

Effectiveness of Proximal Fibular Osteotomy as an Alternative Treatment Modality for Pain Relief and Functional Improvement in Medial Compartment Knee Osteoarthritis

PRATIK RAMESH GANDHI¹, SUMEET SHARAD PATIL², MAROTI RAGHOJI KOICHADÉ³

ABSTRACT

Introduction: Medial compartment knee Osteoarthritis (OA) is a painful and debilitating disease that hinders an individual's day-to-day activities physically and psychologically. Therefore, amelioration of pain is of utmost importance, which can be achieved by decompressing the medial compartment by Proximal Fibular Osteotomy (PFO). PFO is a simple, novel surgical technique that leads to significant pain relief and functional improvement in patients with knee OA.

Aim: To assess the effectiveness of PFO in patients with primary medial compartment OA of the knee joint in terms of pain relief and functional outcome.

Materials and Methods: A prospective and interventional study was carried out in the Department of Orthopaedics at Indira Gandhi Government Medical College, Nagpur, Maharashtra, India, during the period from November 2017 to October 2020. A total of 58 patients with moderate to severe symptoms of medial compartment knee OA underwent PFO. Visual Analogue Score (VAS score), Knee Society Score (KSS), and Femoro-tibial Angle (FTA) were assessed preoperatively, postoperatively, and during

follow-up visits at 1, 3, 6, and 12 months. These parameters (VAS score and KSS) were also compared with groups based on Body Mass Index (BMI) and Kellgren-Lawrence (K-L) grading. Paired-t test was used. A p-value of <0.001 was considered statistically significant.

Results: Remarkable pain relief was observed by the significant decline in mean VAS score from 8.04 ± 0.68 to 2.65 ± 1.14 at the final follow-up. Mean KSS at final follow-up was 69.82 ± 3.03 , which was significantly higher than the preoperative score of 43.38 ± 2.39 (p-value <0.001). A change in mechanical alignment was seen with a decrease in mean FTA from $183.38 \pm 1.29^\circ$ to $179.84 \pm 1.83^\circ$ (p-value <0.001) at the final follow-up. Also, it was observed that results were much more encouraging and consistent in patients with BMI ≤ 24.99 unit kg/m^2 and K-L grades 1 and 2.

Conclusion: The PFO is a simple, safe, reasonable, and effective surgical modality of treatment in patients with primary medial compartment knee OA that provides good pain relief and functional improvement. PFO can be an alternative treatment modality for pain relief in patients with medial compartment knee OA.

Keywords: Body mass index, Decompression, Kellgren-Lawrence score, Knee pain, Knee society score, Upper partial fibulectomy

INTRODUCTION

Primary OA is one of the most ubiquitous chronic degenerative diseases of the knee joint, with an overall prevalence of 28.7% of the population [1]. It is a chronic disabling condition characterised by persistent pain, stiffness, and restriction of range of movements, which encumbers the activities of daily living [2]. Of all the three compartments of the knee, the medial compartment bears 60-80% of the load during weight-bearing in normal healthy individuals [3,4], which makes it the most vulnerable site for OA. Another plausible reason based on the current belief for the involvement of the medial compartment is that the load is distributed along the mechanical axis, which normally passes medial to the centre of the knee [4]. Majority of the patients with medial compartment knee OA present with varus deformity at the knee, indicated by FTA of more than 180° and narrowing of Medial Joint Space (MJS) [5].

Pain is one of the most disturbing presenting symptoms that impede an individual's day-to-day activities physically and psychologically. This debilitating condition can be treated by various treatment modalities including conservative and surgical methods. The conservative management for OA of the knee incorporates analgesics, visco-supplementation, intra-articular injections of steroid or platelet-rich plasma, and physical therapy [6,7]. Total Knee Arthroplasty (TKA) and High Tibial Osteotomy (HTO) are the two established surgical modalities for knee OA, both of which are quite expensive

and associated with procedural intricacies as well as various complications [5,8].

The PFO is a new emerging surgical modality, which has been reported as an alternative surgical option for patients with primary medial compartment knee OA [4,8-10]. PFO is a straight forward, safe, technically less challenging, and affordable procedure. It is suitable for both the young and elderly population, associated with minimal blood loss and short hospital stay [9]. PFO significantly ameliorates pain and improves knee functions in these patients [10]. However, this procedure is not a definitive one and has immense potential in deferring the need for TKA. In the future, TKA or HTO if required can be done easily without any hurdles to the knee which has undergone PFO beforehand [8]. In this part of the world where TKA and HTO pose a great burden on patients with OA as surgical treatment, PFO can provide a cost-effective treatment modality with significant relief of pain and functional improvement, with shorter hospital stays and early rehabilitation.

