(International Print/Online Journal)

SJIF IMPACT FACTOR: 5.565
PUBMED-National Library of Medicine ID-101739732

ISSN (Print): 2209-2870
ISSN (Online): 2209-2862

International Journal of Medical Science and Current Research (IJMSCR)
Available online at: www.ijmscr.com
Volume 4, Issue 6, Page No: 762-766
November-December 2021

IJMSCR

Functional Outcome of HTO by Hemicallotasis Using Dynamic Uniplanar External Fixator in Unicompartmental Osteoarthritis Knee

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Type of Publication: Original Research Paper
Conflicts of Interest: Nil

Abstract

Background:
High tibial osteotomy (HTO) is a well-established procedure for the treatment of unicompartmental osteoteoarthritis of knee especially in active young adults.

Methods:
This prospective study was conducted on 25 patients with medial compartmental osteoarthritis of knee between Jan 2018 and Dec 2019 at a tertiary trauma centre. The inclusion criteria was patients in age group of 40-60years with isolated medial compartmental osteo-arthritis; no ligamentous laxity; no bony deformity; not responded to conservative treatment given for 6months, BMI<30,Non-smoker and having a good pre-operative range of movements. Patients with bi or tri compartmental osteoarthritis knee, patients with Kellgren Lawrence > grade 3, patients with rheumatoid arthritis, having range of motion<900 or flexion contracture of >150, medial compartment tibial bone loss of more than 2-3 mm, lateral tibial subluxation of more than 1cm were excluded from the study.

Results:
The mean pre-operative tibio-femoral angle was 184.20□4.60 which decreased to 172.60□7.10 at the end of 52 weeks which was statistically significant (p=0.03818). The mean time of distraction of the unit to achieve desired alignment was 4.08□0.6 weeks from the surgery while the mean union time was 17.2□2.4 weeks. The average duration of follow-up was 13.4 months. The knee score of KSS improved from 52.43□3.21 pre-operatively to 79.51□1.84 at the end of 1 year. Similarly there was an increase in the functional component of KSS from 31.21□1.26 pre-operatively to 75.38□1.87 at the end of 1 year.

Conclusion:
The open medial wedge HTO using unilateral dynamic fixator provides a strong fixation with minimal complications

Keywords: HTO, Medial, Unicompartmental,osteoarthritis,Hemicallotasis

Introduction

Osteoarthritis (OA) most commonly affects knee and is one of the of primary cause of disability with a prevalence of 22-39% in India[1]. The progressive loss of articular cartilage in OA is characterized by loss of articular cartilage and osteophyte formation further

causing bony deformity (most commonly varus) and soft tissue contractures[2].

The primary aim of the treatment is to alleviate the pain and improve the function. A myriad of treatment options have been proposed in the literature for varus type osteoarthritis of the knee. These includes non-pharmacological options such as physiotherapy[3], bracing or pharmacological options such as NSAID, intra-articular injections such as steroids[4], viscosupplements such as hyaluronic acid or prolotherapy[4-6]. The surgical options include joint sparing procedures like high tibial osteotomy or joint replacement procedures like unicondylar or total knee arthroplasty[6].

High tibial osteotomy (HTO) is a well-established procedure for the treatment of unicompartmental osteoteoarthritis of knee especially in active young adults. In this, the mechanical axis is redirected from the area of degeneration within the joint (most commonly medially in case of varus deformity) to a relatively normal (lateral) side to decrease the load and subsequently delay the progression of osteoarthritis[7,8]. Many techniques have been described for High tibial osteotomy. Four basic types most commonly used are medial opening wedge, lateral closing wedge, dome, and medial opening hemicallotasis[9,10].

The primary aim of the present study was to assess the clinical and functional outcome of patients with uni-compartmental medial osteoarthritis of knee treated by high tibial hemicallotasis osteotomy using a dynamic uniplanar external fixator.

The secondary aim was to assess the change in the mechanical alignment as indicated by the tibio-femoral angle at the end of 1 year.

Material and Methods

Study design and setting

This prospective study was conducted on patients with medial compartmental osteoarthritis of knee between Jan 2018 and Dec 2019 at a tertiary care centre in Navi-Mumbai, India.

