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Dr. Janak Rathod
Professor and Head of Department, Department of Orthopedics, SMIMER Medical College, Surat, Gujarat, India

Dr. Ronak Patel
Junior Resident, Department of Orthopedics, SMIMER Medical College, Surat, Gujarat, India

Dr. Vikram Jasoliya
Associate Professor and HOU, Department of Orthopedics, SMIMER Medical College, Surat, Gujarat, India

Dr. Akshay Dankhara
Junior Resident, Department of Orthopedics, SMIMER Medical College, Surat, Gujarat, India

Dr. Nilesh Kodiyatar
Junior Resident, Department of Orthopedics, SMIMER Medical College, Surat, Gujarat, India

Corresponding Author:
Dr. Janak Rathod
Professor and Head of Department, Department of Orthopedics, SMIMER Medical College, Surat, Gujarat, India

A study of functional outcome of medial open wedge verses lateral closed wedge high tibial osteotomy

Dr. Janak Rathod, Dr. Ronak Patel, Dr. Vikram Jasoliya, Dr. Akshay Dankhara and Dr. Nilesh Kodiyatar

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Abstract
The treatment of unicompartmental osteoarthritis with high tibial osteotomy using medial open wedge verses lateral closed wedge osteotomy. It is a choice of surgery in young age osteoarthritis. In this study we analyse the functional outcome of medial open wedge osteotomy the tom fix plate and lateral closed wedge osteotomy using staple in patients having unicompartmental osteoarthritis with genu varum.

Material and Methods: This is a prospective study of patients who attended the orthopaedic outpatient clinic in tertiary care hospital between July 2021 to December 2022. 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. During this period 30 patients were selected and were included in study.

Results: In both groups a significant improvement of both scores were achieved. Both methods obtained safe and reproducible results for the correction considering the different operation techniques. There were no differences in outcome between the two methods. Satisfactory results were also achieved for early arthrosis of the femoropatellar and the lateral compartment.

Conclusion: Open and closed wedge HTOs obtain significant improvement in patients with medial osteoarthritis of the knee. Using the right technique is very important for good results. For stabilization of the medial ligament we recommend the open wedge osteotomy. The patient should be informed about the routine removal of the metal plate.

Keywords: High tibial osteotomy, virus osteoarthritis, open wedge osteotomy, closed wedge osteotomy

Introduction

Osteoarthritis is a multifactorial disease but abnormal stress produced by biomechanical alteration is one of the major accelerating factors. Minor degree of varus or valgus deformity of knee alters the load on tibial and femoral condyles.

Main symptoms of osteoarthritis are disabling pain, restriction of movements and deformity. Initial symptomatic treatment constitutes analgesics, rest, exercise. Various surgical procedures have been described in literature from time to time like synovectomy, joint debridement, arthrodesis, patellectomy, patelloplasty and menisectomy. Tibial osteotomies were introduced in 1950's and have been variedly used and modified since then. These osteotomies change the weight-bearing axis of the knee. Venous decongestion has also been cited to be one factor responsible for pain relief apart from axial realignment.

Medial compartment osteoarthritis refers to the excessive loading of weight onto the medial femoral condyle and medial tibial plateau. This imbalance of load creates stress risers along the medial compartment of knee. This leads to catalytic cascade of events culminating with erosions of the articular surfaces, extrusion of articular cartilage with subsequent enchondral ossification leading to formation of osteophytes, those events ultimately culminates in medialisation of weight bearing axis of lower limb. In patients with medial compartment osteoarthritis, if mechanical axis is realigned in correcting varus in high tibial osteotomy to unload the medial compartment, patient gets significant pain relief and surgery adds life to the knees.

Friedrich Pauwels in 1964 and Paul Maquet in 1976 described deformity correction principles of bone. Since then, many techniques have been developed for osteotomies around the knee.

