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RESULTS OF OPEN WEDGE HIGH TIBIAL OSTEOTOMY USING PLATE OSTEOSYNTHESIS (TOMOFIX) WITHOUT GRAFTING

PRADEEP KAMBOJ[1a], SURESH KAUSHIK[b], ZILE SINGH KUNDU[c], RAJ SINGH[d], ROOP SINGH[e], MILIND TANWAR[f], SAURABH CHANDRAKAR[g] AND SIDHARTH YADAV[h]

[abcdefgh]Department of Orthopaedics Paraplegia and Rehabilitation, Pt. B. D. Sharma PGIMS, Rohtak, Haryana, India

ABSTRACT

Primary osteoarthritis (OA) most commonly involves medial compartment of the knee. High tibial osteotomy (HTO) is a widely performed procedure to treat medial knee arthrosis. The aim of our study was to assess the early results of medial open wedge osteotomy in medial uni-compartment OA fixed with locking plate. Between June 2013 and August 2015, twenty patients, 6 males and 14 females with mean age of 50.3±10.99 years, suffering from medial unicompartmental osteoarthritis of knee joint were operated for medial open wedge high tibial osteotomy. All the patients were analysed for preoperative and postoperative grade of OA (Kellgren Lawrence grading), mean body mass index, visual analogue score, Knee injury and osteoarthritis outcome score (KOOS) and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) score. Mean VAS decreased significantly postoperatively to 1.4±0.50 from 7.2±1.0 (p <0.001). Mean walking distance increased significantly to 1174±161.81 from 590±91.19 meters preoperatively (p <0.001). In the present study WOMAC (pain) score was 3.11±0.43 preoperatively while postoperatively it was 0.77±0.29 (p<0.001). WOMAC (stiffness) score preoperatively was 3.27±0.30 while at final follow up it was 0.95±0.39 (p<0.001). WOMAC score (global function) was 2.92±0.44 preoperatively and at final follow up it was 0.69±0.14 (p<0.001). WOMAC score (total, average and index) was 75.94±9.46 preoperatively and 18.60±3.38 postoperatively (p<0.001). KOOS score regarding pain; ADL, SR, quality of life and total was 114±7.55 preoperatively and 37.6±8.14 postoperatively with significant difference (p <0.001). KOOS index was 157±19.78 preoperatively and 370.43±30.26 postoperatively with significant difference (p <0.001). All the patients were evaluated at the end of study regarding their experience and they were further graded according to their satisfaction. A total of 12(60%) reported the procedure as excellent; 6(30%) much better and 2 (10%) little better. The average postoperative tibio-femoral angle was 4 degree valgus. Complications observed were leg swelling in 7; infection in 2 and LPN in 1. Medial opening HTO fixed with a locking plate is a physiologically better surgery in medial compartment primary OA of knee in early stages. The procedure is a very good alternative to unicompartmental / total knee arthroplasty in our scenario where patient is reluctant to change their squatting habits and job profile. Early results are very gratifying.

KEYWORDS : Osteoarthritis, Open wedge, Osteotomy, Locking plate, Arthroplasty

Treatment for OA of the knee aims to relieve pain and improve mobility. Most treatments do not alter the natural history or progression of OA, and thus are not curative. Initial management includes non-pharmacologic therapies in the form of education, exercise, braces, shoe raises and weight reduction (Bartels et al., 2007, Christensen et al., 2005). Pharmacologic agents recommended for the initial management of knee OA include acetaminophen, oral and topical NSAIDs, tramadol, glucosamine and chondroitin sulfate, intra-articular corticosteroid injections, intra-articular hyaluronate injections and intra-articular injections of platelet rich plasma (PRP). Varus deformity associated with arthritic knee warrants operative intervention (Gamble et al., 2000, Clegg et al., 2006, Kon et al., 2011).

