

EVALUATION OF FUNCTIONAL RESULTS OF MEDIAL OPENING WEDGE HIGH TIBIAL OSTEOTOMY FOR UNICOMPARTMENTAL OSTEOARTHRITIS VARUS KNEE

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ABSTRACT

BACKGROUND

Osteoarthritis commonly affects the medial compartment of knee giving rise to varus deformity in majority of cases. Significant varus deformity further aggravates the pathology due to medialisation of the weight bearing line osteotomy of the proximal tibia realigns this weight bearing axis, thereby relieving pressure on the damaged medial compartment. OWHTO is a promising option in this scenario because it is associated with high accuracy in correcting the deformity and less number of complications when compared to lateral closing wedge HTO or UKA. In this study, we evaluate the functional outcome of HTO in patients with unicompartmental osteoarthritis.

MATERIALS AND METHODS

This is a prospective study of patients who attended the orthopaedic outpatient clinic in Government Hospital, Kakinada, between August 2013 to August 2015. The patients were evaluated by clinical examination and weight bearing radiographs. The patients who were found to have unicompartmental osteoarthritis with knee pain not relieved by conservative management and who satisfy the inclusion criteria were selected.

RESULTS

Excellent results can be achieved by appropriate selection criteria and planning with long limb weight bearing radiographs. There is an excellent relief of pain, which can be achieved within first few months postoperatively, which is assessed by VAS score. The KSS- knee score is excellent in 35%, good in 40%, fair in 20% and poor in 5%. The KSS- function score is excellent in 30%, good in 45%, fair in 20% and poor in 5%. There is significant improvement in the range of movement of the knee joint postoperatively.

CONCLUSION

In this study, we conclude that medial OWHTO is the preferred modality for unicompartmental OA in those aged <60 years and in developing nations like India where squatting is an important function, it has major role as it can restore near normal knee function without disturbing anatomy.

KEYWORDS

HTO, Unicompartmental OA, Medial Opening Wedge Osteotomy.

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BACKGROUND

Osteoarthritis is a degenerative joint disease that is characterised by cartilage deterioration and joint pain. Global statistics reveal that osteoarthritis accounts for 3% of total global 'years lived with disability' and is associated with significant health and welfare costs. About one third of the

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patients scheduled for total joint replacement of the knee are potential candidates for an osteotomy. Osteotomies around the knee had a significant complication rate in the past and these procedures were largely abandoned until the role of correction of varus alignment in the treatment of ligamentous injuries and imbalance of the knee has led to their revival (Noyes et al, 1993).

High Tibial Osteotomy (HTO) was introduced by Jackson et al in 1961¹ and popularised by Coventry in 1985.² It gained acceptance for correcting deformities and reducing pain in the treatment of unicompartmental osteoarthritic knee. The medial opening wedge HTO, which was originally described by Hernigou et al is a well-established procedure for the treatment of unicompartmental OA of the knee. HTO has become the surgery of choice as joint preserving procedure for young patients with OA involving the medial

compartment, only potential advantages like easier and accurate correction, preservation of bone stock, gain in limb length, restoration of alignment, avoidance of disruption of the proximal tibiofibular joint, the peroneal nerve and muscles of the anterior compartment and better results when converted to TKA (Hooper et al, 2005).

The main problems were the intraoperative choice of the correction angle and the risk of a postoperative loss of correction. The experience and the development of newer implants and new techniques for axis correction around the knee have led to its revival. In this study, we evaluate the outcome of open wedge osteotomy in patients having unicompartmental osteoarthritis with genu varum.

MATERIALS AND METHODS

This is a prospective study of patients who attended the Orthopaedic Outpatient Clinic in Government Hospital, Kakinada, between August 2013 to August 2015. The patients were evaluated by clinical examination and weight bearing radiographs. The patients who were found to have unicompartmental osteoarthritis with knee pain not relieved by conservative management and who satisfy the inclusion criteria were selected.

Inclusion Criteria

1. Pain and disability resulting from osteoarthritis.
2. Age <60 years.
3. Evidence on weight bearing radiographs of degenerative arthritis that is confined to one compartment with a corresponding varus deformity.
4. Motivated patient and who is willing to carry out a suitable rehabilitation program.
5. Good vascular status without serious arterial insufficiency or large varicosities.