Though PFO is an evolving modality in the treatment of knee OA, there are very few studies available related to its outcome. On the other hand, the effect of BMI [11,12] and the relation of K-L grading [13] with the outcome of PFO have also not been taken into consideration by previous studies.

Hence, the present study was undertaken to assess the effectiveness of PFO in patients with primary medial compartment OA of the knee

joint, in terms of pain relief (clinical outcome), improvement in range of motion (functional outcome); probable correction and realignment of the mechanical axis (radiological outcome). Also, to establish the relationship between BMI and K-L grading with the functional outcome of this procedure. Thus, the study aimed to evaluate the effectiveness of PFO on pain relief and functional outcome in patients with medial compartment knee OA.

MATERIALS AND METHODS

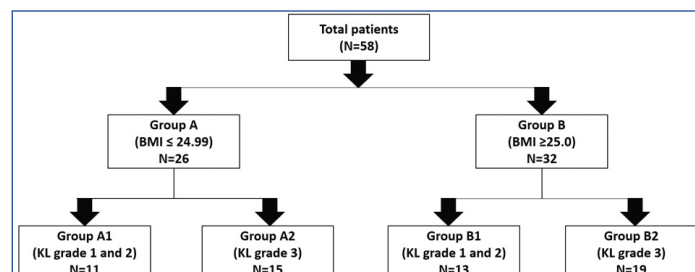
A prospective interventional study with a quantitative research design was carried out in the Department of Orthopaedics at Indira Gandhi Government Medical College, Nagpur, Maharashtra, India, from November 2017 to October 2020. The study was commenced after appropriate approval from Institutional Ethics Committee (IEC) (3201/2017) and written informed consent from all the patients were obtained. Sample size was calculated by using purposive sampling method (non probability sampling method).

Inclusion criteria: Knee pain with medial joint line pain having visual analogue score 5-9, age ranging from 45-60 years, BMI less than 30 kg/m², patients with Grades 1, 2 and 3 of knee OA K-L [13] with genu varus up to 15° were included in the study.

Exclusion criteria: Patients with genu valgum, inflammatory arthritis, acute trauma, tumours, and patellofemoral arthritis. The study included 58 patients visiting the Outpatient Department (OPD) and 18 patients were excluded from the study.

Study Procedure

A detailed history and clinical assessment were carried out for the patients with knee pain, restriction of movements, and radiological corroboration by full weight-bearing anteroposterior (AP) and lateral views of both the knees. Patients were divided into various groups as shown in [Table/Fig-1] based on BMI [11,12] and K-L grading [13].



[Table/Fig-1]: Grouping and subgrouping of patients based on BMI and K-L grading.
** BMI: Body mass index, K-L Grade: Kellgren Lawrence grading

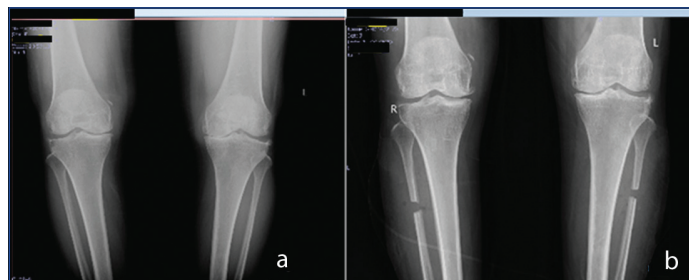
Surgical technique of PFO [4,8,10]: Under spinal anaesthesia, the patient was placed in a supine position, and a pneumatic tourniquet was applied to obtain a clear surgical field. Using Henry's posterolateral fibular approach, approximately 5 cm incision was taken, 7-9 cm distal to the caput fibulae [Table/Fig-2a-c]. Subcutaneous tissue dissection was done and an intermuscular plane was obtained between the peroneus longus and brevis anteriorly and soleus muscle posteriorly [Table/Fig-2d]. For a few initial cases Hohmann's retractors were used to retract the soft tissues which later on were replaced by Langenbeck retractors to expose the fibula. Osteotomy level was marked over the fibula, which was around 6-10 cm distal to caput fibulae [Table/Fig-2e], and cuts were taken 1 cm proximal and distal to it. The osteotomy was carried out by oscillating saw in the first two cases, following osteotomies were done by using sharp 2.7 mm drill bits. A broad, curved osteotome was placed medial to the fibula to avoid damage to the underlying common peroneal nerve and interosseous membrane. The segment to be removed was held by bone holding clamp before making cuts to prevent medial migration followed by easy removal. Osteotomy was performed with the help of an osteotome and mallet [Table/Fig-2f]. Osteotomised ends were checked for any bony sharp spikes and were smoothed as necessary. Tourniquet was released and haemostasis was achieved.

