge high tibial osteotomy combined with arthroscopic evaluation is an excellent treatment option.**

Keywords: Arthroscopic evaluation, High tibial osteotomy, Knee osteoarthritis, Varus knee

1. Introduction

Genu varus deformity is common and leads to atypical stress distribution on the knee joint. Degenerative osteoarthritis changes in the medial tibiofemoral joint are accelerated by stress concentration.[1] Shifting of the medial and lateral load distribution on the tibia occurs during the walking gait. The medial tibial plateau bears ~75% of the joint stress in a single leg stance.[2] This asymmetry is increased by varus alignment, with a 1° varus deviation from neutral alignment and a 5% increase in load distribution to the medial compartment.[3] Since its description by Jackson and Waugh,[4] proximal high tibial osteotomy (HTO) has been utilized to correct varus deformity and degenerative arthritis in the knee joint. The purpose of medial open-wedge high tibial osteotomy (MOWHTO) is to shif the weight-bearing line from the arthritic medial compartment to the healthy lateral compartment of the knee joint.[5] There are many choices for the treatment of degenerative osteoarthritis caused by varus knee deformity, which includes conservative treatments, including physical therapy and medications, and surgical treatments, including proximal tibial osteotomy, and knee joint replacement arthroplasty, proximal tibial osteotomy remains an excellent option for treatment of young and active patients that can slow degeneration progression, relieve pain, and correct lower limb deformity.[6] This work aimed to evaluate the functional and radiological outcome of a MOWHTO for the treatment of

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Table 1. Preoperative and postoperative angles for each patient in the study.

Patient: no.	Age (years)	Preoperative		Postoperative		
		Varus angle	Posterior tibial slope angle	Correction angle	Posterior tibial slope angle	Valgus mechanical axis
1	42	14°	10°	17°	10°	3°
2	40Y	8.5°	8°	11°	9°	2.5°
3	36	10°	10°	13°	10°	3°
4	19	8°	7°	10°	7°	2°
5	37	11°	9°	14°	10°	3°
6	21	12°	10°	14°	10°	2°
7	37	7°	9°	10°	9°	3°
8	50	13°	9°	16°	10°	3°
9	30	13°	8°	16°	8°	3°
10	49	14°	8°	16°	9°	2°
11	24	8°	7°	11°	7°	3°
12	50	9°	9°	12°	9°	3°
13	39	8°	8°	10°	8°	2°
14	38	13°	7°	15°	8°	3°
15	47	9°	8°	12°	8°	3°
Mean	37.3	10.5°	8.5°	13°	8.8°	2°

varus knee in adults combined with arthroscopic evaluation and to clarify and identify its benefits and drawbacks.

2. Patients and methods

The study protocol was receive ethical approval from the Research Ethics Committee, Faculty of Medicine, Al Azhar University, Cairo.

Fifteen patients underwent MOWHTO for treatment of varus knee deformity and were evaluated by arthroscopy for intra-articular pathological lesions. The 15 patients comprised seven females and eight males, with a mean age of 37 years old at the time of the operation. Inclusion criteria: age of male and female between 18 and 50 years old, varus angle more than 5°, medial proximal tibial angle less than 84°, mechanical axis deviation more than 15 mm medial to tibial plateau, medial unicompartmental osteoarthritis and bones of sufficient quality to resist collapse. Exclusion criteria: BMI more than 30, varus angle more than 15°, flexion contracture knee more than 15°, history of knee surgery, neurovascular injury, severe varicose veins, general laxity, lateral compartment or patellofemoral osteoarthritis and any physical disability interfere with rehabilitation. Preoperative preparation: patients were prepared before surgery with routine laboratory

Figure 1. Preoperative picture of the patient.