Exclusion Criteria

1. Narrowing of lateral compartment cartilage space.
2. Flexion contracture >15°.
3. Correction required >20°.
4. Knee flexion <90°.
5. Medial compartment tibial bone loss of more than 2 or 3 mm.
6. Lateral tibial subluxation of more than 1 cm.
7. Inflammatory arthritis.

The patients were explained about osteotomy and its advantages and disadvantages were discussed. Those patients who were willing for the procedure were selected and their consent obtained. Preoperative planning is done using mechanical axis of femur and tibia and correction required is assessed and preoperative evaluation is done by visual analogue pain scale and knee society score. High tibial opening wedge osteotomy is done and fixation done with proximal medial tibial locking compression plate/T-locking proximal medial tibia locking plate/Puddu's plate according to the desired wedge to be created. Bone grafting was done if the required correction $\geq 12^\circ$.

Surgical Technique

The operation begins with the knee in 90° flexion. A 5-cm lazy-J incision is made starting 1 cm below the medial joint line midway between the medial border of the tibial tubercle and the posteromedial border of the tibia.

The infrapatellar branch of the saphenous nerve is preserved. The subcutaneous tissue dissected and the pes tendons retracted.



Figure 1. Surgical Technique

Incision over medial aspect of proximal tibia. It is critical to identify the superficial medial collateral ligament and elevate its entire insertion on the medial aspect of the tibia because if not detached there is a risk that the ligament would be over tensioned and result in increased loads within the medial compartment further compressing it. The leg is now positioned in full extension and the knee joint adjusted in exact AP view under fluoroscopy. A guidewire is placed on the anteromedial aspect of the tibia below the level of the tibial tubercle and aimed toward the tip of the fibular head such that the wire passes the tuberosity across its inferior third. A second guidewire is passed parallel and 2 cm posterior to the first one.



Figure 2. Insertion of K-Wires

The osteotomy is done just parallel to the guidewires, initially using a small oscillating saw followed by an osteotome advancing to within 1 cm of the lateral tibial cortex. Attention must be paid to complete the osteotomy of

the hard posteromedial tibial cortex. The anatomical structures dorsal to the posterior tibial surface are protected by a Hohmann retractor. The entire sawing procedure is performed slowly with very little pressure and under constant cooling of the saw blade by irrigation.



Figure 3. Osteotomy of Proximal Tibia



Figure 4. Fixation with Proximal Medial Tibial Locking Plate

Isometric quadriceps exercises, active ankle pumping and straight leg raising exercises were started on the first postoperative day. The drain and compressive dressing were removed on the second day after surgery. Each patient was allowed to move the knee as much as tolerated and walk with toe-touch weight bearing for the first 2 weeks after surgery. Partial weight bearing was permitted for the next 2 weeks and full weight bearing was permitted beginning 4 weeks after the operation.

The degree of osteoarthritis was assessed preoperatively using the Kellgren-Lawrence radiographic grading scale. The Picture Archiving and Communications System (PACS) measurement tools were used for determining the following radiographic values- 1) The preoperative and postoperative medial joint space, which are defined as the narrowest width of joint space in the medial tibiofemoral compartment as observed from the anteroposterior view of the knee; 2) The preoperative femorotibial varus angle (Figure 3) and the postoperative femorotibial valgus angle; 3) The correction

The osteotome tip should be at least 1.25 times further from the tibial plateau than from the lateral cortex to mitigate the risk of fracture line propagation into the plateau. The osteotomy site is then opened very slowly with the help of wedges or bone reader. Leaving the two guidewires in place while opening the gap leads to stiffening of the proximal segment and prevents fracture of the articular surface of the tibia.

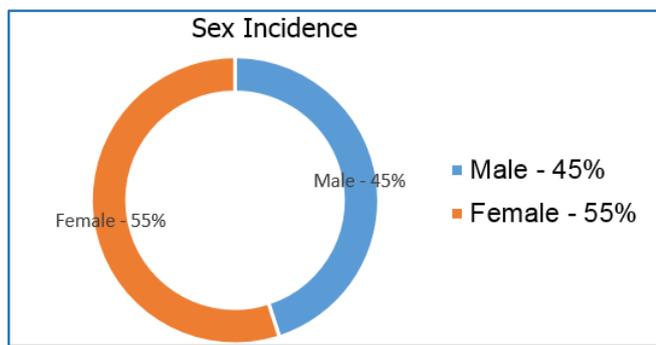
The correction is then confirmed with a Bovie cord from the centre of the femoral head to the centre of the ankle, such that line passes the knee joint at the Fujisawa point and then fixation is performed with the desired implant.

angle (e.g., the difference between the preoperative and postoperative femorotibial angles; and 4) The medial defect of the osteotomy, which is defined as the length of the defect that is at least 5 mm wide from the lateral edge of the defect to the lateral plate border in perpendicular with the tibial axis.