A thorough wound wash was given with 0.9% normal saline. Direct subcutaneous tissue closure was done without closing underlying muscle fascia followed by skin closure [Table/Fig-2g].



[Table/Fig-2]: Images of surgical procedure of PFO. a) Depicting measurement taken to decide the level of incision from caput fibulae, b) Markings of caput fibulae and level of incision, c) Incision of PFO, d) Intermuscular plane identification, e) Marking the level of osteotomy, f) Osteotomy done with the help of osteotome and mallet, g) Skin closure of a surgical site.

The patients were permitted to walk full weight bearing without any support at the end of 24 hours after surgery. Postoperatively patient was assessed for Visual Analog Score (VAS score) [14], Knee Society Score (KSS) [15], and FTA [16] on antero-posterior and lateral radiographs of full weight-bearing knee [Table/Fig-3]. All patients were discharged on the second postoperative day and were followed-up for suture removal on postoperative days 12-14. Subsequent follow-up of patients was done at one month, three months, six months, and at 12 months. At all follow-up visits, each patient was evaluated for VAS, KSS, and FTA. All the surgeries and follow-up visits were performed by a single surgeon.



[Table/Fig-3]: Preoperative and postoperative radiographs. a) Showing preoperative AP and lateral views, b) Postoperative AP and lateral radiograph of the knee joint after PFO.

STATISTICAL ANALYSIS

The standard descriptive statistical method was used to describe parameters using statistical software, STATA, version 10.1, 2011. Continuous variables were described using means, standard deviations, and ranges, and tabulation was done accordingly. Inferential statistics

included paired t-tests for comparison among various parameters such as VAS, KSS and FTA from baseline (preoperative) to one month, three months, six months, and 12 months period. A p-value of <0.001 was considered statistically significant.

RESULTS

A total of 58 patients were included in the study, of which 38 underwent surgery for bilateral knees and 20 were operated on for unilateral knees. Among these, three patients were lost to follow-up. Thus, a total of 55 patients were evaluated postoperatively for upto 12 months. The demographic data of the 58 patients are illustrated in [Table/Fig-4].

Variables	Values
No. of patients	58
Age	45-60 years (53.76±3.79)
Sex	Females: 41 (70.69%) Males: 17 (29.31%)
Surgical duration	34.8±4.36 minutes
Complications	Paresthesia on the dorsum of the foot: 03 EHL weakness: 02 Transient foot drop: 01

[Table/Fig-4]: Demographic data and complications.

*EHL: Extensor hallucis longus

The mean age of patients was 53.76±3.79 years, and there was a female preponderance. The mean surgical duration was 34.8±4.36 minutes for the unilateral knee. Postoperatively each patient was assessed for VAS, KSS, and FTA, and compared with the preoperative findings, which are illustrated in [Table/Fig-5-8].

Findings	Preoperative	Postoperative	1 month	3 months	6 months	12 months	p-value**
VAS	8.04±0.68	3.07±0.81	2.33±0.57	1.98±0.45	2.01±0.63	2.65±1.14	<0.001
KSS	43.38±2.39	53.84±2.75	57.75±2.46	63.18±2.34	67.74±2.03	69.82±3.03	<0.001
FTA (°)	183.38±1.29	182.33±1.18	181.51±1.18	180.56±1.24	179.67±1.23	179.84±1.83	<0.001

[Table/Fig-5]: Preoperative, postoperative, and follow-up values of VAS, KSS and FTA.