High Tibial Osteotomy(HTO) for osteoarthritis of the knee gained acceptance in the 1960s and is now well established modality (Amendola and Bonasia, 2010). Many techniques have been developed i.e. closing wedge, opening wedge, dome and "en chevron" osteotomies, but opening (medial) and closing (lateral) wedge osteotomies are the most commonly used. Medial open wedge HTO is a simple procedure and requires less dissection, fibular osteotomy is not required, so less neurovascular complications. No bone resection of the lateral tibia is done hence, the normal anatomical tibial bone shape is maintained post HTO, which allows for easy conversion to knee replacement later on. There is no shortening of the limb. These features made it the osteotomy of choice for correcting varus defomity in unicompartmental OA knee (Ivarsson et al., 1990, Lee and Byun, 2013).

HTO helps in many ways 1) it reduces knee pain by shifting the weight bearing axis to the relatively unaffected lateral compartment in varus knee thus redistributing the load; 2) slows / stops destruction of medial joint compartment and delays the need for knee replacement. Thus, aim of our study was first to evaluate the early results of medial open wedge HTO and then to evaluate union at the osteotomy site and strength of the construct in view of weight bearing.

[1]**Corresponding author**

MATERIALS AND METHODS

Subjects

A total of 20 patients were operated between June 2013 to November 2015. All but two cases were operated by senior surgeon (PK). All patients were followed for at least six months post operatively. There were 6 males and 14 females with mean age at the time of surgery being 50.3 years (range: 30-66 years). All patients were operated on single knee. Consent was taken from all the patients and only cases of Primary Osteoarthritis were included. The mean body mass index (BMI) was 27.09. 11 patients (55%) had grade III and 9 patients (45%) grade II severity according to Kellgren Lawrence grading system.

Radiographic Measurements

Bilateral weight bearing antero-posterior and lateral view of knee along with scanogram of both the lower limbs was performed pre and post operatively to assess the angle of deformity, patellar height and tibial slope. The angle of deformity was calculated from the full-length scanograms as shown in Figure 1A. The weight-bearing axis was calculated to pass through the lateral tibial plateau at about 60-62% of the width of the plateau (Figure 1B).

Figure 1A: X-ray Antero-posterior View Including Hip, Knee and Ankle Joint (Scanogram) Showing Varus Angle Between the Mechanical Axis of Femur and Tibia of 12°. The Weight-Bearing Axis is Passing Medial to the Joint

Figure 1B: After Correction The Weight Bearing Axis is Passing Through the Lateral Tibial Condyle at About 62% of Width of the Tibial Plateau With Mechanical Alignment of 2.5°Valgus