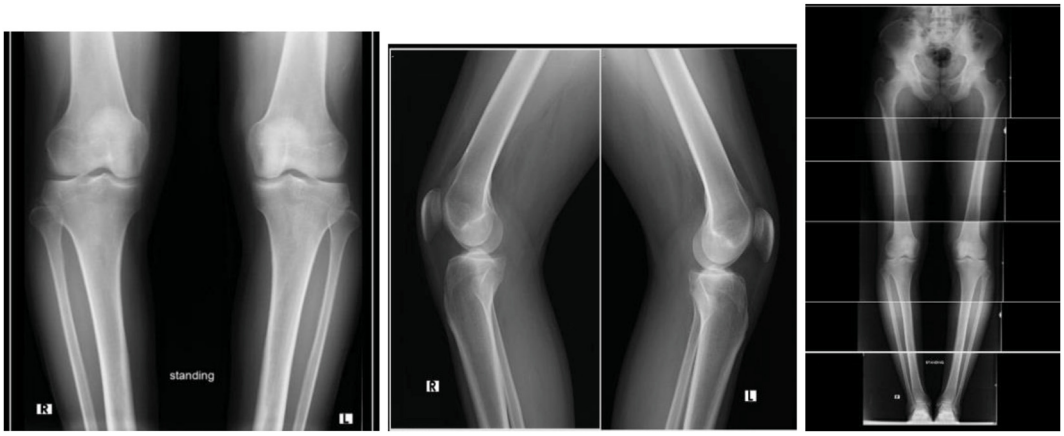

Figure 2. Plain radiography of the patient preoperative.

investigations, including liver function test, complete blood count, international normalized ratio, glycated hemoglobin for diabetic patients, and kidney function test. The radiological investigation included standing lateral and anterior–posterior views of plain radiography of the knee joint, MRI, and scanogram of both lower limbs. All patients were subjected to knee examination by inspection for skin condition, bone position and gait, and palpation of the joint line for knee joint tenderness. Full range of motion, anterior and posterior drawer tests, valgus and varus stress tests, and Lachman's and McMurray's test were applied to all patients before knee arthroscopy. The degree of knee osteoarthritis is evaluated by the narrowing space of the knee joint, the presence of subchondral sclerosis, and osteophytes. The mechanical axis of the lower limb, hip–knee–ankle angle, medial proximal tibial angle, and posterior tibial slope angle were measured. The varus angle and correction angle were determined before osteotomy. Knee Injury and Osteoarthritis Outcome Score (KOOS) and Lysholm knee score were applied. Surgical technique: patient position: in a supine position, a tourniquet was applied around the thigh, and the affected knee was flexed at 90°, using lateral support for the thigh

Figure 3. Arthroscopic evaluation.

Figure 4. Propping of (anterior cruciate ligament) and PHMM.

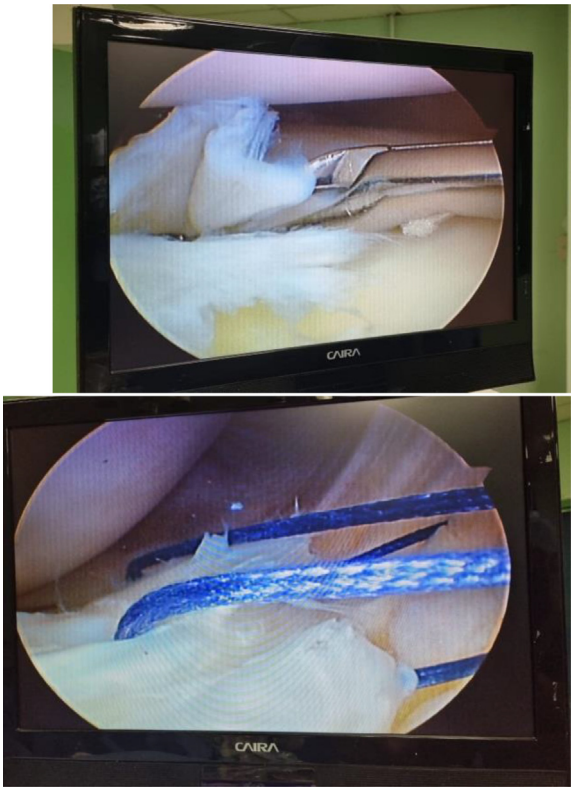

Figure 5. Repair of tear at AHMM by suture.