VAS: Visual analog score; KSS: Knee society score; FTA: Femorotibial angle; **Paired-t test used (from baseline (preoperative) to 1 month, 3 months, 6 months, and 12 months period)

BMI	Group A				Group B			
	A1		A2		B1		B2	
	VAS	KSS	VAS	KSS	VAS	KSS	VAS	KSS
Preoperative	8.33±0.81	46.67±1.96	8.25±0.75	44±1.75	8±0.53	43.87±1.4	8.77±0.52	41.82±0.59
Postoperative	2.17±0.4	58.33±2.25	2.92±0.79	55.5±1.63	2.93±0.88	53.47±2.03	3.5±0.59	51.95±1.84
1 months	1.83±0.75	61.17±2.13	2±.042	59.5±1.38	2.53±0.51	57.67±1.49	2.5±0.51	55.91±1.84
3 months	1.67±0.51	65.83±1.72	1.92±0.51	64.83±1.52	2±0.53	63±1.96	2.09±0.29	61.68±1.91
6 months	1.5±0.54	69.67±1.36	1.75±0.45	68.83±1.26	1.87±0.51	67.4±1.24	2.36±0.65	66±1.9
12 months	1.33±0.51	73.33±1.63	2.33±0.98	71.17±1.74	2.47±1.06	70.67±1.23	3.36±0.9	67.55±3.14

[Table/Fig-6]: Depicting trend of VAS and KSS in groups formed based on BMI and K-L grading.

*p-value <0.001 is for preoperative vs. 1 month; preoperative vs. 3 months, and preoperative vs. 12 months

BMI: Body mass index; K/L: Kellgren lawrence; VAS: Visual analog score; KSS: Knee society score

Groups	Preoperative	Postoperative	12 months follow-up	p-value** (preoperative vs. 12 months)	
Group A	A1	182.33±0.81	181.33±0.83	178.17±0.75	<0.0001
	A2	182.83±1.93	181.92±0.99	178.83±0.93	<0.0001
Group B	B1	183.27±1.16	182.29±1.08	179.53±1.3	<0.0001
	B2	184.05±1.36	182.91±1.19	181.05±1.4	<0.0001
Overall mean	183.38±1.29	182.33±1.18	179.84±1.83	<0.0001	

[Table/Fig-7]: Comparison of Femoro-tibial axis (FTA) at preoperative, postoperative, and at final follow-up.

**paired-t test used for comparison

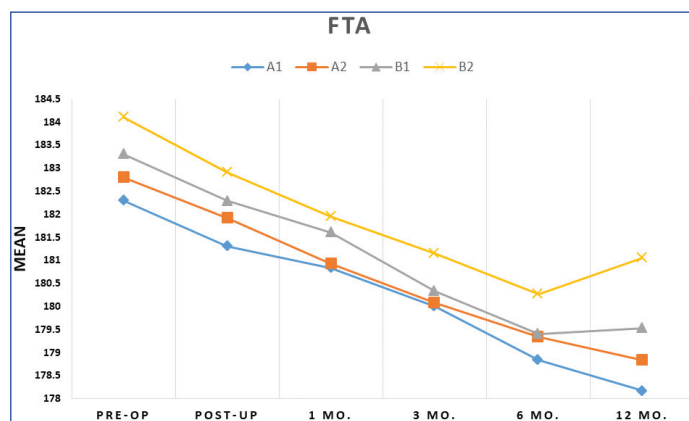
Outcome values of parameters such as VAS, KSS and FTA at 12-month follow-up among the Groups A1, A2 and B1 were significantly improved when compared with their respective values at six months. Among Group B2, it was found that values of VAS

and KSS at 12 months follow-up were quite reversed as compared to values at six months as depicted in [Table/Fig-6,8].

Complications such as Extensor Hallucis Longus (EHL) weakness were seen in two patients, of which one recovered completely over a period of eight weeks. Transient Foot Drop was reported in one patient, which resolved in 12 weeks. Paraesthesia on the Dorsum of the foot was reported in three patients, which settled down over 4-6 weeks.

DISCUSSION

Knee pain secondary to primary medial compartment knee OA is one of the most common clinical presentations encountered. Incidence of knee OA is directly proportional to age, weight, and microtrauma to the knee joint secondary to cyclical loading [17]. The initial stages of knee OA can be managed effectively with physiotherapy, Non Steroidal Anti-Inflammatory Drugs (NSAIDs), and local analgesic applications [18]. Despite these conservative measures, patients with the progressive disease might require surgical interventions in the form of HTO and TKA [19]. But, the procedural complexity and extensiveness lead to the patient reluctance. Hence, as of late a minimally invasive surgical treatment i.e., PFO has been proposed for the management of knee OA, which has become much more popular in the Eastern world (China and India) than elsewhere [4,8,9,20-23]. The PFO helps in the correction of a varus deformity, shifts the loading force from the medial compartment, and therefore, diminishes the agony with satisfactory functional recovery [24]. The use of PFO has become popular in the recent past and very few papers related to its outcome have been published so far.