Mark Coventry published his technique for closed wedge osteotomy in 1965, which became the gold standard for many years. The success of an osteotomy around the knee depends on the biomechanics of the lower extremity, Wolff's law of continuous transformation of bone under stress, load distribution in knee and also on the mechanical property of the implants used for osteotomy fixation.

Osteotomies around the knee have had a significant complication rate in the past and many surgeons abandoned these procedures although the favourable long-term results were well known. After many years of closed-wedge osteotomy, open wedge valgus osteotomy has become popular. Medial opening wedge osteotomy has advantage over lateral close wedge osteotomy in maintaining bone stock and correcting the deformity close to its origin, which may facilitate subsequent arthroplasty. Fibular osteotomy is not required and osteosynthesis of osteotomy is technically easier.

New techniques for knee axis correction has-lead to evolution of knee osteotomies.90% of all osteotomies around the knee are for valgization of tibia (high-tibial osteotomy = HTO). Whereas in the past closed-wedge osteotomy from the lateral side with fibula osteotomy was the gold standard in many countries; and in 1990s fixation plate came to vogue. This procedure looked very attractive to many surgeons because of the small incision and the simple surgical steps. Open-wedge osteotomy of the tibia can be performed without bone grafting or bone substitution in most cases.

In this study we analyse the outcome of open wedge osteotomy verses closed wedge osteotomy in patients having unicompartmental osteoarthritis with genu varum using the Tomo fix plate in open wedge osteotomy and staple in closed wedge osteotomy.

Materials and Methods

Study design, sample size and period

This is a prospective study of patients who attended the orthopaedic outpatient clinic in tertiary care hospital. 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. During this period 30 patients were selected and were included in study.

Inclusion criteria

- Patient willing to participate in study and giving written consent for the same.
- Pain and disability resulting from osteoarthritis that interfere with high-demand employment or recreation.
- Evidence on weight bearing radiographs of degenerative arthritis that is confined to medial compartment with a corresponding varus deformity. Age < 60 years.

Exclusion criteria

- Patients not willing to participate in the study.
- Narrowing of lateral compartment cartilage space.
- Lateral tibial subluxation of more than 1 cm.
- Flexion contracture of more than 15 degrees.
- Knee flexion of less than 90 degrees.
- More than 20 degrees of correction needed
- Rheumatoid 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. Pre-operative planning is done by Miniaci method and pre-operative evaluation by Visual Analogue pain scale, Knee society knee scale. High tibial opening wedge osteotomy was done using Tomofix plate and closed wedge osteotomy was done using staple.

Fig 1: Determination of correction angle pre-operative drawing at digital work station using weight bearing x-ray. (Miniaci method)

Surgical Technique

After appropriate anaesthesia (preferably spinal), torniquet was applied and painting draping was done to start with-

For open wedge osteotomy

Incision Between tibial tuberosity & pace anserinus, incision is taken just above the pes anserinus, subcutaneous tissue is cut but periosteum is not raised. The infrapatellar branch of the saphenous nerve is preserved. The subcutaneous tissue dissected and the pes tendons retracted. This exposes the medial collateral ligament, which is elevated from the tibia with a raspatorium. The long fibres of the superficial medial collateral ligament are then carefully detached until the posteromedial cortex of the proximal tibia is exposed. A Hohmann retractor is inserted behind the tibial ridge.

At the anterior edge of the incision, the insertion of the patellar tendon at the tibial tuberosity and the medial border of the patellar ligament are exposed. The cranial border of the patellar tendon insertion must be clearly visualised so that the destination of the ascending osteotomy can be defined later in the procedure.

Insertion of k-wires: 1st k wire passed 4cm below the articular margin just above the pes insertion in oblique manner towards the fibular head, this represents the osteotomy plane.

2nd k wire is inserted under fluoroscopic guidance parallel to tibial slope in anteroposterior direction.

Since both wires end at the lateral tibial cortex, the width of the tibial head can now be measured with reference to the two inserted wires. This is done by holding a third wire of the same length onto the cortex and measuring the against the wires in order to leave a lateral bone hinge. Than osteotomy is performed using osclillating saw, using k wire as a guide.