during arthroscopy. Once an arthroscopic knee evaluation was performed, the ipsilateral knee was extended, and the contralateral limb was extended at the hip joint using the surgical table to provide a good view of the proximal tibia medially during osteotomy. Arthroscopic evaluation: knee arthroscopy was carried out before high tibial osteotomy to evaluate tibiofemoral and patellofemoral joints and to treat intra-articular lesions such as meniscus debridement, microfracture for femoral condyle ulcer, partial meniscectomy and repair meniscal tear. Incision and exposure: the skin incision about 5–7 cm distal to the knee joint line medially to tibial tuberosity at the line of medial border of the patella, deep fascia, pes anserinus, and superficial medial collateral ligament was identified and exposed at the osteotomy level. Two Hohmann retractors were applied under the patellar tendon anterior and superficial medial collateral ligament posterior while the knee joint was flexed. Osteotomy: in a fully extended knee, 1–2 cm below and parallel to the joint line, a single K-wire from the medial cortex into the lateral cortex was inserted to maintain the lateral tibial plateau intact, then two K-wires were inserted medially toward the proximal tibiofibular joint at the corrected angle. The osteotomy gap was performed using an oscillating bone saw and sharp osteotomes started medially with K-wires guidance to cut anterior, posterior, and medial cortices by the saw. The sharp osteotome was used to complete the cut of the posterior cortex. The lateral cortex was preserved by 1 cm of intact bone. The knee joint was supported, and the distal part of the tibia was pushed laterally, opening the wedge. Under the control of fluoroscopy, the medial open wedge had to be more posteromedial than anterior to maintain the posterior tibial slope angle and achieve mechanical axis valgus by ~1–3° to avoid under correction. Plate fixation: after complete osteotomy and wedge opened medially, the guide K-wires was removed. According to the preoperative planning, the Fujisawa point was used as a reference to correct the varus angle deformity, and then the suitably sized plate was used to fill the osteotomy gap. The plate was placed medially, not antero-medial or postero-medial, to avoid altering the posterior tibial slope angle. Under fluoroscopy control and using a cautery cord, the mechanical axis was corrected and passed through the center of the knee joint. The

Figure 6. Operative steps (incision-osteotomy-plate fixation-corrected mechanical axis).

medial open wedge was fixed by a four-hole puddu plate, the proximal two holes were fixed by 6.5 mm cancellous screws and the distal two holes were fixed by 4.5 mm cortical screws. Finally, skin and subcutaneous tissue were repaired layer by layer, and a hinged knee brace was applied to the knee joint. Postoperative care: isotonic exercise flexor and extensor muscle training were initiated directly

postoperative to promote early joint motion. For the first 6 weeks, patients only walked on crutches with continuous passive motion exercises and strength training under physiotherapist supervision. Postoperative radiological assessment by plain radiography was scheduled at 4, 8, and 12 weeks, and full weight bearing was initiated after complete bone healing. Patients were assessed using a functional scoring system KOOS and Lysholm score, and the functional outcome was compared with the other healthy side (Table 1).

3. Results

Demographic characteristics: the age of the patients, both women and men, ranges from 18 to 50 years, with a mean of 37. Ten (66%) patients were less than 40 years old, 55% were men and 45% were women. The varus deformity was eight (55%) patients at the right knee and seven (45%) patients at left knee. Postoperative characteristics: during the arthroscopic evaluation, seven patients with medial femoral condyle ulcers were identified and treated arthroscopically by debridement and microfracture of the osteochondral lesion. Six patients with a medial meniscus tear were identified by arthroscopic evaluation and treated by arthroscopic partial meniscectomy to posterior horn medial meniscus for five cases, and anterior horn medial meniscus tear was repaired by sutures for one case. The preoperative mean varus angle 10.5° (range, 7°–14°), the postoperative mean correction angle 13° (range, 10°–17°), the preoperative mean posterior tibial slope 8.5° (range, 7°–10°), the postoperative mean posterior tibial slope 8.8° (range, 7°–10°), and postoperative mean of valgus mechanical axis over correction 2° (range, 2°–3°). Lysholm knee scoring scale was 68.8 preoperative and 93.7 postoperative. Each subscale of KOOS was calculated independently, resulting in an improvement of 30–40%. All patients were observed and ensured to regain a full range of movement after rehabilitation with a mean 3 months of follow-up postoperative. Complications: a superficial wound infection was detected in two patients and treated with appropriate antibiotics. The proximal lateral tibial cortex was fractured extra-articularly during osteotomy in one patient and fixed with a transverse cancellous screw and above knee splint applied for 6 weeks (Figs. 1-10).

