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EARLY OUTCOMES OF HIGH TIBIAL OSTEOTOMY USING DYNAMIC AXIAL EXTERNAL FIXATOR IN MEDIAL COMPARTMENT OSTEOARTHRITIS OF KNEE.

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ABSTRACT

Structured abstract: Medial compartment osteoarthritis of knee in young adults has a variety of management options. Realignment surgeries by high tibial osteotomy unload the medial joint and are gaining popularity with increasing focus on knee preservation surgeries. Medial opening wedge osteotomy is one such time tested technique with the fixation being done using internal or external fixators. Here we present the early outcomes of infra-tubercle medial opening wedge osteotomy using a dynamic axial external fixator. **Methodology:** A single group cohort study was conducted to assess the functional outcomes of high tibial osteotomy with a uni-axial dynamic external fixator for medial compartmental osteoarthritis in younger patient. **Results:** Function was assessed using knee scores at 6 months and 12 months follow-up which was 85.5 and 83.1 respectively. On bivariate analysis of pre and post-operative Knee-scores, significant improvement was noted with average being 44.2 ± 4.01 which was statistically significant p value-<0.00001. Excellent results were obtained in 15 cases (75%) and good results in 5 cases (25%).Three patients developed pin track infections and were treated with antibiotics and pin tract care. **Conclusion:** High tibial osteotomy using dynamic external fixator is a simple and effective option for management of medial compartment osteoarthritis in young patients with good short-term functional outcomes and low risk of infection.

INTRODUCTION

Medial compartment osteoarthritis of knee is a common degenerative condition that is typically associated with varus malalignment [1]. Conservative management in such patients includes weight reduction, low impact activity, physiotherapy, supervised monitoring monitoring in the early stages and joint replacement in later stages [2].

High Tibial Osteotomy (HTO) is an accepted surgical technique for treatment of medial compartment osteoarthritis of knee especially in younger patients[3-4]. HTO transfers mechanical axis from medial to slightly lateral to the midline of the knee, thereby decreasing the load and subsequently delaying further progression of osteoarthritis. The biomechanical principle of high tibial osteotomy is to redistribute the weight bearing forces from the worn medial compartment across to the lateral compartment to relieve pain and slow the disease progression.

HTO involves biological angular distraction i.e. hemicallotasis following gradual medial open wedge osteotomy with intact lateral cortex to provide a stable hinge. Without the intact hinge this fixator is unstable. Using a dynamic axial external fixator leads to neo-histogenesis, gradual correction of varus deformity & change in the line of weight transmission from medial side of the knee to its native mechanical centre.

Tibial osteotomy of arthritic painful genu varum in younger patients has its advantages. The mechanical correction produced leads to symmetrical distribution of body weight and uniform distribution of joint forces in both the compartments. Furthermore, the biological effect produced by reduction of the local venous intraosseous pressure may also help to alleviate pain.

In this study we sought to evaluate the early outcome of high tibial osteotomy with a uniplanar axial dynamic external fixator for medial compartmental osteoarthritis in younger patient.

AIM

To evaluate the outcomes in young patients of high tibial osteotomy using dynamic axial external fixator in medial compartment osteoarthritis.

METHODOLOGY

This was a single group cohort study conducted in the Department of Orthopaedics, Government Medical College, Calicut, Kerala, India from May 2015 - May 2018. Institutional Ethics Committee approval was obtained before the commencement of the study. 20 patients admitted with clinically and radiologically diagnosed degenerative medial compartmental osteoarthritis of knee between the age 35-65 years met the inclusion criteria. Clinical features considered were knee pain on walking, joint line tenderness, presence of varus deformity and limitation of range of motion. Radiological features included the presence decreased joint space, osteophytes and varus malalignment. Patients with tricompartmental osteoarthritis, restricted range of movements at knee i.e. knee flexion of less than 90 degrees or flexion contracture of more than 15 degrees, age more than 65 years of age those with varus deformity of more than 20 degree were all excluded.

A uniplanar axial external fixator was used in all cases (Orthofix). It is an articulated dynamic axial lengthening fixator with bi-axial mobility. All cases were followed up for a minimum of 1 year.