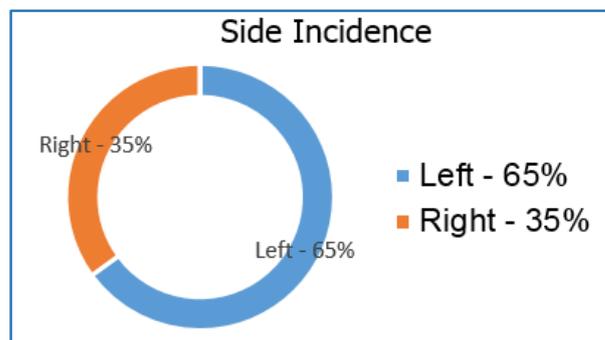
RESULTS

In the present study, 20 cases of opening wedge HTO were performed from August 2013 to August 2016. The follow-up period ranged from twelve months to twenty six months with an average follow-up of eighteen months. Patients were analysed for any complications and their functional outcome was compared with their previous status.

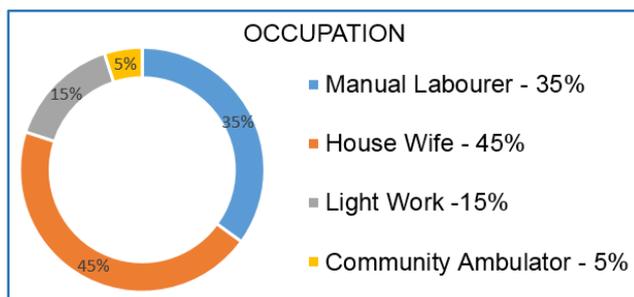
All patients were evaluated objectively by weightbearing radiographs and subjectively by visual analogue pain scale and knee society score.



