Original Article

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High Tibial Osteotomy versus Proximal Fibular Osteotomy in Medial Compartmental Osteoarthritis of Knee: A Longitudinal Study

Orthopaedics Section

TANMAY DATTA[1], KUNAL MONDAL[2], AVIJIT BASAK[3], PINAKI DAS[4]

ABSTRACT

Introduction: Osteoarthritis (OA) is a chronic degenerative intra-articular disorder of cartilage and bone. Knee joint is most commonly involved due to its pivotal role in weight bearing as it is constantly exposed to wear and tear. Osteotomy procedures can achieve normal alignment of the weight bearing axis of the lower limbs.

Aim: To evaluate and compare the functional outcome of High Tibial Osteotomy (HTO) and Proximal Fibular Osteotomy (PFO) in medial compartmental osteoarthritis of knee joint.

Materials and Methods: This prospective longitudinal study was conducted in a tertiary healthcare centre, IPGMER and SSKMH, Kolkata, West Bengal, India from October 2019 to November 2021 for a duration of 26 months, in which 40 osteotomies were performed around the knee. Considering the inclusion and exclusion criteria 20 proximal fibular osteotomies and 20 high tibial osteotomies were operated avoiding the patients with advanced stage or tricompartmental OA. The scoring system considered for evaluation of the functional outcome was Oxford Knee Score (OKS) and Visual Analouge Scale (VAS) Score. The analysis was done through paired t-test with determining of p-value where value ≤0.05 was considered as statistically significant.

Results: Majority of the patients in the present study were more than 45 years of age. The most frequent age group was 46-50 years followed by 51-55 years. The follow-up period was atleast 15 months where the OKS score was 39.35±3.51 and 41.20±4.50 with p-value of 0.1556 and VAS score was 5.50±1.10 and 3.80±1.10 with p-value of <0.0001 for PFO and HTO, respectively. Only two of the patients developed surgical site infection in both cases.

Conclusion: In long term follow-up the final functional status of both treatment modalities were comparable although HTO was considered superior with significant improvement in pain relief perspective than PTO.

Keywords: Knee osteoarthritis, Kellgren lawrence score, Oxford knee score, Visual analouge scale score

INTRODUCTION

Osteoarthritis is a chronic degenerative disorder of multifactorial aetiology characterised by the loss of articular cartilage, hypertrophy of bone at the margins, subchondral sclerosis, and range of biochemical and morphological alterations of the synovial membrane and joint capsule. It is usually characterised by pain after prolonged activity or weight-bearing; and inactivity induced stiffness. Pain, stiffness, disability, and fatigue in varying severity are the most commonly reported symptoms [1]. The initial management is always conservative which includes the lifestyle modification and drug therapies [2].

The surgical options available for the management of unicompartmental osteoarthritis of the knee are limited to proximal fibular osteotomy, HTO and unicondylar knee replacement [3,4]. Unicondylar knee replacement surgery is not ideal for active young patients with physically demanding work. PFO is being gradually done by various orthopaedic surgeons and favoured over HTO due to ease of technique, less expenditures on surgical practice and lesser need for restoration as compared to HTO [4]. There is a dearth of knowledge about PFO mainly in developing countries as this is a relatively a novel procedure. Moreover, there is no extensive research comparing HTO and PFO in patients having osteoarthritis of medial compartment of knee joint. Hence, the present study was conducted with an aim to evaluate and compare the functional outcome of HTO and PFO in medial compartmental osteoarthritis of knee joint.

MATERIALS AND METHODS

This prospective longitudinal study was conducted in a tertiary healthcare centre, IPGMER and SSKMH, Kolkata, West Bengal, India from October 2019 to November 2021 for a duration of 26 months. The study was approved by the Institution Ethical Committee (IPGME&R/IEC/2020/351). The process of randomisation was alternative patient considering the age group between 35-75 years. A total number of forty patients were targeted referencing previous standard research [5]. A systematic randomised technique was followed for final enlistment of the patients dividing into two groups:

- 20 proximal fibular osteotomies
- 20 high tibial osteotomies.