Care is taken, wire should be posterior to tibial tuberosity and not to breach the lateral cortex. For quick and safe bone healing of the osteotomy as much excess length compared to the inserted wires. The tibial diameter is generally 5-10 mm smaller anteriorly than posteriorly. The measured values should be noted. The depth of the saw cut is 10 mm less

than the value measured biological potency as possible must be preserved in the area of the bone separation. We use an oscillating saw at an extremely low pace and continuous irrigation with cold Ringer's lactate solution.

The posterior osteotomy is stopped 10 mm before the lateral cortex. This intact lateral bone stock serves as a fulcrum when the osteotomy is opened. The osteotomy is opened gradually using flat chisels.

A first broad chisel is inserted in the transverse part of the osteotomy. This chisel glides into the saw slot under the K-wires and is inserted as deep as the saw has protruded. A second broad chisel is now inserted between the first chisel and the K-wires. This chisel is now tapped into the osteotomy with light blows of a hammer slightly less deep than the first chisel. The surgeon should take some time for this step to allow the bone to adapt to the gradual opening of the osteotomy.

The opening of the transverse and anterior oblique osteotomy plane should be monitored carefully. There should be a continuous and smooth separation of the two planes. A third chisel can now be inserted between the first two chisels, and, again, this chisel is tapped into the osteotomy with light blows of a hammer over 1–2 min. If necessary, this elastic deformation manoever can be repeated until the desired opening is achieved. Alternatively a special tool combining two chisels and a distraction mechanism called bone spreader can be inserted. Gradual opening of this tool has the same effect. Corticocancellous bone graft of adequate size as per size of opening was harvested from ipsilateral iliac crest and was placed in osteotomy site before removing bone spreader and plate fixation. Center the plate, with the 4.3 mm threaded LCP Drill Guide (s) installed, over the osteotomy and place onto the bone. The three holes in the head and the most proximal Combi hole on the shaft should be positioned proximal to the correction gap. The solid midsection of the plate should be placed over the osteotomy site Osteosynthesis is completed, wash is taken and sterile dressing is kept.

Fig 2: Osteotomy by power saw

Fig 3: Incision

Fig 4: k wire insertion

Fig 5: Osteosynthesis

For closed wedge osteotomy

Incision

Make an inverted L-shaped incision. Start approximately 1 to 3 cm distal to the joint line, staying just lateral to the border of the patella tendon. Curve the incision anteriorly over Gerdy tubercle and then extend it distally, staying about 1 cm lateral to the anterior border of the tibia. The exact length of the incision depends on the pathology to be treated and the implant to be used. The tibial head is freed sub-periosteally exposing its lateral surface back to the tibio-fibular joint. The infrapatellar bursa is entered and the patella ligament is protected by a Langenbeck retractor at all times. The posterior-lateral edge of the tibia is approached immediately beneath the tibio-fibular joint and for a length of 2 cm the periosteum is elevated from the edge and from the posterior surface of the tibia by careful dissection with a curved periosteum. The knee is bent to 90° during this part of the dissection. The base of the wedge should now be free of soft tissues from anterior to posterior.

• Insertion of k-wires: o 1st k wire inserted parallel to the joint line and 1 cm beneath it. The position of this wire is controlled fluoroscopically because it will guide all the following steps. A second wire is drilled parallel and more posteriorly according to the first osteotomy guide. The transverse osteotomy done with help of osteotome is shifted over the wires and fixed to the tibial head. o 2nd k wire is inserted distally in an oblique fashion in order to meet the first pin at the medial tibial cortex. The distance between the two entry points depends on the pre-operative planning under fluoroscopic guidance obliquely according to the planned angle. Again the patella ligament and the posterior soft tissues are protected by retractors.