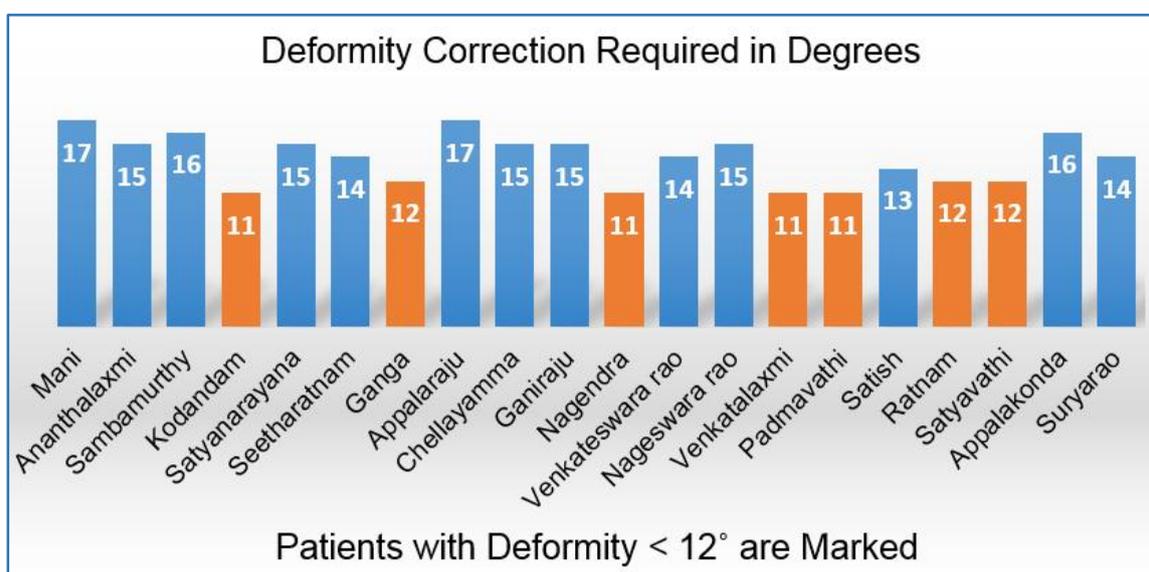
Graph 1. Sex Incidence



Graph 2. Side Incidence



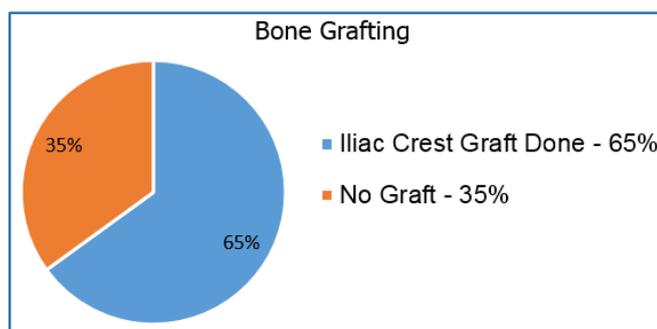
Graph 3. Occupation



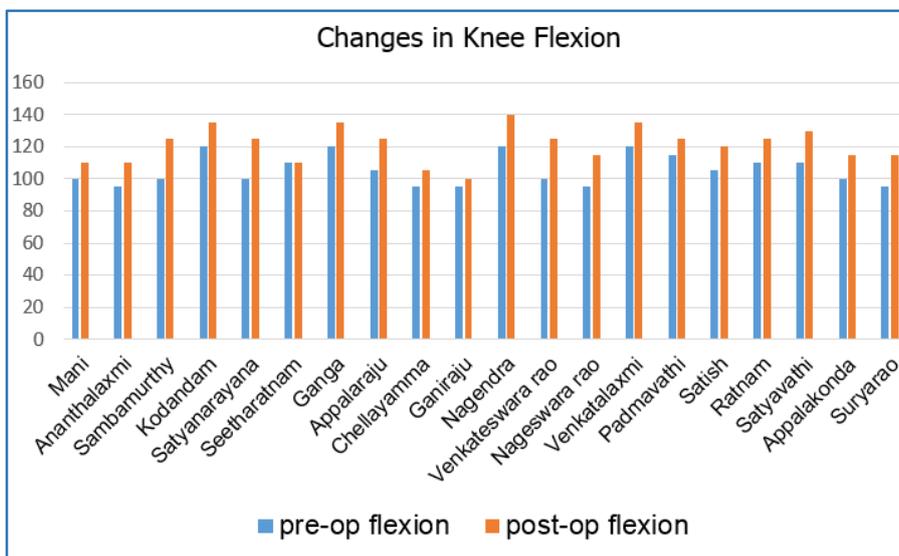
Graph 4. Deformity Correction Required in Degrees

BONE GRAFT

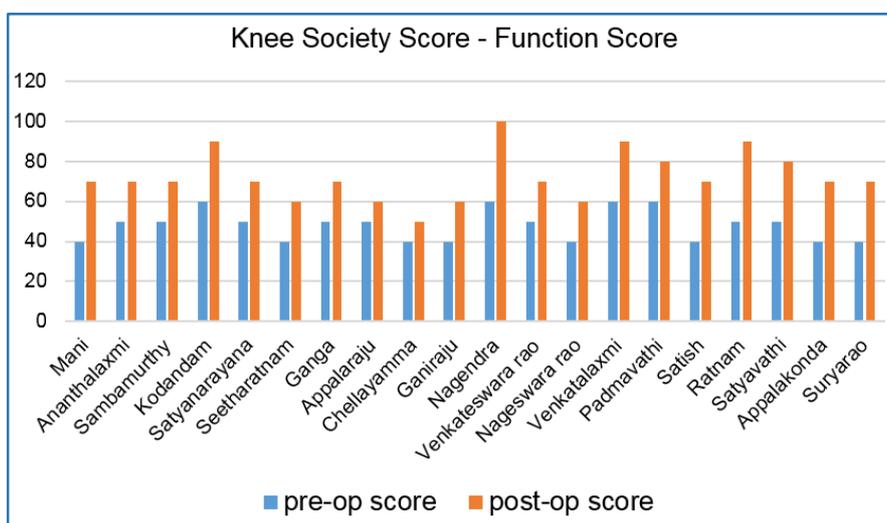
Bone grafting was done in 13 cases all having a preoperative varus angle of >12 degrees.



