

Original Research Article

A clinico-radiological evaluation of functional outcome of proximal fibular osteotomy for medial compartment knee osteoarthritis: a new emerging technique

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ABSTRACT

Background: The medial compartmental osteoarthritis (OA) knee is initially treated conservatively followed by lateral close/open medial wedge high tibial osteotomy (HTO), or by unicompartmental or total knee replacement (UKR/TKR). Though HTO and UKR/TKR yield good results but are technically more demanding and are fraught with risk of complications, moreover replacement may not be the treatment of choice for younger patients. The objective of this study was to evaluate the efficacy of proximal fibular osteotomy (PFO), a minimally invasive procedure minus risks associated with HTO/TKR.

Methods: Thirty-eight patients, 15 males and 23 females with a mean age of 54.46 years (range, 35 to 80 years) underwent PFO for OA knee and were followed for a mean period of 8.63 months (range 6 to 12 months).

Results: After PFO all patients experienced immediate significant relief in medial knee pain with improved walking distance. Postoperatively, all patients showed radiological improvement in femorotibial angle (FTA), medial/lateral joint space ratio.

Conclusions: PFO is safe, minimally invasive technique with minimal complications. It gives immediate relief of medial knee pain with improved function of joint.

Keywords: OA, HTO, TKR, PFO

INTRODUCTION

The primary osteoarthritis (OA) of knee is a very common degenerative disorder which is chronic and progressive in nature that ultimately results into disabling pain and deformities in sagittal plane like genu varum or genu valgum.¹ OA knee usually starts after 40 years of age and progresses to affect about 30% population beyond 60 years of age because of certain precipitating factors like mechanical, structural, genetic, and environmental, involving medial compartment more frequently than the lateral one.²⁻⁴ The progression of degenerative process causes altered mechanics of weight bearing resulting into

genu varum deformity in about 74% of patients of primary OA.⁵ Genu varum deformity is more common in OA because of the fact that the mechanical axis, even in normal knees, passes a little medial to the centre of the joint that drives 60%-80% of body weight through the medial compartment of the knee joint.⁶ In addition to various biomechanical alterations, the increased internal tibiofemoral rotations and peak knee adduction moment during weight bearing because of altered gait mechanics, are supposed to be the main culprits in the initiation and progression of medial compartment OA.^{7,8} Any option of treatment for OA is aimed at restoration of tibio-femoral rotation and peak adduction moment to normal to relieve pain and to delay progression of OA. Various treatment

options available are conservative that encompasses the life style modifications, NSAIDS, physical therapies like hot wet packs/ice packs/ultra violet rays/paraffin wax bath, exercise program, intraarticular steroid injections, viscosupplementation, biological agents like platelet rich plasma, modified footwear and assistive devices like lateral insole wedges with or without subtalar strapping, variable stiffness shoes with softer medial side, abduction knee braces using three-point bending.⁹⁻¹⁴ But once all these modalities of treatment are exhausted due to progression of disease or are non-responsive, then surgical intervention becomes inevitable, such as high tibial osteotomy, unicondylar/total knee replacement (UKR/TKR). Under the shadow of the complications associated with osteotomy and UKR/TKR there had been a continuous desire to develop a technique to relieve the pain of moderate to severe OA of medial compartment and which should be possibly least invasive and should not commensurate with problems of aforesaid procedures. In the present study, to meet these challenges recently a new procedure in the form of proximal fibular osteotomy (PFO) has been carried out with gratifying results.

This study was undertaken to assess the efficacy of proximal fibular osteotomy in the treatment of medial compartment OA knee in terms of clinical functional outcome regarding improvement in pain and in walking distance and use of stairs and radiographic improvement in medial joint space narrowing.

METHODS

A prospective nonrandomized study was conducted, with Institutional Ethics Board approval, in the department of Orthopaedics at Chatrapati Shivaji Subharti Hospital affiliated to N.S.C.B. Subharti Medical College of Swami Vivekanand University, Meerut, for a period of two years from July 2017 to June 2019.