SURGICAL TECHNIQUE

All patients were operated by the same surgeon with experience in knee osteotomies and limb reconstruction. Procedure was performed under spinal anesthesia with patient lying supine, knee in patella forward position by placing a pillow each under the trochanter and under the thigh so as to facilitate easy application of fixator. The surgeon stood on the contralateral side of the affected limb to obtain

access to medial side. A 6 mm pin was first inserted at the level of fibular head, parallel to joint line and as close as possible to the posterior tibial cortex under fluoroscopic guidance. (Figure 1-3).

Figure 1: Intra-operative positioning of operating limb with supports under the knee and the heel. This allows for easier access to medial tibial surface and application of the fixator.

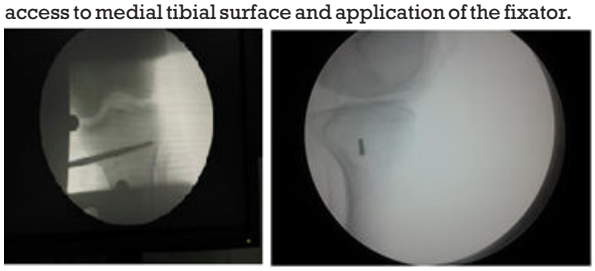

Figure 2: Placement of the first proximal pin(Left) – at the level of fibular head parallel to joint line taking care to avoid penetrating the proximal tibiofibular joint
Figure3 :Lateral view of the first pin(Right)-as close to the posterior cortex as possible; to be confirmed by end-on lateral view

The external fixator is connected to this pin to use as a pivot guide for the distal pins. Second pin was inserted parallel to the first pin and anterior to it(Figure 4). Two pins were then inserted at the distal third of shaft of tibia. A percutaneous infra-tubercular oblique opening wedge osteotomy with closed osteoclasis was performed taking care not to break the lateral cortex of the apex of osteotomy.[Figure5] Finally the fixator applied, completion of osteotomy was confirmed by slight distraction of osteotomy and observing the opening up under C-arm .Osteotomy gap was closed and fixator was locked with limb in varus position[Figure 6]. A compression dressing was given to prevent the formation of hematoma.

Figure 4: Placement of 2nd pin(Left) – placed parallel and anterior to the first pin
Figure 5: Medial Oblique Opening Wedge Osteotomy (Center)- osteotomy started 1.5-2 cm below proximal pins, directed towards proximal tibiofibular joint
Figure 6: Final intra-operative picture(Right)- wedge closed, limb in initial varus position

Physiotherapy was initiated early with closed chain quadriceps exercises and ankle pumps under analgesic cover and was continued till complete distraction of the fracture. Bedside mobilization was started in early post-operative period under the supervision of the surgeon. Toe-touch weight bearing with a walker or a pair of crutches was started after attaining adequate quadriceps control.
Spot radiographs were obtained on postoperative day 2. Distraction was given on days 5-7 and confirmed by a repeat radiograph. Follow-up radiographs were taken each month. The fixator was removed once adequate consolidation had been achieved.[Figure 8] Patients were advised protected weight-bearing for a month's duration. Angular correction was assessed using full-length anteroposterior (AP) and lateral radiographs. Corrections in the coronal and sagittal planes were determined by measuring mechanical axis deviations (MAD), tibio-femoral angles (TFA), and medial proximal tibial angles (MPTA) on AP radiographs; proximal posterior tibial angles (PPTA) on lateral radiographs.

Prior to removal, a clinical stress test for gradual disassembly was performed. This involved the following steps:

1. Trial of unassisted full weight-bearing to look for pain, limp and instability. After measuring the amount of distraction on the fixator, the central locking nut was loosened and the compression-distraction(CD) unit taken out. If the fracture was united , there should be no pain or limp and not more than 1-2 mm collapse as measured by checking the fixator reading.

2. The fixator was then removed and the patient was allowed to walk full weight bearing again with the half pins still in situ. If there was pain or limp, the fixator was just slipped on again, and maintained for a few days more.