Fig 7: K wire insertion

Fig 6: skin incision

Fig 9: Fixation with staple

Fig 8: Osteotomy in situ

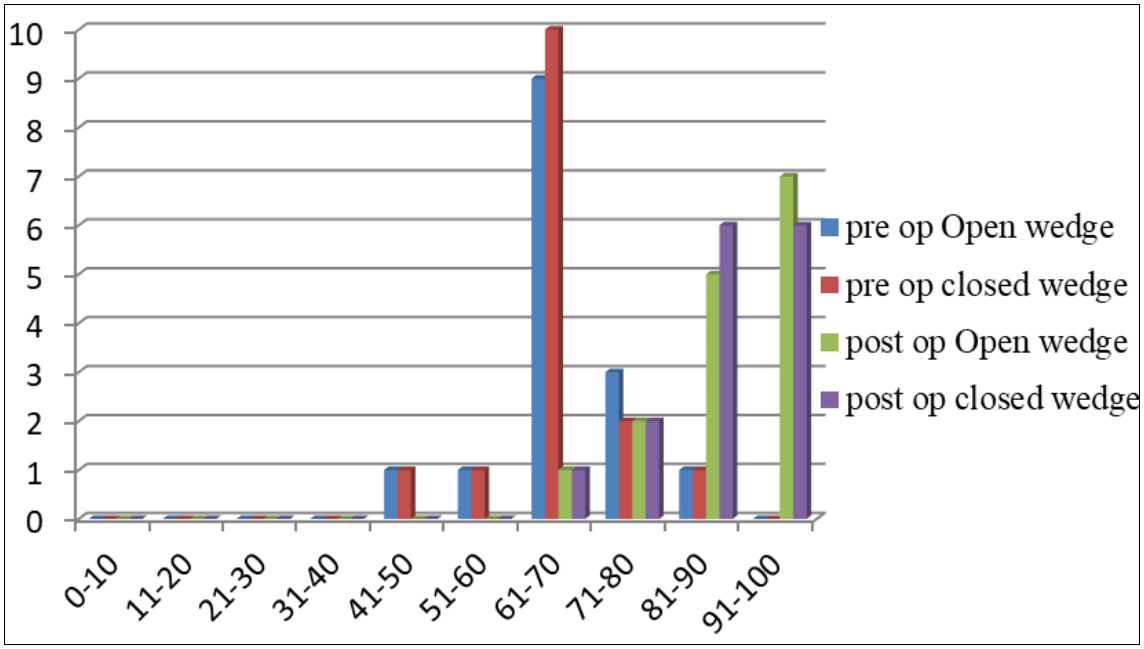
Continued or discontinued and allow weight bearing with: support or without support and mobilization according to physiotherapy. Repeat x-ray was taken and union was measured. Post op HKA axis x-ray was taken and alignment was evaluated. Assessment is done according to knee society score. Further assessment was done on follow up at 6, 8, 12, 24 weeks.

Results

Major group of patients in our study belong to age group 46-50 years (62%). The mean age of patients in our study is 48.38 years.