Inclusion criteria: The criteria of selection include knee pain with medial compartment arthrosis aided by radiographic documentation (Kellgren-Lawrence grading 3) and range of motion of greater than 90° of flexion with no ligamentous laxity and no coronal plane deformity through clinical evaluation [6] were included in the study.

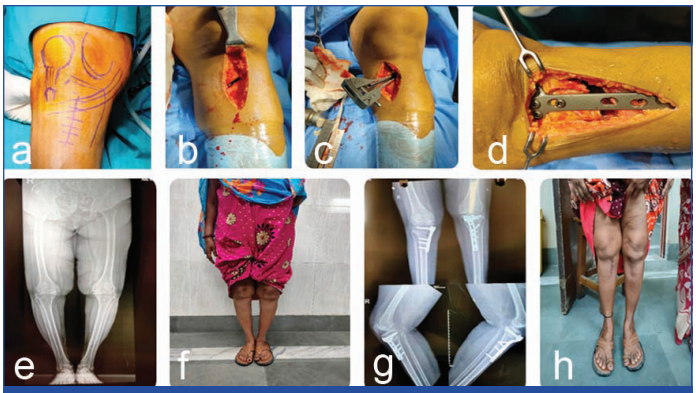
Exclusion criteria: Bi or tricompartmental osteoarthritis or osteoarthritis involving more than one compartment, more than 15 degrees of varus or valgus deformity in anatomical axis and patellar maltracking, congenital lower limb deformity, fixed flexion deformity greater than fifteen degrees, rheumatoid or post-traumatic arthritis, joint infection, previous meniscal injuries and those unwilling or unfit for surgery were excluded from study.

Study Procedure

The method of study consists of detailed history taking and clinical examination as per the proforma, investigations after taking written informed consent, to assess the functional outcome of the operation postoperatively following up of the patient at regular intervals for a period of minimum 15 months.

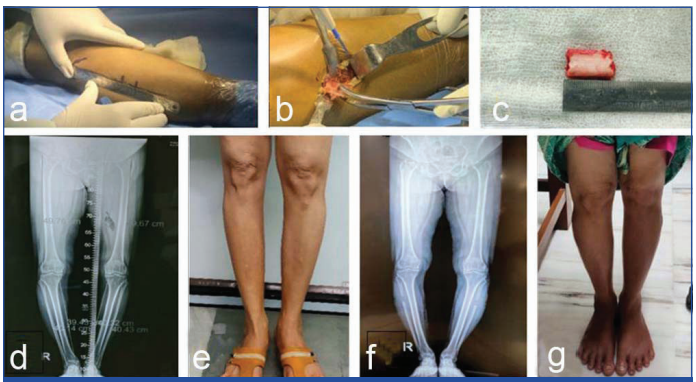
High tibial osteotomy: For HTO, a simple approach to determine the angle of correction was used that originally goes back to the research of Fujisawa Y et al., and later adapted as a guideline to determine pre and postoperative amount of varus [7]. The Weight Bearing Line (WBL) should pass from 62.5% of the tibial plateau

width when measured from the edge of the medial tibial plateau. This point called Fujisawa point matches over the mechanical axis with 3-5° valgus and locates slightly lateral to the lateral tibial spine. To determine the amount of required correction, a line was drawn from this point to the centre of the femoral head and another to the centre of the ankle joint. The angle created by these two lines indicates the amount of correction. Then the osteotomy line was drawn at about 4 cm below the medial joint line toward the fibular head [Table/Fig-1a,b]. This line was measured in millimetres and should be transferred to the apex of triangle [Table/Fig-1c]. The width of the triangle's base was measured in millimetres, which corresponds to the amount of correction required during a medial open wedge. osteotomy [Table/Fig-1c] [8]. The standard Tomofix plate was used to stabilise the osteotomy part of tibia [Table/Fig-1d]. The preoperative and postoperative radiological and clinical evaluation have been shown in [Table/Fig-1e-h].



[Table/Fig-1]: (a) Surface anatomy and bony landmarks before proceeding to osteotomy; (b) Incision over anteromedial aspect of proximal tibia; (c) Angle measured duoplaner medial open wedge osteotomy done; (d) Supported by Tomofix plate. (e,f) Preoperative radiological and clinical evaluation (g,h) Postoperative radiological and clinical evaluation.