4. Discussion

The uneven distribution of load-bearing forces in the knee joint occurs due to varus knee deformity, degenerative osteoarthritis are accelerated by the

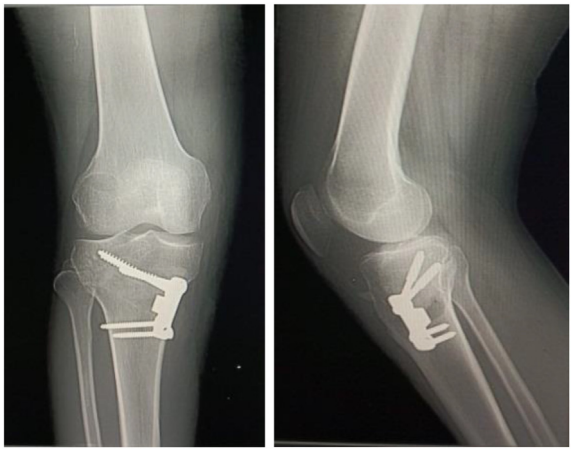

Figure 7. Plain radiography right knee (anteroposterior, lateral) 4 weeks postoperative.

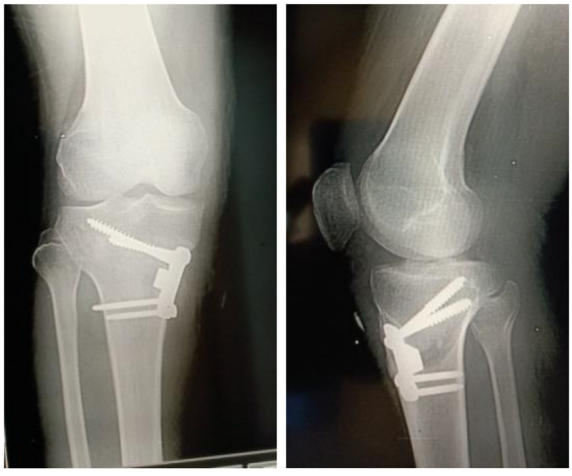

Figure 8. Plain radiography right knee (anteroposterior, lateral) 8 weeks postoperative.

stress's forces. Varus knee deformity is the most common cause of developing osteoarthritis in the medial tibiofemoral joint. The possible explanation between varus malalignment and knee osteoarthritis

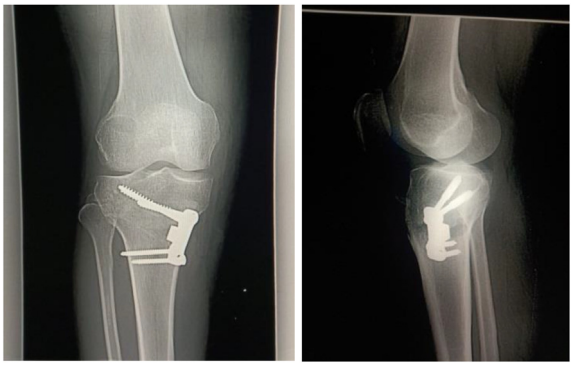

Figure 9. Plain radiography right knee (anteroposterior, lateral) 12 weeks postoperative.

Figure 10. Postoperative picture right knee of the patient after 3 months postoperative.