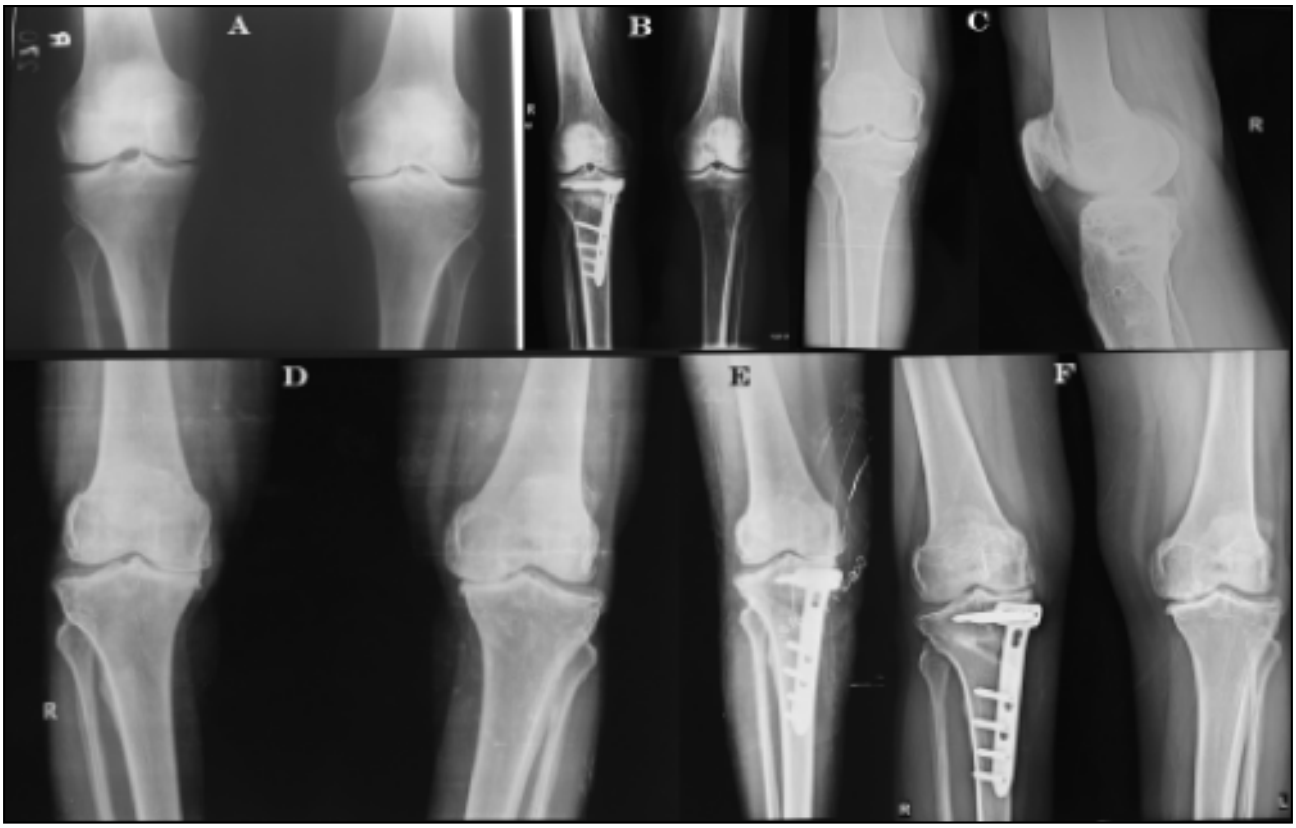

Figure 2A : Full weight bearing preoperative X-ray of a 66 year old male;
Figure 2B : X-ray at 7 months showing consolidation of the osteotomy site;
Figure 2C : X-ray after removal of the plate at 1 year.
Figure 2D : Standing preoperative X-ray of a 42 year old female;
Figure 2E : Immediate post-operative X-ray;
Figure 2F : Full weight bearing X-ray at 8 months showing consolidation of osteotomy site.

Serial radiographs were taken postoperatively at 1,3 and 6 months to assess the bony union and correction of the varus deformity (Figure 2)

Operating Technique

The patient was placed in supine position on a radiolucent operating table and a tourniquet was applied. A 5-cm vertical incision was made over the center between the medial aspect of the tibial tuberosity and the posteromedial aspect of tibia below the joint line. The pes anserinus was detached from the tibia to expose the superficial medial collateral ligament. The distal portion of exposed ligament was separated from bone and a blunt retractor was inserted posterior to the medial collateral ligament and the tibia to protect the neurovascular structures posterior to incision line. After identifying medial border of the patellar tendon sub periosteal dissection was performed from the tibial tuberosity to posteromedial aspect of the tibia. Two guide wires were inserted at a point 3.5-4 cm below medial joint line and passed obliquely 1 cm below the lateral articular margin of tibia towards the tip of fibular head. After checking the appropriate location with fluoroscope, a tibial osteotomy was performed immediately below the guide wires using an oscillating saw or an osteotome. It was ensured that the osteotomy line extended from tibial tuberosity along posteromedial aspect of the tibia to 1 cm medial to lateral tibial cortex and was in parallel with the posterior tibial slope on the sagittal plane. The mobility of the osteotomy site was checked and the osteotomy was opened with a valgus force. If the opening of the osteotomy seemed insufficient, we used 2 or 3 stacked osteotomes to reduce the risk of intra articular fractures. Subsequently, a calibrated wedge was inserted until the osteotomy opened to

Figure 3: X-ray After Removal of the Plate for Infection

the desired extent. Once the desired degree of correction was achieved, internal fixation of a metal plate was performed. Wound was closed in layers. Negative suction drain was used as and when required.