[Table/Fig-8]: Depicting trends of FTA in all 4 groups at preoperative, postoperative, and various subsequent follow-ups.

**FTA: Femorotibial axis

In this study, the mean age was 53.76 ± 3.79 years with 70.69% of them being females. The average surgical duration required for the unilateral knee was 34.8 ± 4.36 minutes, which was quite similar to a study conducted by Wang X et al., [8]. Efficacy of PFO in this study was assessed in terms of improvement in clinical outcome (VAS score), functional outcome (KSS score) and radiological outcome (FTA) measured at immediate postoperative and subsequent follow-ups and was compared to that of preoperative state. Wang X et al., followed 150 patients for two years and noticed significant decrease in mean VAS score from 8.02 ± 1.50 to 2.74 ± 2.34 at final follow-up and improvement of mean KSS from 41.24 ± 13.48 to 67.63 ± 13.65 . In their study, they suggested that PFO could be a good alternative treatment modality for medial compartment OA [8]. In a study conducted by Yang ZY et al., 150 patients with medial compartment OA, stated that there was significant decrease in mean VAS score from 7.0 to 2.0 at final follow-up. Mean KSS at final follow-up was 92.3 ± 31.7 , which significantly improved from 45.0 ± 21.3 preoperatively. They concluded that PFO is safe and effective treatment for medial compartment OA [4]. Prakash L and Prakash I found that there was decrease in VAS score from 6.7 (preoperative) to 2.2 (postoperative). There was improvement of mean KSS from 54.4 (preoperative) to 77 (postoperative). Mean FTA in preoperative period was $181^\circ \pm 1.9^\circ$, which changed towards valgus alignment and was $178^\circ \pm 2.0^\circ$ postoperatively. They inferred that PFO was the simple, less invasive and it significantly reduced pain [25].

In this study, there was significant relief in medial knee pain after PFO, depicted by a declining trend in mean VAS of 8.04 ± 0.68 (preoperative stage) to 2.65 ± 1.14 at final follow-up (p -value < 0.001). Also, there was significant progressive improvement in knee joint function, depicted by increase in KSS from 43.38 ± 2.39 (preoperatively) to 69.82 ± 3.03 at 12 months follow-up (p -value < 0.001). Radiographic evaluation was carried out by assessing and calculating the FTA on weight-bearing AP radiographs of the knee joint. It was observed that preoperatively patients had varus malalignment with increased mean FTA ($183.38 \pm 1.29^\circ$), which slightly changed to valgus alignment at subsequent follow-ups to $179.84 \pm 1.83^\circ$ (p -value < 0.001). Results of this studies were quite similar to the aforementioned studies as illustrated in [Table/Fig-9] [4,8,25].

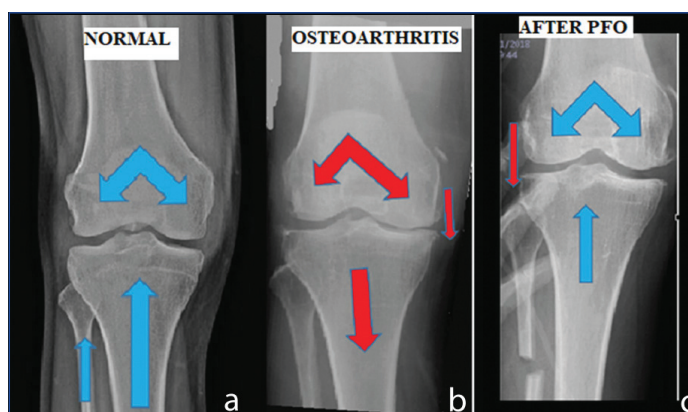
Parameters	Present study	Yang ZY et al., [4]	Wang X et al., [8]	Prakash L and Prakash I [25]
Change in VAS	8.04 ± 0.68 to 2.65 ± 1.14	7.0 to 2.0	8.02 ± 1.50 to 2.74 ± 2.34	6.7 to 2.2
Change in KSS	43.38 ± 2.39 to 69.82 ± 3.03	45.0 ± 21.3 to 92.3 ± 31.7	41.24 ± 13.48 to 67.63 ± 13.65	54.4 to 77
Change in FTA	183.38 ± 1.29 to 179.84 ± 1.83	--	--	181 ± 1.9 to 178 ± 2.0

[Table/Fig-9]: Illustrating change of values from preoperative to final follow-up of VAS, KSS, and FTA in various studies [4,8,25].