Proximal fibular osteotomy: In PFO, 5-7 cm incision was made over the posterolateral aspect of the fibula [Table/Fig-2a]. A plane was developed between peroneus longus and soleus. After adequate exposure, osteotomy was performed at 6 cm distal to tip of fibula with an osteotome and mallet or a narrow blade oscillating power saw. A 2-2.5 cm bone fragment can be removed with a Kocher forceps, attachments removed with a periosteum [Table/Fig-2b,c]. Wound was closed after achieving haemostasis, closed in layers. A light compression bandage was done. The preoperative and postoperative radiological and clinical evaluation have been shown in [Table/Fig-2d-g].



[Table/Fig-2]: (a) Skin measurement along with osteotomy planned; (b) Fibula is exposed and measured cut has been done; (c) 2.5 cm fibular part. (d,e) Preoperative radiological and clinical evaluation; (f,g) Postoperative radiological and clinical evaluation.

All the exercises (static quadricep drill, bed side knee bending, ankle ROM) were resumed within seven days of operation which were also done preoperatively, seven days prior to surgery. Postoperative Anteroposterior (AP) and lateral radiographs were obtained after surgery [Table/Fig-1g,2f]. After checking proper quadricep power walking with full weight bearing by four point walker support was allowed after two weeks in postoperative patients of HTO [Table/Fig-1h]. But with patients of PFO full weight bearing ambulation was allowed with quadriceps drill and knee range of motion exercises from day three depending upon the tolerance of postoperative pain by the patient [Table/Fig-2g]. All patients were discharged from hospital after dressing. Stitches were removed on postoperative day 14. Patients were followed-up in the Outpatient Department (OPD) every four weeks and evaluated till 15 months.

At each follow-up, patient's functional status was assessed using the OKS Questionnaire which has 12 questions based on both functional and pain parameters with five available options, each scoring 0 to 4 [8]. The final score was summed up. The intensity of pain in patients with OA was assessed by using a VAS, consisting of a 10 cm long horizontal line marked with no pain on one end, and worst pain imaginable on the other end. Patients marked the place that corresponds best to their pain intensity on the given line. The numerical values on the VAS were obtained as the distance in centimeter from "no pain" to the point marked on the line by each patient [8]. Complications were noted. The OKS and VAS at one month, three months, six months, one year and 15 months follow-up were documented and analysed.

STATISTICAL ANALYSIS

For statistical analysis data were entered into a Microsoft excel spreadsheet and then analysed by Statistical Package for the Social Sciences (SPSS) (version 27.0; SPSS Inc, Chicago, IL, USA) and GraphPad Prism version 5. Data had been summarised as mean and standard deviation for numerical variables and count and percentages for categorical variables. Two-sample t-tests for a difference in mean involved independent samples or unpaired samples. A p-value ≤0.05 was considered for statistically significant.

RESULTS

Majority of the patients in our study were more than 45 years of age. The most frequent age group was 46-50 years followed by 51-55 years [Table/Fig-3]. Both left (n=20) and right knees (n=20) were equally considered in our study.

	HTO		PFO		
Age group	Male	Female	Male	Female	Total
41-45	1	2	1	1	5
46-50	4	4	3	4	15
51-55	2	5	2	2	11
56-60	1	1	1	6	9
Mean age±SD	50.76±3.18		52.61±3.77		

[Table/Fig-3]: Age and gender distribution of participants.

As per scoring, after 15 months of follow-up HTO had a total 13 patients scored between 40-48, rest all ranged between 30-39. For PFO total 6 patients scored above 40 after 15 months, rest all were between 30-39.

The mean preoperative oxford knee score was 20.05±3.25 and 20.65±3.88 in cases of high tibial osteotomy and proximal fibular osteotomy. But at 15 months of follow-up the score lied 39.35±3.51 and 41.20±4.50 for PFO and HTO, respectively. Though functional outcome came better with HTO but it was still non significant (p-value=0.155) [Table/Fig-4]. The mean preoperative VAS Score was 7.90±0.78 and 7.65±0.81 in cases of high tibial osteotomy and proximal fibular osteotomy, respectively. But at 15 months of follow-up the score lied 5.50±1.10 and 3.80±1.10 for PFO and HTO, respectively. So, pain relief status came better with HTO and it was statistically significant (p-value <0.0001) [Table/Fig-5].