Postoperative Rehabilitation

Once the effect of anesthesia weans off isometric quadriceps, active ankle exercises and toe movements were started. Ice fomentation and elevation was also advised to decrease postoperative edema. From postoperative day 1 range of motion exercises of knee, patellar mobilization and straight keg raises were initiated. Drain if used was removed after 48 hours. Toe touchdown walking with the help of walker in a protective knee brace was allowed from second postoperative day. Stitches were removed after 12-14 days. Full range of motion was achieved gradually up to fourth postoperative week. Partial weight bearing in protective knee brace was allowed after one week, which increased progressively to full weight bearing over 6-12 weeks. Activities like cycling, brisk walking, driving and riding were allowed after confirming complete consolidation of osteotomy at around 4 months.

Complications were noted and managed accordingly.

The results were assessed by visual analogue scale (VAS) (McCarrel and Fortier, 2009), Knee injury and osteoarthritis outcome score (KOOS) (Gobbi et al., 2012) and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) score.

RESULTS

Varus Deviation

The mean preoperative varus deviation was 10.6±1.04 degrees. The maximum number of patients (55%) had varus deviation of more than 10 degrees. The postoperative mean valgus angle was 3.95±0.88 degrees.

Pain

All patients were assessed regarding pain by using Visual Analogue Scale (VAS). The mean VAS preoperatively was 7.2±1.0, which decreased significantly to 1.4 ±0.50 postoperatively ($p < 0.001$).

Walking Distance

The mean walking distance preoperatively was 590±91.19 meters, which increased significantly to 1174±161.81 postoperatively ($p<0.001$).

WOMAC Score

Table 1,2 and 3 reveal WOMAC scores regarding pain, stiffness and global function pre and post operatively with significant difference ($p<0.001$) respectively. The total, average and index WOMAC score preoperatively were 69.65±8.12, 2.98±0.42 and 75.94±9.46 respectively which decreased with a significant difference ($p<0.001$) postoperatively to 17.1±3.47, 0.72±0.14 and 18.60 ±3.38.

Table 1: WOMAC Score (Pain) Preoperative and Postoperative

Parameter	Before	After	Statistical Significance
Walking	3.05±0.68	0.7±0.57	<0.001
Stair climbing	3.55±0.51	1.1±0.30	<0.001
Nocturnal	2.85±0.67	0.55±0.51	<0.001
Rest	2.65±0.58	0.4±0.50	<0.001
Weight bearing	3.6±0.50	1.1±0.30	<0.001
Total	15.55±2.18	3.85±1.46	<0.001
Total pain average	3.11±0.43	0.77±0.29	<0.001

Table 2: WOMAC Score (Stiffness) Preoperative and Postoperative

Parameter	Before	After	Statistical Significance
Morning stiffness	3.6±0.50	1.05±0.60	<0.001
Stiffness later in day	2.95±0.22	0.85±0.48	<0.001
Stiffness total	6.55±0.60	1.9±0.78	<0.001
Stiffness average	3.27±0.30	0.95±0.39	<0.001