is a dynamic component associated with lateral laxity and bone deformity.[7] MOWHTO is a good technique for relieving pain and improving activity of daily living for an isolated medial tibiofemoral joint osteoarthritis and delayed total knee replacement arthroplasty option for adults with varus knee deformity.[8] Furthermore, additional arthroscopic evaluation of high tibial osteotomy allowed treatment of intra-articular pathological lesions, prevention of osteoarthritis progression, and acceleration of the rehabilitation period. After follow-up for 46 patients with HTO and 43 patients with unicompartmental knee arthroplasty by Spahn *et al.,*[9] clinical and radiological results and complications showed no difference between the two surgeries over time, so high tibial osteotomy was the best choice for treatment of young and active patients.[9] According to a retrospective study of 533 patients by Floerkemeier *et al.,*[10] the clinical prognosis for elderly patients with severe intra-articular surface damage was improved by proximal MOWHTO compared with unicompartmental knee arthroplasty.[10] The results of arthroscopy combined with proximal tibial osteotomy have been the subject of numerous research efforts. By combining arthroscopic curettage and microfracture with a proximal tibial osteotomy, the radiological and clinical outcomes were outstanding, with 94.9% of patients reporting satisfaction.[11] Proximal HTO combined with arthroscopic evaluation have been criticized by some authors. Retrospectively, 30 patients of proximal HTO combined with arthroscopic subchondral drilling were compared with 31 patients of only HTO by Jung et al.[12] At 2 years of follow-up, there were no significant variations in clinical results or degree of fibrous cartilage regeneration between the two groups. They concluded that arthroscopic subchondral drilling did not produce desirable results.[12] According to a literature study by Harris *et al.,*[13] the survival rate after high tibial osteotomy combined with arthroscopic evaluation for 5 years was 97.7%, while it was just 92.4% after high tibial osteotomy alone. When comparing survival rates, a combined arthroscopic evaluation with proximal HTO operation is preferable to a conventional HTO alone.[13] In the last 20 years, MOWHTO has grown in popularity due to the integrity of the common peroneal nerve, proximal tibiofibular joint and lateral ligaments are not disrupted during the operation.[14] To obtain successful results of MOWHTO must surgical skilles be used and appropriate patients must also be selected. The success rate of MOWHTO combined with arthroscopic evaluation for the treatment of varus knee in adults, including medial unicompartmental osteoarthritis, active young patients less than 50 years, varus knee requiring correction less than 15°, BMI less than 30, stable knees and intact neurovascular status, with pain and disability interfering with daily activities. Arthroscopic evaluation followed by MOWHTO reduces microfractures of the subchondral bone due to weight bearing, decrease the

intraosseous venous hypertension and alleviates clinical symptoms like pain, and improves patients functional status. In theory, the opening wedge of HTO is preferable to the closing wedge because it can restore anatomy, ability to correct varus deformity in multiple planes, it requires only a single bone cut, integrity of the common peroneal nerve, proximal tibiofibular joint and lateral ligaments are not disrupted, and it is easy to combine with other procedures as anterior cruciate ligament reconstruction. Disadvantages of the MOWHTO include the long time to start weight-bearing postoperative, risk of nonunion, osteotomy gap defect requiring bone graft, and patients with medial compartment osteoarthritis often have anterior cruciate ligament or posterolateral corner laxity.[15] The reported complication rates for the MOWHTO vary from 2.1 to 5.1%. Most complications include overcorrection, undercorrection, delayed union, injury of the posterior neurovascular bundle during osteotomy, lateral hinge fractures, infection, and deep venous thromboembolism. The success of MOWHTO with arthroscopic evaluation relies on its correct implementation. Close attention to the following details can increase successful results: determining an accurate osteotomy location and size with preoperative planning, taking great care to avoid lateral hinge fractures while opening the bone wedge, checking the angle of correction during surgery, selecting a Puddu plate size that fits well with the osteotomy gap and avoid over or under correction. In the short term, this technique reduces discomfort and improves the activity of daily living, but in the long term, the success of MOWHTO combined with arthroscopic evaluation lies in shifting the weight-bearing line from an arthritic medial compartment to a healthy lateral compartment in the knee joint, the final results from this research need to be corroborated by other researches with long-term follow-up.

4.1. Conclusion

The final results demonstrate that MOWHTO combined with arthroscopic evaluation was characterized by safety, simplicity, and cost-effectiveness for pain relief and lower limb realignment and prevents the progression of osteoarthritis.

The best option for the treatment of varus knee deformity in adults is MOWHTO combined with arthroscopic evaluation to prevent degenerative osteoarthritis of the medial compartment of the knee joint and to treat intra-articular pathological lesions.

Conflicts of interest

None declared.

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