3. Finally, if there was no pain on the previous step, the half pins were removed. Thereafter, a compression bandage is applied and the patient was made to rest for 15-20 min with the leg elevated to allow coagulation in the pin tracks.

From this point, onwards patient resumed gradual daily activities. Pin site healing was confirmed by follow-up at two weeks. Thereafter, a 6 monthly review was done to look for the opening up of joint space in the medial compartment that indicates healing up of the cartilage, maturation and remodeling of the regenerate and the filling up of pin sites. At the end of 1 year, full-length radiographs were taken to confirm the maintenance of the realigned axis. The functional outcome was assessed with the aid of Knee Society Score (KSS) at 6th month and 12th month.

RESULTS

A total of 20 patients of ages in the range of 44-58 years were enrolled in the study with mean age being 50.65. 95% of the patients recruited in the study were females (19). There was equal distribution of right and left knees.

Postoperatively patients were followed up at 6 weeks, 3 months, 6 months and 12 months and assessed with the aid of Knee Society Score (KSS) for functional outcome.

The Knee Society Scoring is subdivided into a knee score that assesses the clinical status of the knee joint and a functional score that rates the patient's ability to walk and climb stairs. The dual rating system eliminates the problem of declining knee scores associated with patient infirmity. With regard to the knee assessment, only the three main parameters of pain, stability and range of motion is judged and the flexion contracture, extension lag and mal-alignment is dealt with as deductions. Thus, 100 points will be obtained by a well-aligned knee with no pain, 125 degrees of motion, and negligible anteroposterior and mediolateral instability. Patient function considers only walking distance and stair climbing, with deductions for walking aids. The maximum function score, which is also 100, is obtained by a patient who can walk an unlimited distance and go up and down stairs normally. 50 points are allotted for pain, 25 for stability, and 25 for range of motion. Walking ability is expressed in blocks (approximately 100 meters). Stair climbing is considered normal if the patient can ascend and descend stairs without support.

The mean knee score at 6months and 12 months follow up was

85.5 and 83.1, respectively. Three patients had pin track infections on initial follow up and were treated with antibiotics and pin tract care. None of them required debridement or re-surgery. Bivariate analysis of pre and post operative Knee-scores using paired t-test showed significant improvement in Knee scores, the average being 44.2+4.01 with p value-<0.00001. Excellent results were obtained in 15 cases (75%) and good results in 5 cases (25%) it is good results.

The functional score evaluated walking distance and stair stepping with a maximum score of 100 points. A mean of 84.3 points was attained after high tibial osteotomy compared to an average 38.2 points preoperatively. The improvement was assessed by paired-t test and found to be statistically significant.

All our patients had an over correction of 7-9 degrees. Any further valgus correction, though biomechanically advantageous, is to be deferred as it can potentially lead to lateral compartment osteoarthrosis [11-13].

DISCUSSION

Medial compartment osteoarthritis is a common entity in the the spectrum of knee osteoarthritis. It is of crucial importance to recognise it early to prevent it from progression to tri-compartmental osteoarthritis. According to a study by Spahn et al, knee realignment to facilitate cartilage healing is an underutilized technique. With joint preserving surgeries becoming more popular, success of High tibial Osteotomy has come into sharp focus[8,12].

Osteoarthritis of knee usually occur secondary to mechanical factors in young patients, which include malalignment of the tibia or femur, ligamentous laxity, post-trauma, partial or complete meniscectomy, femoral and tibial osteonecrosis. Literature has shown that body weight has no co-relation with initiation of the disease. However, literature confirms the mechanical malalignment of the limb to be the single-most important factor for progress of MCOA [14] .

In the past decade, there has been a paradigm shift in India towards total knee replacement(TKR) for knee osteoarthritis. Although TKR is an excellent surgery in indicated cases, it has its fair share of complications including loosening and the need for multiple revisions. Moreover, the morbidity of knee replacement approaches that of knee amputation, particularly in young patients. This has led to a rejuvenated interest in joint preserving surgeries including osteotomies .