Graph 5. Bone Grafting



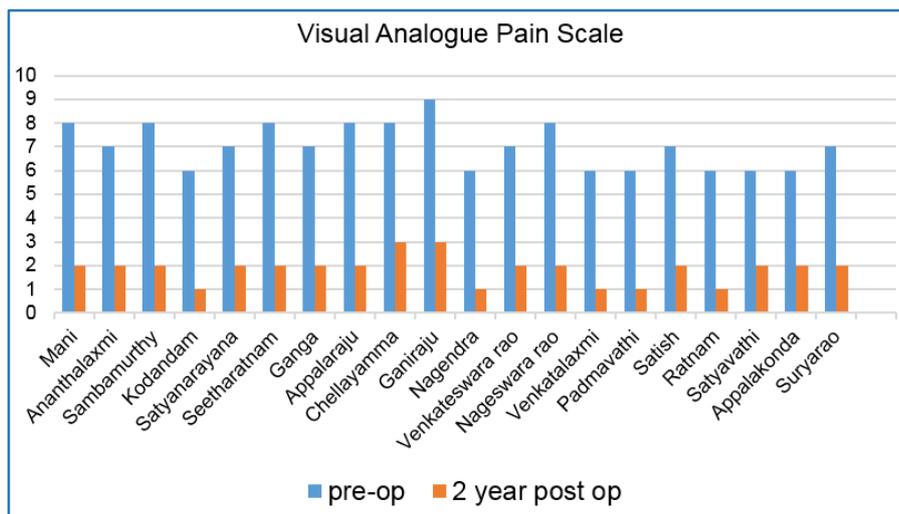
Graph 6. Changes in Knee Flexion



Graph 7. Knee Society Score- Function Score

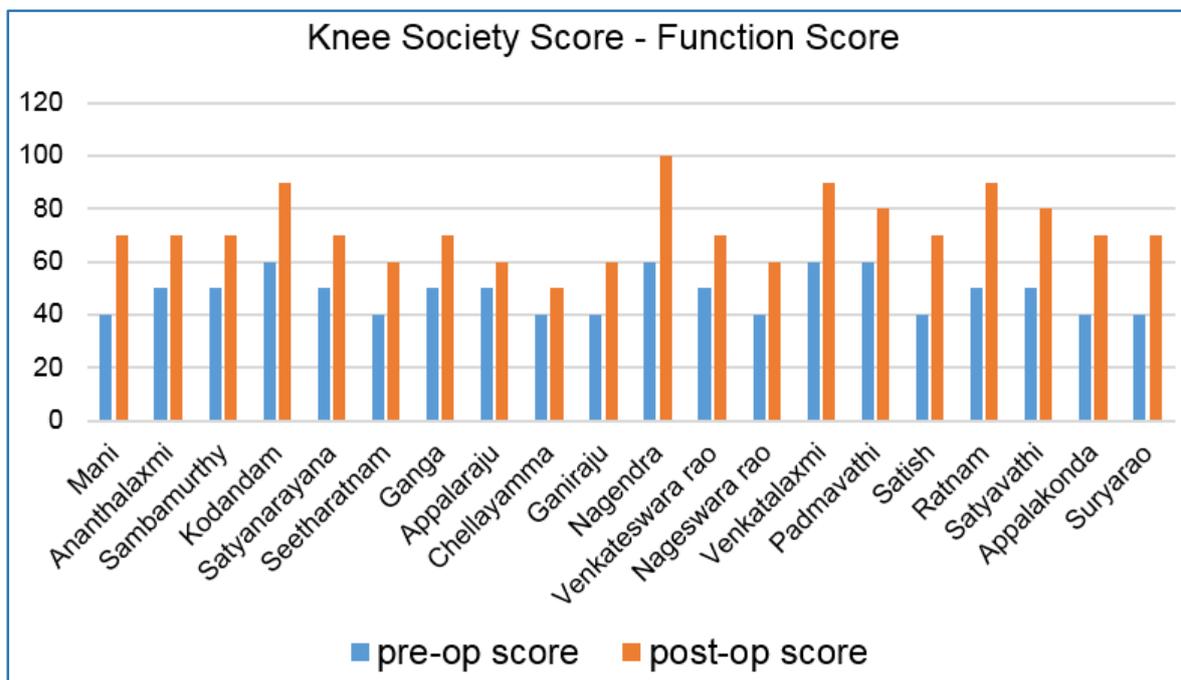
VISUAL ANALOGUE PAIN SCALE

Except 2 patients who had under correction, all patients had excellent to good pain relief at the end of one year postoperatively.