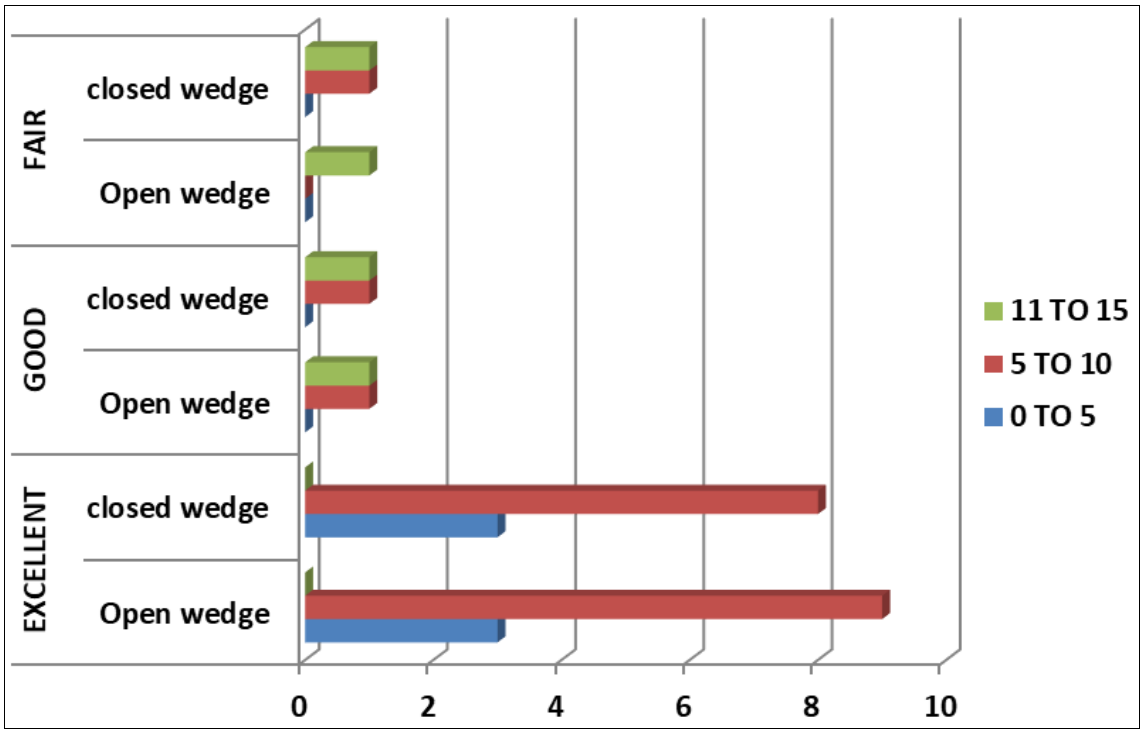
In open wedge oateotomy

15 Patient was operated for medial opening open wedge high tibial osteotomy, 10 were operated for right OA knee and 5 for left OA knee. we got union by 3-5 months of time. The mean time of union is 4.0 months, 3 knees had 0 to 5 degree of varus deformity and 10 have 6 to 10 degree varus deformity and 2 had 11 to 15 degree varus deformity. as far as complications are concerned there were 3 complications we encountered 1 among them was superficial infection which resolved by dressing at 2 weeks without any residual infection, 1 had lateral tibial condyle involvement due to higher correction angle due to which weight bearing was delayed, 1 patient had under correction noted on post operative HKA axis scanogram. The average JOA Knee score preoperatively was 52.6 which improved postoperatively with average score of 82.9.average functional knee society score was 70.80 preoperatively which improved postoperatively to 90.57. Average VAS score preoperatively was 6.95 which reduced considerably to an average score of 2.09 postoperatively. We got excellent results in 13 patients (86%), good results in 1 patients (9.5%) and fair results in 1 patient (4.5%).



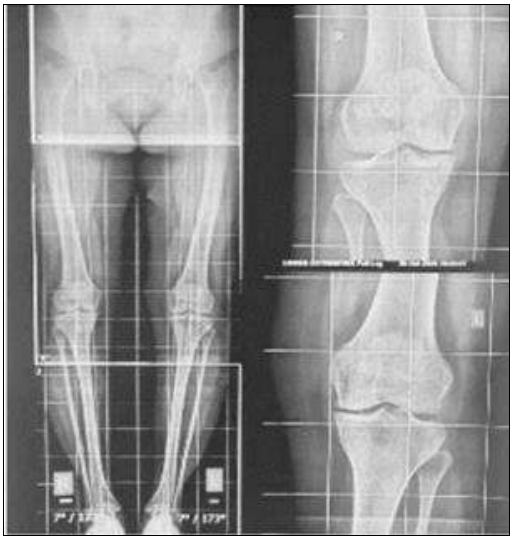
Graph 1: Knee society score (functional) in open wedge osteotomy vs closed wedge osteotomy