The benefits of osteotomy are: customized osteotomy gives good or excellent results at 15 years in more than 95%; open wedge osteotomy burns no bridges - can be revised to TKR and may even make TKR easier .This challenges the myth that cartilage cannot regenerate.[13-16]

High tibial osteotomy is a well accepted procedure for medial compartment arthritis since the work of Coventry and Maquet[15,16] .High tibial osteotomy can be done by closed or open wedge techniques. Fixation can be done internally by means of plates or externally using Ilizarov ring or unilateral external fixators such as Orthofix, bone subtraction techniques like lateral closing wedge, Maquet dome osteotomy and additive techniques like medial opening wedge osteotomy can also be used.

The classical lateral closing wedge osteotomy has been associated with complications including tibiofibular disruption, lateral muscle detachment, peroneal nerve dissection and possible palsy, bone stock loss and difficulty in placing future endoprosthesis; Ilizarov technique had the risk of translation. For all these reasons, medial opening wedge ostetomy have become more popular. However, similar to other fracture fixation procedures, chances of implant failure exist, though negligible.The older technique was the Coventry[14] method where lateral wedge resection was done and fixed with plate. The disadvantages include difficulty in future TKR, and need for accurate correction intraoperatively as it is a one time fixed correction technique. This makes it difficult for inexperienced surgeons and mistakes are unforgiving.

With gain in popularity of Ilizarov in 1990s Circular External fixator were used for correction of varus deformity .But they were complex and caused undue discomfort to the patient discomfort. In addition to this there is translation deformities as both cortices are cut and osteotomy is done away from the entre of rotation and angulation (CORA).

The lightweight, unilateral External Fixation (Orthofix) was designed specifically to address the problems inherent in classical external fixation techniques.The basic philosophy of fracture treatment with the dynamic external fixator is respect for, and enhancement of the natural physiological process of fracture healing, which demands rigidity in the early stages and a degree of movement at the fracture site in the later stages of the healing process.

Advantages of Unilateral Orthofix external fixator include:

1. No loss of bone stock; rather regeneration of good quality bone at the osteotomy site.
2. Fibular osteotomy not required.
3. Limb is not shortened.
4. Patellofemoral function is not altered as the osteotomy is below the tibial tubercle.
5. Restoration of physiologic alignment of the limb.
6. Strenuous physical activity is permissible after recovery from the procedure.
7. Future total knee replacement is easy.
8. No fear of the complications of joint replacement such as loosening, metastatic infection etc.

Disadvantages:

1. Cumbersome to bear the fixator for 3months.
2. risk of pin tract infection.
3. risk of collapse of soft regenerated bone if the fixator is prematurely removed (before 3 months).

In this study, the functional outcomes of the patients were assessed by Knee Society Score (KSS) with all patients having good to excellent pain relief, improvement of function, range of motion, muscle strength, flexion deformity and knee stability.

All patients considered for the study had an average preoperative KSS <60, graded as poor. The average improvement in KSS was 44.2+4.01 with major improvement in the domains of pain and function. Post operatively, excellent results (scores in 80-100 category) were seen in 70% patients.

Our outcomes were similar to the study by Manfred Pfahler[17] et al who conducted a retrospective study to assess the long term results of HTO for medial osteoarthrosis of knee. The study assessed the outcome with KSS and Hospital for Special Surgery Score over a course of almost 14 years. He reviewed patients from 1985-93 and of these 90% of patients had an excellent outcome in terms of pain relief and function.

Igemar Ivarsson[18] et al conducted a retrospective analysis of osteotomy done using staples and subsequent immobilization of MCOA. They analysed the function and radiological parameters with follow-up ranging from 5 to 11 years. 57% patients had a good result on initial 5 yearsfollow-up with significant improvement in the walking distance. They had assessed the patient with initial grades of osteoarthritis.

Aglietti [3] et al conducted a study in 1983 for HTO and

assessed outcome after 10 years of follow up. Grade 1 or 2 osteoarthritis patients were included in the study, 64 % patients had an excellent outcome. They had over corrected the angle and it also contributed significantly to the positive outcome.