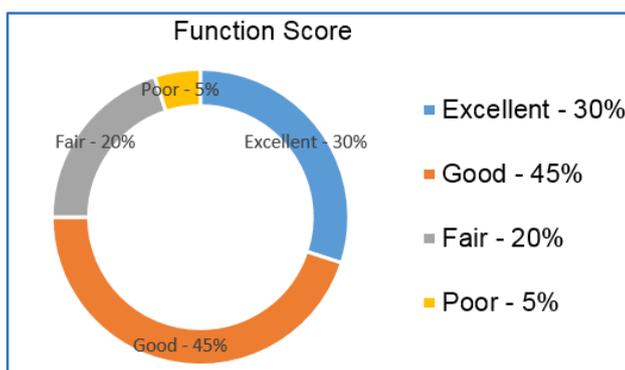


Graph 8. Visual Analogue Pain Scale

The function scores were excellent in 6 cases, good in 9 cases, fair in 4 cases and poor in 1 case.



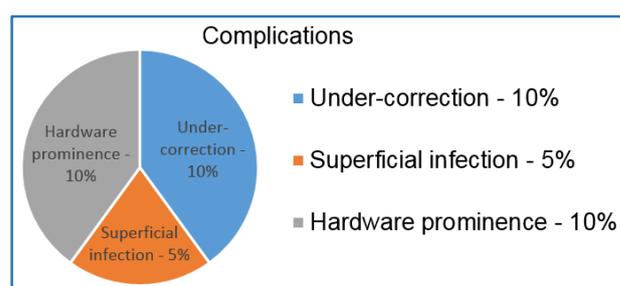
Graph 9. Knee Society Score- Function Score



Graph 10. Function Score

Sl. No.	Complication	Number of Cases	Percentage
1.	Under correction	2	10%
2.	Lateral tibial plateau fracture	0	-
3.	Lateral cortical hinge fracture	0	-
4.	Superficial infection	1	5%
5.	Deep vein thrombosis	0	-
6.	Delayed union	0	-
7.	Nonunion	0	-
8.	Hardware prominence	2	10%
9.	Compartment syndrome	0	-

Table 1. Complications



Graph 11. Complications

DISCUSSION

In medial compartment osteoarthritis due to shift of the weight bearing axis medially results in more cartilage destruction and subsequently varus deformity. Therefore, a unicompartmental knee replacement will not correct the alignment. A corrective osteotomy to alter this axis will be ideal to slow down the degenerative process.^{3,4}

Many studies including one by Khan et al⁵ have stressed the effect of local alignment on osteoarthritis occurring in respective compartments. Analysis of the 362 knees with predominantly medial compartment OA showed that each degree of increase in varus angle was associated with a significantly increased adjusted risk of having severe medial disease (odds ratio, 1.52, p<0.001). Raymond H. Kim⁶ has stated osteotomy as a reasonable option to treat active physiologically young patients. Akamatsu et al⁷ in their series consisting 144 knees detected that mineral densities and

sclerosis of medial femoral condyles and tibial bone plateau are denser than those of the lateral compartment assessed using preoperative dual x-ray absorptiometric measurements. They performed high tibial osteotomies for 23 patients and stated that the degree of bone mineral density and sclerosis decreased by distributing mechanical stress evenly and diminishing weight bearing forces impinging on medial compartment.

Study	Number of Knees/Patients	Mean Follow-up in Years	Results
Hernigou et al (1987)	93	11.5	90% of the knees had satisfactory outcome at 5-year follow-up, but deteriorated to 45% at 10-year follow-up.
Asik et al (2005)	65	2.8	They proved postoperative pain resolves promptly and a significant degree of improvement of knee functions of the patients are achieved.
Niemeyer et al ⁸ (2010)	43	2	68% good or excellent results were obtained.
Kolb et al (2009)	51	4.3	Hospital for special surgery score was excellent in 57% of patients, good in 24%, fair in 8% and poor in 10%.
Saragaglia et al ⁹ (2011)	124	10	88.8% survivorship at 5 years, 74% at 10 years.
DeMeo et al ¹⁰ (2010)	20	8.3	70% survivorship at 8 years.
Present Study	20	18 Months	Significant improvement in pain as measured by VAS pain scale. KSS- Knee score excellent in 35%, good in 40%, KSS- Function score excellent in 30% and good in 45% at 1-year follow-up

Table 2. Comparison of Results

Song et al¹¹ have analysed the complications of 104 lateral closing wedge and 90 medial opening wedge osteotomies and stated that the latter had slightly lesser complication. Luites et al¹² stated that both types of osteotomies had equal fixation stability, pain relief and certainly improved knee function, although the intended correction was achieved more likely with medial opening wedge technique. Initially, a number of plates were used and later locked plates came into being. Kolb et al¹³ have analysed good results with locked low-profile plates. They

have analysed 51 medial open wedge osteotomies and found that 50 osteotomies healed in an average period of 3 months without bone grafts. Asik et al¹⁴ performed 65 open wedge osteotomies fixed with the Puddu plate. They reported significant improvement of pain and knee function at an average follow-up of 34 months. But, they stressed that long-term studies are required in elderly patients to know whether the results are satisfactory.