In Close wedge osteotomy, 15 Patient was operated for lateral close wedge high tibial osteotomy, 9 were operated for right OA knee and 6 for left OA knee. we got union by varus deformity, 3 knees had 0 to 5 degree of varus deformity and 10 knee had 6 to 10 degree varus deformity and 2 had 11 to 15 degree varus deformity. as far as complications are concerned there were 3 complications we encountered 1 among them was superficial infection which resolved by dressing at 2 weeks without any residual infection, 1 had pin loosening which prevented the patient from putting weight on right away, 1 patint had under correction noted on post operative HKA axis scanogram. The average JOA Knee score preoperatively was 50.4 which improved postoperatively with average score of 80.5. average functional knee society score was 68.20 preoperatively which improved postoperatively to 89.10 Average VAS score preoperatively was 7.15 which reduced considerably to an average score of 2.89 postoperatively. We got excellent results in 12 patients (80%), good results in 2 patients (13.3%) and fair results in 1 patient (4.5%).



Graph 2: Pre-operative Varus Angle In open wedge osteotomy verses closed wedge osteotomy

Pre-Op Xray



Pre-Op HKA Axis

Post Op X-Rays

Sitting

Standing

Pre-Op Xray

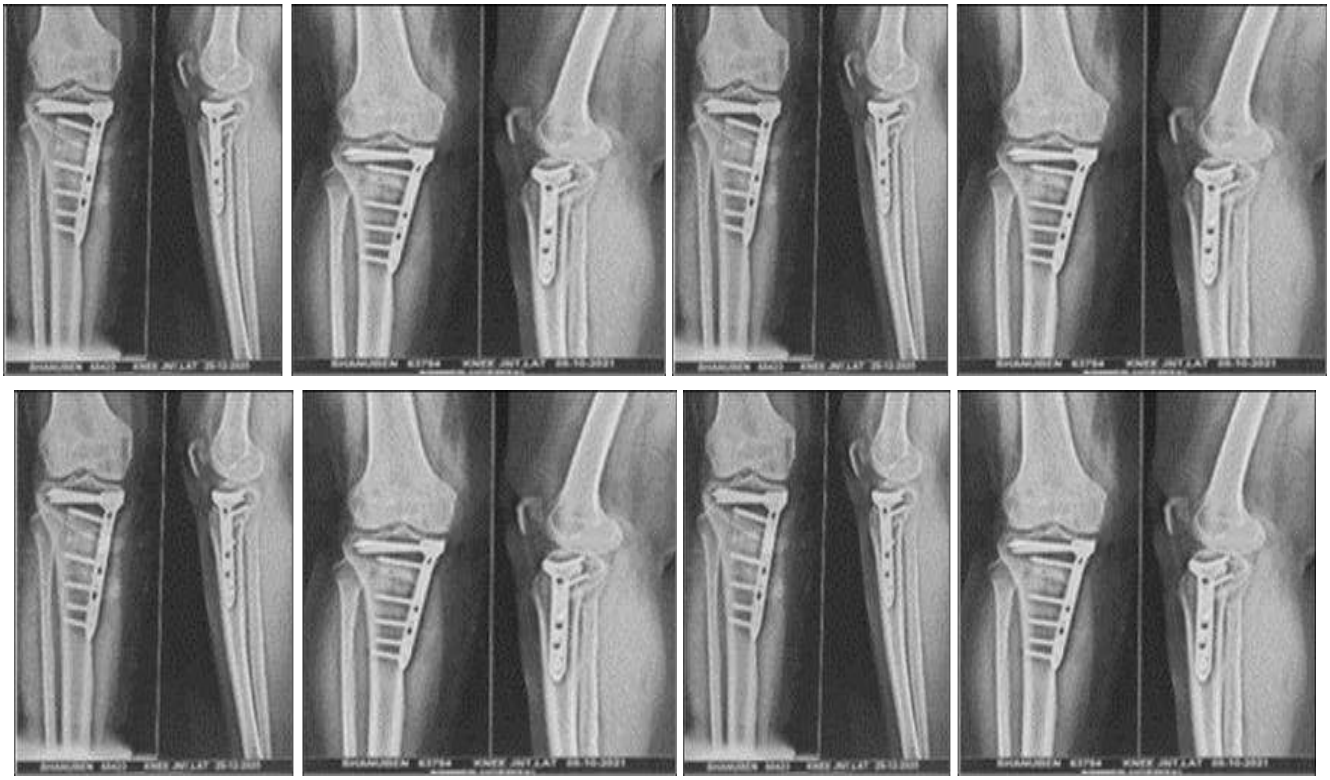
Pre-Op HKA

Pre-Op Xray

Pre-Op HKA

Sitting

Standing



Discussion

Our results showed that the closing-wedge osteotomy achieved significantly more accurate correction with less deviation from our objective of 4° valgus overcorrection at follow-up at one year.

We expected a better outcome in the opening-wedge group, because of the precise positioning possible with the tomofix plate and because it is performed under fluoroscopic control. Additionally, it is easier to create an opening wedge than to remove a wedge of bone from the proximal tibia. In our experience, with the closing-wedge technique it can be difficult to remove the wedge totally, especially at its apex at the medial side. A tomofix plate design, in which the screw-head locks into a more rigid plate, may provide more stability and give better results.

There was no statistical difference in the improvements in both groups. However, a follow-up of one year may be too short to demonstrate whether the benefit of the slight overcorrection approximating to 4° greater than physiological valgus remains true as previously suggested. To determine whether one type of osteotomy delays the requirement for total knee replacement more than the other requires a much longer follow-up.