**VAS: Visual analog score; KSS: Knee society score; FTA: Femoro-tibial axis

In the present study, it was observed that patients belonging to group B2 (BMI > 25.0 kg/m² and K-L grade 3), had a recurrence of symptoms with the onset of pain. The increase in VAS score, FTA changing to varus alignment and a moderate decrease in KSS was encountered in group B2 at subsequent follow-ups and 12 months. This implicates that patient in Group B2 with high BMI and with more osteoarticular deformation as seen in K-L grading 3 had recurrence of symptoms and deterioration in parameters at 12 months. The fibula strut support which acts as a constrain, causes increased loading and wearing of the medial condyle as described by Yang ZY et al., in his non uniform settlement of bilateral tibial plateau [4] [Table/Fig-10a,b]. Removal of this fibular strut support leads to redistribution of load equally over both the tibial condyles [8,22], decompression of the medial compartment,

and realignment of the mechanical axis of the lower limb which all together bring about significant pain relief and improve knee function [Table/Fig-10c]. The significant improvements in various parameters from the preoperative stage to that of final follow-up shown by numerous studies conducted previously [4,8,22-24] are comparable to the results obtained in the current study.



[Table/Fig-10]: Probable mechanism of pain relief and load redistribution after proximal fibular osteotomy. a) Equal loads were distributed on the medial and lateral tibial plateau in the normal condition; b) A greater load was shifted to the medial tibial plateau; c) Equal redistribution of load after proximal fibular osteotomy.

Additionally, this study gives an insight into the impact of high BMI and Grade 3 OA on the outcome of PFO in such cases. Overall, it affirms that PFO is a dependent and safe alternative for pain relief and better functional outcomes in primary medial compartment knee OA. Though PFO is a safe procedure, a few complications were observed, which were-EHL weakness, transient foot drop, and paraesthesia over the dorsum of the foot. These complications occurred probably due to traction injury over the common peroneal nerve resulting in transient neuropraxia which recuperated over 6-12 weeks with methylcobalamin-pregabalin supplements. Common peroneal nerve injury was also encountered in four cases in the study conducted by Yang ZY et al., [4]. Transient foot drop (one patient), EHL weakness (eight patients), and paraesthesia over the dorsum of the foot (seven patients) were encountered in the study carried out by Prakash L and Prakash I [25]. A study carried out by Laik JK et al., also noticed EHL weakness in three cases [26]. Sabir AB et al., also documented EHL weakness in five cases and paraesthesia over the dorsum of the foot in seven cases in the study [27].

Limitation(s)

The follow-up time period was limited. The short-term results turned out to be quite promising and encouraging but do not shed light on respect to the consistency of these outcomes for a longer duration of follow-up. Thereby, it is crucial to establish its effectiveness over a longer period as an alternative procedure and long-term side-effects on other joints such as the hip and ankle. A further detailed study is imperative to establish the exact biomechanics of pain relief, increase in the medial joint space, and correction of alignment in patients who had undergone PFO. Finally, the absence of a control group was another important limitation of this study.

CONCLUSION(S)

The PFO is a prudent alternative procedure for pain relief and better functional improvement in primary medial compartment knee OA. It is a straight forward, pragmatic and efficacious procedure that is reproducible even in modest set-ups. The study figured out that PFO is more effective in patients with BMI ≤ 24.99 kg/m² and K-L grade 1 and 2 as compared to patients with higher BMI and K-L grade. This procedure provides a midway path to the patients who are not willing for complex procedures such as HTO and TKA, additionally it defers the prerequisite of these intricate procedures. This modality is a simpler option, and also preserves the anatomy of the knee joint for future TKA, whenever required. A more extended

period of follow-up is desirable to evaluate the longevity of the beneficial impacts, which PFO offers to the patients in the short-term as concluded in this study.

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PARTICULARS OF CONTRIBUTORS:

1. Assistant Professor, Department of Orthopaedics, Indira Gandhi Government Medical College, Nagpur, Maharashtra, India.
2. Senior Resident, Department of Orthopaedics, Indira Gandhi Government Medical College, Nagpur, Maharashtra, India.
3. Professor, Department of Orthopaedics, Indira Gandhi Government Medical College, Nagpur, Maharashtra, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Sumeet Sharad Patil,
Senior Resident, Department of Orthopaedics, Indira Gandhi Government Medical College, Nagpur, Maharashtra, India.
E-mail: sumpatil92@gmail.com

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