Study	Number of Knees/Patients	Implant Used	Outcomes
Asik et al (2005)	65	Puddu's plate	KSS-knee score- preop 35.7 (0-60) and postop 85.6 (34-100). KSS-functional score- preop 53.5 (15-70) and postop 83.5 (30-100).
Kolb et al (2009)	51	Locked Low-Profile Plate	Lysholm and Gillquist knee scoring- excellent in 9 patients (18%), good in thirty-one (63%), fair in three (6%) and poor in six (12%).
Hernigou et al ¹⁵ (2010)	53	Buttress plate	No pain in 40; slight pain in 2; moderate/severe pain in 6; severe pain in 6→revision (10 yrs.).

DeMeo et al ¹⁰ (2010)	20	Puddu plate	Preop Lysholm score 54.2 Postop Lysholm score 89.1 (2 yrs.), Lysholm 83 (8 yrs.)
Shallberger et al ¹⁶ (2011)	71	Bent one-half tubular plate	WOMAC 84, KOOS 71 (15 yrs.)
LaPrade et al ¹⁷ (2012)	47	Puddu plate	Modified Cincinnati Knee Scores Preop- 42.9, Postop: 65.1 (3.6 yrs.)
Bode et al ¹⁸ (2013)	51	Tomofix	Preop Lysholm score 54.3 Postop Lysholm score 76.6 (5 yrs.)
Bonasia et al ¹⁹ (2014)	99	Puddu plate	Preop scores- KSS 135.6 Postop scores- KSS 160.5 (5 yrs.)
Present study	20	Puddu plate and locking plate	KSS- Knee score- Excellent in 35%, good in 40%, fair in 20%, poor in 5%. KSS- Function score- Excellent in 30%, good in 45%, fair in 20%, poor in 5%.

Table 3. Comparison of Outcome Based on Implant Used

The consolidation of the wedge occurred in all 7 of our patients without bone grafting in about 3 to 5 months. This is comparable to the results of Kolb et al¹³ (fifty of the fifty-one osteotomies healed after an average period of 12.9 weeks without bone grafts). Zorzi et al²⁰ concluded that autologous bone graft is unnecessary for wedges of <12.5 mm. They concluded that there was no significant difference in time to clinical bone union between patients that had an autologous bone graft- mean time of 12.35 weeks and those that did not- mean time of 13.65 weeks and the difference was not statistically significant (P=0.128). Hankemeier et al²¹ compared the difference in accuracy between open-wedge osteotomy and closed-wedge osteotomy in about 61 patients and found that the accuracy in the open-wedge group was significantly higher than in the closed-wedge group. They concluded that open-wedge osteotomy with fixed-angle plates improves the accuracy of HTO significantly and is the recommended technique. Asik et al¹⁴ and Esenkaya et al²² have used Puddu plate and plates with wedges respectively and showed that these plates provides adequate stabilisation to maintain the desired correction and to allow early functional rehabilitation. Although, TKA post-HTO is a demanding surgery, however, with newer.

Component designs, results are comparable to primary TKA. Karabatsos et al²³ demonstrated that arthroplasty in the setting of a previous HTO is more technically demanding than primary arthroplasty. Total knee arthroplasty after a closing-wedge is much more complicated and technically difficult than in an opening-wedge osteotomy. Preston et al²⁴

found that functional outcomes for arthroplasty after conversion from lateral closing-wedge HTO to be similar to those after conversion from medial opening-wedge HTO. The opening wedge, however, has the advantage of preserving the bone stock for future arthroplasty (Haslam et al²⁵).