Table 3: WOMAC Score (Global Function) Preoperative and Postoperative

Parameter	Before	After	Statistical Significance
Descending stairs	3.2±0.69	1.05±0.22	<0.001
Ascending stairs	3.3±0.65	1.05±0.22	<0.001
Rising from sitting	3.3±0.65	1±0	<0.001
Standing	3±0.72	0.75±0.44	<0.001
Bending to floor	2.75±0.44	0.65±0.48	<0.001
Walking on flat	2.8±0.76	0.5±0.51	<0.001
Getting in our out of car	2.87±0.35	1±0	<0.001
Going shopping	2.9±0.64	0.85±0.36	<0.001
Putting on socks	2.6±0.50	0.55±0.51	<0.001
Rising from bed	2.9±0.64	0.6±0.50	<0.001
Taking off socks	2.45±0.51	0.25±0.44	<0.001
Lying in bed	2.6±0.50	0.2±0.41	<0.001
Getting in / out bath	3±0.32	0.9±0.30	<0.001
Sitting	3.15±0.67	0.8±0.41	<0.001
Getting on / toilet	3.15±0.48	0.8±0.41	<0.001
Heavy domestic duties	3.8±0.42	1.2±0.42	<0.001
Light domestic duties	2.9±0.55	0.4±0.50	<0.001
Total score	47.05±5.95	11.3±2.31	<0.001
Average score	2.92±0.44	0.69±0.14	<0.001

Table 4: KOOS Score Preoperative and Postoperative

Parameter	Before	After	Statistical Significance
Pain	25.6±2.54	8.9±2.69	<0.001
Sym	13.35±2.00	5.4±2.23	<0.001
ADL	47±5.92	11.3±2.31	<0.001
SR	15.1±1.77	5.65±1.95	<0.001
QL	12.9±1.20	6.55±1.98	<0.001
Total	114±7.55	37.6±8.14	<0.001

Table 5: KOOS Index Preoperative and Postoperative

Parameter	Before	After	Statistical Significance
Pain	29.99±6.78	75.52±7.83	<0.001
Sym	52.32±7.16	80.71±7.97	<0.001
ADL	30.80±8.75	83.38±3.41	<0.001
SR	24.5±8.87	71.75±9.77	<0.001
QL	19.37±7.56	59.06±12.41	<0.001
Total	157±19.78	370.43±30.26	<0.001

KOOS Score

Table 4 and 5 show KOOS score and KOOS index pre and postoperatively respectively. The scores regarding pain, activities of daily living, quality of life etc decreased significantly postoperatively ($p<0.001$).

DISCUSSION

Osteoarthritis is most common joint disease of the elderly and knee being the commonest joint involved in Indian sub-continent. Patient with symptomatic OA knee has great disability. Risk factors for primary OA include age, obesity, genetics, muscle weakness and joint injury. Initial management consists of analgesics (NSAIDS), physical therapy and weight reduction (Cooper et al., 2000, Beyaz, 2012). Glucosamine or other cartilage enhancing drugs have not been proven to be effective. Role of intra-articular injections (steroids/hyaluronic acid) is also controversial. Intra-articular injection of PRP has shown some beneficial results by few authors but they are short lived. Plethora of surgical treatment modalities to manage medial compartment OA have been cited in literature with their pros and cons (Jubb et al., 2003, Pornattanamaneewong et al., 2012).

Unicompartmental/total knee replacement is the main stay of treatment in the western world. But the needs and habits of people in Indian sub continent (squatting for toilet purposes and cross leg sitting/kneeling for prayer purposes) are little different. Hence, joint conserving surgeries suit such patients better than replacements. Moreover, most of these patients are manual laborers. High tibial osteotomy resolves pain in the joint due to its decompressive effects in the early period, and then due to the translation of mechanical axis into the relatively better lateral tibial plateau in the long run. This improves the knee function and prevents further deterioration of the joint at the previous speed. Conventional HTO with lateral close wedge or dome shaped osteotomy requires more dissection, involvement of lateral popliteal nerve and sacrifice of proximal tibio-fibular joint, due to which lateral closed wedge HTO became unpopular. The closed wedge HTO may also lead to shortening of patellar tendon and loss of inclination of the tibial plateau which makes the subsequent total knee arthroplasty technically more challenging (Sangwan et al., 2000, Devgan et al., 2003).