Application of a plaster cast after an opening-wedge osteotomy did not appear to prevent loss of correction, with no difference in the mean hip-knee-ankle angles between the plaster and non-plaster groups at one year. However, the sample size in our study was calculated to detect a difference between the closing-wedge and opening-wedge techniques. This study lacks sufficient power to make a confident statement about the advantages or otherwise of using a plaster cast in conjunction with an opening-wedge osteotomy.

There were some limitations to our study like we were unable to obtain the standing full-length radiographs on the first day after operation because the patients could not stand on their operated leg.

Based on our study we conclude that open-wedge high tibial osteotomy achieves a more accurate correction and that both techniques reduce pain and improve function at follow-up.

The aim of the study was to evaluate the results of medial opened wedge High tibial osteotomy verses lateral closed wedge osteotomy with osteosynthesis in medial compartment osteoarthritis of the knee.

Table 1: Knee society score among different study groups

Study	Mean KSS
Howells *et al.* [6]	84
Aydogdu S *et al.* [7]	93
Saito T *et al.* [8]	89.4
Open wedge high tibial osteotomy	92.66
closed wedge high tibial osteotomy	90.33

Table 2: Comparison of complication rate

Study	Complication
Staubi *et al.* [9]	1(1%)
Lobenhoffer *et al.* [10]	1 deep infection 4 months postop
Valkering *et al.* [11]	4 (10%) superficial infection and under correction
Zaki *et al.* [12]	2 superficial infections
Kolb *et al.* [13]	0
Niemeyer *et al.* [14]	1 superficial infection
Gebhard *et al.* [15]	2 (4%) superficial infection
Open wedge high tibial osteotomy	1 superficial infection 1 under correction 1 lateral compartment involvement
Closed wedge high tibial osteotomy	1 superficial infection 1 under correction 1 staple loosening

Table 3: Comparison of mean age group in years

Study group	Mean age group (years)
M. Pfahler *et al*. [16]	52.8
Goran Magyer *et al*. [17]	54
G F McCoy *et al*. [18]	59.8
Anis Shiha *et al*. [19]	38.5
Present Study	48.38

Conclusion

Open and closed wedge HTOs obtain significant functional improvement in patients with medial osteoarthritis of the knee. Using the right technique is very important for good results. For stabilization of the medial ligament we recommend the open wedge osteotomy. The patient should be informed about the routine removal of the metal plate.

Conflict of Interest

Not available

Financial Support

Not available

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