Robertsson and Dahl²⁶ compared the results and complications of primary TKR, HTO revision to TKR and UKA revision to TKR. They found a risk of revision significantly higher after previous closing wedge HTO and UKA than de novo TKR, whereas open wedge HTO did not affect the outcome. The complications which are seen in this study could be prevented by proper preoperative planning and correct surgical technique. Infection control is also essential as the medial aspect of tibia is devoid of soft tissues and proper postoperative care and rehabilitation is essential. Brouwer et al²⁷ have used the Puddu plate for opening wedge osteotomy and compared it with staples for closed wedge osteotomy in overall 92 patients and have found that pain caused removal of Puddu plate in 60% patients. Hoell et al¹⁸ reported an implant removal rate of 50% in patients treated with an opening-wedge osteotomy due to irritation around the pes anserinus by the implant and reported significantly more implant removals in those patients than in patients treated with closing-wedge osteotomy. 10% of patients had implant removal in present study due to hardware prominence causing pain.

Study	Number of Knees/Cases	Implant Removal Rate
Hoell et al (2005)	108	50%
Brouwer et al (2006)	92	60% in opening-wedge group; 23% in closing-wedge group
Haviv et al ²⁸ (2012)	22	9.09% due to pain
Present study	20	10%

Table 4. Comparison of Implant Removal Rate

Houten et al²⁹ studied on the factors, which can lead to delayed union or nonunion and found that use of tobacco was a major risk factor for development of nonunion in patients undergoing opening wedge HTO.

They also found that the modified Radiographic Union Score for Tibial Fractures (RUST) score can help identify patients at high risk of developing delayed or nonunion. Duivenvoorden et al³⁰ in a randomised control trial with six-

year follow-up found that OWHTO was associated with more complications (38% vs. 9% in closing-wedge group), but closing-wedge HTO was associated with more early conversions to total knee arthroplasty (22% vs. 8% in opening-wedge group). They advised an OWHTO with rigid

plate fixation and without bone graft for patients with medial compartment OA of the knee and varus malalignment of $<12^\circ$ to minimise the risk of complications and to maximise the survival.

Study	Number of Knees/Cases	Complications
Esenkaya et al (2005)	40	Lateral tibial plateau fracture in three (7.5%), lateral cortex fracture in 11 knees (27.5%), delayed wound healing and delayed union and breakdown of a distal screw in one patient each (2.5%).
Asik et al (2006)	65	Superficial wound infection in two patients (3%), deeper wound infection in one patient (1.5%), deep vein thrombosis in two cases (3%).
Kolb et al (2009)	51	One case of superficial wound infection (1.9%), one case of nonunion (1.9%).
Niemayer et al ³¹ (2010)	69	Overall complication rate 8.6%.
Shroter et al ³² (2011)	35	Overall complication rate 34%; plate-related complication rate 23%.
Chaturong et al (2012)	60	5 cases (8.3%)- One case of superficial wound infection, one case of lateral tibial plateau fracture, one case of screw penetration into joint, two cases of local hardware irritation.
Duivenvoorden et al (2014)	92	38% in opening-wedge group.
Present study	20	25%.

Table 5. Comparison of Complications

Table 5- Comparison of complications depending on the type of implants, previous studies showed that the use of Puddu plates has been reported to be associated with a high complication rate (37.7-55%), whereas using LCP and non-locking T-plates has been associated with a much lower complication rate (1.9-8.6%), whereas Chaturong et al³³ showed low complication rate with both the use of T-buttruss plates (6.7%) and the TomoFix technique (10%). This study has its limitations like short duration of follow-up and small sample size. As stated by Asik et al, long-term studies are lacking in high tibial osteotomies and are necessary for more clear idea about the outcome. But, this short-term study shows that osteotomy of the knee is definitely a viable option in unicompartmental osteoarthritis of the knee.

CONCLUSION

On the basis of the study, the following conclusions can be made.

1. Medial OWHTO is the preferred modality for unicompartmental OA in those aged <60 years.
2. In developing nations like India where squatting is an important function, it has major role as it can restore near normal knee function without disturbing anatomy.
3. In Indian scenario where patients cannot afford UKA, HTO is the only surgical option as it can be done using implants of low cost like the Puddu's plate.
4. It is associated with more accuracy and less complications when compared with lateral closing wedge HTO or UKA.
5. Revision to TKA at a later date is also easier after medial OWHTO than after a lateral closing wedge HTO or after a UKA.

Even though, this study has the drawbacks like small sample size, short duration of follow-up, usage of different implants and not being a double-blind study, it concludes that medial opening wedge high tibial osteotomy is a reliable option in the treatment of unicompartmental osteoarthritis as it gives very good pain relief and improves knee flexion, especially in Indian scenario.

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