None of patients were observed to develop neurological palsy. Only two patients developed surgical site infection in both cases. The complaints ranged from swelling over dorsum of the foot to lateral

Duration	Groups	Number	Mean	SD	Minimum	Maximum	Median	p-value
Preoperative	HTO	20	20.05	3.2521	14.00	26.00	20.00	0.5994
	PFO	20	20.65	3.8835	14.00	28.00	21.00	
At 1 month follow-up	HTO	20	9.65	0.9333	8.00	11.00	9.00	<0.0001
	PFO	20	34.55	4.1987	26.00	43.00	35.00	
At 3 months follow-up	HTO	20	26.85	3.3131	21.00	33.00	27.50	<0.0001
	PFO	20	40.05	4.2237	33.00	48.00	39.50	
At 6 months follow-up	HTO	20	33.25	4.3271	24.00	40.00	33.00	<0.0001
	PFO	20	42.00	4.3649	35.00	49.00	41.50	
At 12 months follow-up	HTO	20	38.50	4.9151	31.00	46.00	39.00	0.0286
	PFO	20	41.70	3.9216	36.00	49.00	41.00	
At 15 months follow-up	HTO	20	41.20	4.5026	31.00	47.00	42.50	0.1556
	PFO	20	39.35	3.5135	35.00	46.00	39.00	

[Table/Fig-4]: Distribution of mean OKS.
Two sample t-test was used, p-value <0.05 was considered significant

Duration	Groups	Number	Mean	SD	Minimum	Maximum	Median	p-value
Preoperative	HTO	20	7.90	0.7881	7.00	9.00	8.00	0.3296
	PFO	20	7.60	0.8127	6.00	9.00	8.00	
At 1 month follow-up	HTO	20	7.90	0.7881	7.00	9.00	8.00	<0.0001
	PFO	20	6.00	0.7947	5.00	8.00	6.00	
At 3 month follow-up	HTO	20	6.45	0.9445	5.00	8.00	6.00	0.0008
	PFO	20	5.40	0.8826	4.00	7.00	5.00	
At 6 month follow-up	HTO	20	5.70	1.0311	4.00	8.00	6.00	0.0587
	PFO	20	5.10	0.9119	4.00	7.00	5.00	
At 12 month follow-up	HTO	20	4.55	1.2344	3.00	7.00	4.50	0.2766
	PFO	20	4.95	1.0501	3.00	7.00	5.00	
At 15 month follow-up	HTO	20	3.80	1.1050	2.00	6.00	3.50	<0.0001
	PFO	20	5.50	1.1002	3.00	7.00	5.50	

[Table/Fig-5]: Distribution of mean VAS score.
Two sample t-test was used, p-value <0.05 was considered significant

leg observed in PFO. All patients were managed conservatively and improved over the course of five months.

DISCUSSION

The prevalence of osteoarthritis in the Indian subcontinent is 28.7% [10]. Chronic knee pain due to knee osteoarthritis is among the most common orthopaedic problems patient's present with. There are a multitude of options available to treat osteoarthritis. Often patients present with osteoarthritis limited to the medial compartment. In these patients, there are classically two surgical options offered once medical treatment fails to provide relief, that is, HTO and PFO. When the prerequisites for HTO are met, the outcomes are favourable. But the procedure of conversion to arthroplasty later on becomes technically challenging. PFO provides an effective, less invasive option for these patients [11]. In this study the two surgical procedures are compared on basis of functional outcome and pain relief over a certain period of follow-up [12].

In this comparative study of 40 patients having osteoarthritis of the knee and treated by either PFO or high tibial open wedge Osteotomy, it was found that females were affected more commonly as compared to males. Srikanth VK et al, undertook a meta-analysis of population based studies of OA providing sex specific data [13]. The authors found that males had a reduced risk for prevalent knee osteoarthritis. The authors concluded that females tend to have more severe knee osteoarthritis, particularly after menopausal age. Similar predominant female affection was also reported by Quintana JM et al., and Pal CP et al, [10,14]. The most frequent age group was 46-50 years followed by 51-55 years. Age undoubtedly contributes to the prevalence of osteoarthritis [15].