Study population

Out of the 103 patients with osteoarthritis knee, 37 patients fulfilled the inclusion criteria. Of these, 29 patients agreed and underwent surgical intervention using the dynamic uniplanar external fixator. Since 4 patients were lost to follow-up, they were excluded from the study leaving 25 patients at the end for final evaluation. The study was commenced after the approval from the institutional ethical committee board (no.2018/SC/1/60).

Inclusion and exclusion criteria-

All young adults between 40 and 60 years of age with clinically and radiologically evident (Kellgren Lawrence[11] grade 2 and 3) isolated medial compartmental osteoarthritis knee who have not responded to conservative line of management for 6 months, BMI<30, non-smokers, having good pre-operative knee range of movements, and without ligamentous laxity or bony deformity were included in the study. Patients with bi or tri compartmental osteoarthritis knee, patients with Kellgren Lawrence > grade 3, patients with rheumatoid arthritis, having range of motion<90^0 or flexion contracture of >15^0, medial compartment tibial bone loss of more than 2-3 mm, lateral tibial subluxation of more than 1cm and patients not consenting for the surgery were excluded from the study. Well-written informed consent was obtained from all the patients enrolled in the study and pre-operative haematological and radiological (weight bearing antero-posterior and lateral radiographs of the affected side and orthoradiogram) assessment was done.

Surgical technique:

All the patients were operated under regional anaesthesia and in supine position under tourniquet coverage. A total of three doses of second-generation cephalosporin (one 30 mins before and two doses at 12 hourly intervals post-operatively) were administered to all the patients). A guide wire was passed 2cm below and parallel to the joint line at the level of fibular head in antero-posterior and just anterior to the posterior cortex in the lateral view. The guide wire was over drilled with 4.5mm drill bit which was then replaced with 4.5mm Schanz pin. The second Schanz pin was passed in the similar manner and parallel to the first pin, using the screw hole from the T-piece of the dynamic axial fixator. The third and fourth Schanz pin was then passed and finally tightened through the antero-medial surface from the first and fifth screw seats of the straight end clamp. For performing the osteotomy, a guide wire was passed through the tunnel in the cam at the level of hinge directing towards the fibular head below the

Volume 4, Issue 6; November-December 2021; Page No 762-766
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tibial tuberosity. A 4.5mm drill bit was then passed just before the lateral cortex maintaining the lateral hinge. Keeping the limb in neutral position, the osteotomy site was then closed using the compression distraction unit until the desired level of correction was achieved.

Post-operative protocol

Active assisted ankle mobilization was started within 24 hours. Partial toe touch weight bearing was started from the post-operative day 2 with the help of elbow crutches for 3 weeks followed by full weight bearing.

Distraction was commenced 7^{th}-10^{th} days postoperatively at the rate of 1mm/day (divided in four quarter turns every 6 hours) and was continued until the desired correction angle is achieved and the mechanical axis of limb passes through the base of lateral tibial spine i.e. Fujisawa point (3º to 5º mechanical axis valgus). The mechanical axis was calculated digitally on weight bearing orthoradiogram. The distractor was removed at the end of 3 months after the osteotomy site showed radiographic signs of consolidation. The Knee society scores (KSS) were calculated pre-operatively and at 6, 12, 24 and 52 weeks, respectively.

Statistical analysis

The statistical analysis was done using SPSS for windows version 21.0.0.1 (SPSS Inc., Chicago IL). Paired *t* test was used to compare the Knee society scores and tibio-femoral angles. Statistically significant difference was said when P value was <0.005.

Results

The mean age of the patients were 57.68±6.87 years. Fifteen (60%) patients in the present study were females. Right side was involved in 13 (52%) patients. The most common occupation of the patients was homemaker accounting for 13(52%) patients. The mean pre-operative tibio-femoral angle was 184.2^0±4.6^0 which decreased to 172.6^0±7.1^0 at the end of 52 weeks which was statistically significant (**p=0.03818**). The mean time of distraction of the unit to achieve desired alignment was 4.08±0.6 weeks from the surgery while the mean union time was 17.2±2.4 weeks. The average duration of follow-up was 13.4 months. The knee score of KSS improved from 52.43±3.21 pre-operatively to 79.51±1.84 at the end of 1 year which was statistically significant* (Table 1).