Correction of varus deformity by open wedge HTO in an active patient with medial compartment arthritis unloads the joint and gives significant pain relief and further adds to the life of the joints, thus postponing the ultimate joint replacement by significant number of years. HTO enables medial approach that minimizes the risk of neurovascular lesions and the need for wide dissection of the soft tissues. The procedure allows controlled opening of

the wedge leading to proper alignment and adequate correction of the deformity. The strength of construct with a medial locking plate (TomoFix) and minimum dissection (preserving the blood supply of the bony fragments) allows early weight bearing without collapse or loss of correction in the absence of any graft at osteotomy site. The postoperative rehabilitation programme allows immediate active movements and early weight bearing in view of a stable solid construct provided by the plate, which is able to bear the postoperative, compressive and torsional loads. The osteotomy site slowly and steadily gets consolidated as the lateral hinge is maintained and the lateral cortex is not breached.

Few investigators have reported excellent results of medial open wedge HTO fixed with external fixators with or without grafting with only less than 5% of patients having loss of correction postoperatively. Sangwan et al stated that gradual distraction with external fixators without bone grafting is a safe, simple and very effective treatment for unicompartmental OA of knee. Infection of pins was the main complication, which was reported by some authors to as high as 45% and stability of the construct was also not very good. Patient experiences difficulty in ambulation and is very inconvenient while sleeping.

The preservation of lateral tibial cortex by gradually increasing the osteotomy gap over several minutes with number of chisels and remaining within 10 mm from the lateral cortex provide prompt union. We did not graft any of our patients and none went into delayed/nonunion. Hence there were no morbidities of graft harvesting site. Staubli et al in their study of 92 high tibial osteotomies fixed with medial plate without bone graft or substitutes showed similar results. However 40% of their patients required removal of implants (Staubli and Jacob, 2010).

Statistically significant improvement in VAS score from 7.2±1.0 to 1.4 ±0.50 postoperatively ($p < 0.001$) was observed in our study from baseline to 6 months follow-up. Similar results were reported by Sampson et al., 2010 in VAS score in knee at rest, while moving and while bent with p value<0.0005, 0.0004, 0.0349 respectively.

Similarly assessment of WOMAC score and normalized KOOS score showed significant improvement in activities of daily living, pain, quality of life and other criteria. All patients were evaluated at end of the study regarding their experience and they were further graded according to their satisfaction. 12(60%) reported procedure as excellent, 6 (30%) much better and 2 (10%) little better.

We had our share of complications. Leg swelling was observed in 7 patients that persisted for 3-4 months. The swelling used to increase in the day time but would disappear after limb elevation or overnight. Infection occurred in 2 patients. In one patient, infection developed in muscular plains, which was managed by incision and drainage and intravenous antibiotics for 3 weeks. The second patient developed superficial infection, which healed spontaneously with antibiotics. The infection reappeared after 6 months and plate was removed as the osteotomy got consolidated (Figure 3). The cultures from the plate site were sent for microbiological examination but they came out to be negative. The infection healed completely after implant retrieval. This patient had a little increase in tibial slope but fortunately there was no restriction in range of movements. One patient developed lateral popliteal nerve palsy, which has not recovered till date and is waiting for tendon transfer procedure. One patient complained of local irritation by plate for which implant removal was required. The complication rates of our study are comparable with those of others.

CONCLUSION

We believe that medial open wedge HTO fixed with TomoFix without any graft provides excellent stable construct leading to satisfactory union rates and acceptable complication rates. It is a physiologically better surgery in medial compartment primary OA in Kellgren Lawrence grade II and III. The procedure is a very good alternative to unicompartmental/ total knee arthroplasty in our scenario where patient at this old age is reluctant to change their squatting, cross leg sitting and kneeling habits and job profile. Early results are very gratifying though long-term follow-up and larger group design is required.

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