In a study by Hui C et al., the mean OKS score for HTO cases was 40 and a study by Robinson PM et al., the mean was 35.40 whereas in our study it was 38.50±4.91 after 1 year of follow-up [16-18]. Munshi N showed a mean recorded preoperative Oxford knee score 23.87±3.74 mm and postoperative score of 40.2±5.8 mm over one year follow-up. Another study by Utomo DN et al., the preoperative and postoperative (over one year follow-up) OKS was 25.66±4.18 and 36.80±3.00 [5] and in the present study it was 20.65±3.88 preoperatively with postoperative one year follow-up it became 41.70±3.92. Also in the present study within first six months of follow-up from preoperative stage, the OKS risen up to 21.35±3.71 by number in case of PFO but in HTO the number was only 13.2±3.60. If compared the improvement was statistically significant for PFO in first 6 months with a p-value of <0.0001. But in 15 months of follow-up the score lied 39.35±3.51 and 41.20±4.50 for PFO and HTO with p-value of 0.15. So, if summed up a significant functional improvement seen in patients treated with PFO at initial stage. But in long term follow-up over 15 months the functional score was comparable.

The VAS score is the numerical reflection of pain. A study by Shin CS and Lee JH over HTO the average preoperational VAS score 6.6 with postoperative one year follow-up score 3.9 [19], but in the present study it was 7.90±0.78 and 4.55±1.23. In PFO a study by Huda N et al., shows mean VAS score of 8.3 preoperatively changed to 6.3 at 6 months follow-up and 7 at 12 months follow-up [20]. A study by Sabir AB et al., the VAS was improved from 7.33±0.72 to 7.13±1.64 at three months and remained the same at final follow-up [21]. In present study the mean difference from preoperative stage

to six months duration were 1.95±1.50 and 2.45±2.06 for HTO and PFO respectively with p-value of 0.3867. Which means at first six months functional improvements in both groups were comparable. But at 15 months interval those stood 4.1±1.02 and 2.15±1.04 for HTO and PFO groups with a significant p-value of <0.0001. That implies better painless status with HTO cases. Mahadik SK et al., concluded that functional outcome and improvement in VAS were comparable in both the groups [22].

There is progressive declination of both scores with cases of proximal fibular osteotomy whereas the HTO cases show slow and gradual progression over time. The reasons behind declination with PFO may be multifactorial as it depends on patients Body Mass Index (BMI), physical rehabilitation, bone morphology which hinders the progress over time.

Limitation(s)

Firstly, sample size was small comprising of 40 patients despite the large number of patients presenting to our OPD. Many patients opted for a medical management and refused surgery. Secondly, due to the limited study period, the impact of the surgery on the biomechanics of the ankle or hip could not be assessed. A longer follow-up period will be required to assess the long-term effect of this surgery on osteoarthritis of the knee. And finally, as this was not a multicentric and multiobserver study, biasness may be there for the chosen surgical methods.

CONCLUSION(S)

From the present study, it is concluded that HTO and PFO both were a valid surgical option for medial compartment osteoarthritis knee. Although PFO is a simple procedure, but it has proven its significance in terms of results over HTO at first six months duration. But at the end of 15 months duration the final functional status of both treatment modalities were comparable although High Tibial Osteotomy came out superior with significant improvement in pain relief perspective than Proximal Fibular Osteotomy.

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PARTICULARS OF CONTRIBUTORS:
1. Associate Professor, Department of Orthopaedics, IPGMER and SSKMH, Kolkata, West Bengal, India.
2. Orthopaedic Resident, Department of Orthopaedics, IPGMER and SSKMH, Kolkata, West Bengal, India.
3. Assistant Professor, Department of Orthopaedics, IPGMER and SSKMH, Kolkata, West Bengal, India.
4. Senior Resident, Department of Orthopaedics, IPGMER and SSKMH, Cuttack, Odisha, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Kunal Mondal,
Subuddhipur, Beltala, Green Park, Baruipur, Kolkata, West Bengal, India.
E-mail: kunal.doc91@gmail.com

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