	Mean±SD	P value
Pre-operative	52.43±3.21	0.0472*
6weeks	61.27±2.12	
24weeks	71.34±1.17	0.0308*
52weeks	79.51±1.84	

Table 1- Knee society score (Knee score)

Similarly there was an increase in the functional component of KSS from 31.21±1.26 pre-operatively to 75.38±1.87 at the end of 1 year which was statistically significant (table 2).

Knee society score (Functional component)	Mean±SD	P value
Pre-operative	31.21±1.26	0.0035*
6 Weeks	45.87±2.34	
24 Weeks	61.53±1.21	0.0376*
52 Weeks	75.38±1.87	

Table 2- Knee society score (Functional component)

One (4%) patient in the present study had superficial pin tract infection at the end of 2 weeks that responded well to oral antibiotics while one (4%) patient had over correction of the mechanical axis with a tibio-femoral angle of 168^0. One patient (4%) in the present study had delayed union at 19 weeks. However, no additional surgical intervention was required for the same.

Discussion

The gradual correction in the tibio-femoral angle indicating an improvement in the mechanical axis of the lower limb in the basically decides success of high tibial osteotomy[12]. In a study conducted by Singh et.al concluded the range of 170-175° as normal in Caucasian population of both gender[13]. The mean pre-operative tibio-femoral angle in our study was 184.2^0±4.6^0 which decreased to 172.6^0±7.1^0 at the end of 52 weeks which was statistically significant (p-0.038). We had one (4%)

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patient with over correction of the mechanical axis with a tibio-femoral angle of 168^0. One patient (4%) in the present study had delayed union at 19 weeks. Involvement of lateral compartment post-surgery is one of the known complications because of overcorrection and worsening of varus deformity post-surgery is also a common complication due to under-correction via this procedure[14].

Same post-op complication was also reported by V. Bachhal et al. where 31 out of 37 knees operated obtained desired alignment via the same technique[15]. Uniplanar external fixator preserves bone stock and osteogenesis at the osteotomy side; no requirement of fibular osteotomy; limb length is maintained; patella-femoral joint anatomy is not altered as the site is below tibia tubercle; restoration of physiological alignment of limb; future knee replacement can be done with ease and no fear of aseptic loosening or metastatic infection. But it is difficult to bear the fixator for 3 months with associated pin tract infection and a major risk of pre-mature collapse in case fixator is removed16-18. Kapila et.al also reported that uniplanar external fixator for HTO gives better control in alignment of limb[19]. V.Bachhal et al.; Khurana et al and Mondanelli N et al reported superficial pin tract infection rate of about 16.4%; 16.6% and 25% respectively. In the present study only one patient had superficial pin tract infection at the end of 2 weeks that responded well to oral antibiotics.

Fouad ZHim et.al in their study of biomechanical stability in opening wedge HTO compared internal vs external fixation and conclude although plate fixation was far better than external fixator; fine tuning during healing process helps in correcting both sagittal and coronal plane deformity[20].

The results of the present study of uni-planar external fixator in High tibial osteotomy were compared with results from standard literature. The results were compared with studies conducted by by Kandaswamy et al[21], bonasia et al[22] and Gokhan Polat et al[23].(Table 3)

Knee Society Score (KSS)	Pre-op KSS	Post-op KSS
Kandaswamy Ganeshsanka et al[21]	54.25	82.55
Davide Edoardo Bonasia [22]	50.7±20.8	76.1±18.5
Gökhan Polat[23]	56.2 ± 14.6	70.1 ± 9.8
Our Study	49.32	80.28

Comparison of Functional Outcome with other studies: Table 3

This study is not without limitations. The small sample size and shorter duration of follow up remain the limitations of the present study. Thus from our prospective study on "HIGH TIBIAL OSTEOTOMY BY HEMICALLOTASIS USING A DYNAMIC UNIPLANAR EXTERNAL FIXATOR IN OSTEOARTHRITIS OF KNEE "with our experience with 25 knees we arrive at the conclusion that Medial open wedge osteotomy is a useful option in case of unicompartmental osteoarthritis of knee and it relives pain and improves the functional outcome in patients, also future total knee replacement will not be a problem as the bone stock is preserved.

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Volume 4, Issue 6; November-December 2021; Page No 762-766

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