Kashif Ashfaq et al [19] conducting a study with 68 patients, performed 91 HTOs using external fixator for medial arthrosis and noted a significant improvement in activity and range of movement after an accurate correction. The study compared the outcomes of two different constructs among patients with varied degrees of correction of varus deformity. Overcorrected group had better results. Assessment was conducted at only 6 months, while our patients were followed up for 12 months . In our study, correction of deformity was predetermined and all patients had slight over correction. Preoperative knee score significantly affected the final outcome in our study as well.

Trevor B [20] conducted HTO in 126 patients and assessed their outcome after 2 years of follow up, their goal was to shift the load from medial to lateral compartment and improve outcomes for the patient. They assessed outcome using KOOS score and gait analysis and 73% had a good outcome ,which is similar to our study after 12 months follow up.

Table 1: Comparison of outcomes in various previous articles.

STUDY GROUP	NO OF PATIENTS	FOLLOW UP	OUTCOME
Pfahler et al[17]	49	14 yrs	90% excellent
Aglietti et al[3]	176	6-7 yrs	64% excellent
Rudan et al[21]	268	8-10 yrs	60-70% good
Pogliacomi et al[22]	24	8 yrs	90% good
Tevor b et al[20]	126	2 yrs	73% better

HTO relieves the pain by unloading the medial compartment and shifting the mechanical axis to the normal side. Cartilage regenerates over a period of time. There is a consensus in the literature that slight over correction results in more satisfying results. Naudie et al, Sprenger et al, Koshino et al [24], noted 80%, 90% & 93.6% survivorship of HTO at 10-15 year follow-up, respectively. Existing literature shows that the HTOs with maximum survival for 15 or more years had a range of correction of 3-6º of femoro-tibial valgus angle. An angle < 3º & angle>6º would lead to persistence of MCOA or leads to LCOA. The open wedge HTO with the assistance of an external fixator (Orthofix)provides the adjustability to get an accurate correction down to a degree.

In our study, all patients underwent HTO using Orthofix, 75% had an excellent outcome and 25% a good outcome. This concurs with the studies listed in Table 7 . Most patients in our study had good/excellent outcomes, irrespective of comorbidities and early complications.

Our goal was to accomplish a minimum of 3-5 degrees of mechanical axis valgus. This is equivalent to 8-13 degrees of anatomic axis valgus (tibial-femoral anatomic alignment). The most successful alignment has been described as between 5 degrees and 13 degrees of valgus. Undercorrection (less than 5 degrees) may not give long-term pain relief. Overcorrection (greater than 13 degrees) is cosmetically objectionable, may lead to arthritic changes on the lateral side. Furthermore, distortion of the proximal tibia makes total knee arthroplasty more challenging if required in future.

Patients with a good outcome had an overall correction of 7-9 degrees of valgus. Previous studies have shown that slight over correction of the normal 7 degrees of anatomical valgus improved the long-term result especially in those with preoperative varus less than 20 degrees. So it is desirable to have a minimum of 8 to 10 degrees of valgus as the surgical goal to improve outcomes in high tibial osteotomy. (17-24).

Infection was defined as the presence of redness, warmth, and swelling around the scar alone with purulent drainage or significant elevation of the erythrocyte sedimentation rate and C-reactive protein These patients were treated with a short course of antibiotics as a precaution. Valkering et al and Takeuchi et al who reported 10% (4/40) and 1% (1/104) infection rates respectively, in their studies. None of the patients in our study had deep infection.

Limitations of our study include small sample size and lack of long term follow-up. More prospective studies are needed in this regard.

CONCLUSON

Medial opening wedge osteotomy using a dynamic axial external fixator is technically easier, has low complications with good functional outcomes and reduces difficulty of a future knee replacement, should it be needed. Furthermore, gradual correction using external fixator (Orthofix) allows for postsurgical correction of deformity .

Medial compartment osteoarthritis in young patients merits the use of knee preserving surgeries. Dynamic axial external fixator provides an accurate correction with excellent early functional outcomes. Valgus correction upto 10 degrees helps in unloading correction upto 10 degrees helps in unloading the joint and providing long lasting pain relief.

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