Sample population

Thirty eight patients of both sexes with a mean age of 53.08 years attending outpatient department (OPD) with symptoms of pain during walking and while going up and down the stairs along with radiographic evidence of Kellgren Lawrence grade II-IV osteoarthritis of medial compartment of knee joint with/without mild to moderate genu varum deformity (not $>15^{\circ}$) not responding to conservative treatment and were consenting to undergo proximal fibular osteotomy (PFO) were included in the study. Patients suffering from post-traumatic or inflammatory secondary OA and patients with bi or tri compartmental OA or patients with genu varum deformity $>15^{\circ}$ or with genu valgum deformity were not included in the study.

Evaluation of functional and radiological outcomes

Improvement in pain was evaluated by postoperative vis-a-vis preoperative numerical rating scale (NRS) score, a

modified version of visual analogue scale (VAS) and by verbal descriptor/rating scale (VDS/VRS).¹⁵

Improvement in walking distance was assessed in terms of metric or block system (one block=100 meters) which the patient was able to walk postoperatively vis-a-vis preoperatively.

Improvement in use of stairs was assessed by noting whether they could go up and down the stairs normally, normal up but down with railing/wall support, both up and down with rail/wall, or not able to use stairs postoperatively vis-a-vis preoperatively.

Radiographic evaluation of femorotibial angle and medial joint space narrowing

The femorotibial malalignment angle (Figure 1) and ratio of medial and lateral compartment joint space (Figure 2) were evaluated in accordance with the method described by Wang et al in which the angle subtended between the anatomical axis of femoral shaft and tibia is measured on the outer side preoperatively and post operatively at the final follow up, to evaluate any reduction in femorotibial angle (FTA) in concurrence with any improvement in medial joint space narrowing.¹⁶

The final outcome of PFO was evaluated utilizing American knee society scoring system by comparing postoperative score with baseline preoperative score.¹⁷

Technique of proximal fibular osteotomy

After spinal anaesthesia patient is laid supine and a tourniquet is applied over the thigh, the lower limb is prepared from mid-thigh to ankle joint and is draped and tourniquet is inflated after exsanguinations of the limb with Esmarch bandage. A sand bag is applied under the gluteal region to keep the lower limb in slight internal rotation.

The caput fibulae are palpated and a 5-7 cm longitudinal incision is given over the proximal fibula starting about 5 cm distal to its caput, the skin and subcutaneous tissues are reflected on either side and the deep fascia is incised in the line of skin incision.

A plane is developed between peroneus and soleus muscles which are then subperiosteally erased and fibula is exposed. About 2-3 cm long cuff resection from shaft of fibula at a level about 6-10 cm from caput fibulae is performed with a power saw and the cut ends of fibula are sealed with bone wax. Wound is irrigated and closed in layers.

Postoperative care and follow up

Full weight bearing ambulation was allowed with quadriceps drill and knee range of motion exercises from day one depending upon the tolerance of postoperative

pain by the patient. A full weight bearing radiograph of both knee joints shall be obtained the next morning.

All patients were followed up at 1, 3, 6, and 12 months from the date of surgery.

At every follow up a weight bearing radiograph in AP and lateral projections were obtained for assessment of improvement in the femorotibial malalignment angle and medial joint space narrowing in accordance with the method of Wang et al and were compared with the preoperative status.

Statistical analysis

Statistical analysis was performed using IBM^(R) SPSS version 25.0 statistical software. Continuous variables were expressed as mean±SD. A paired t test was used to compare the differences in outcome scores. Differences were considered significant at p<0.05.

RESULTS

Thirty eight patients, 15 males and 23 females (Table 1) with a mean age being 54.46 years (range, 35 to 80 years) underwent PFO for OA of 6 right, 6 left and 26 both knee joints (Table 2) and all patients were followed for a mean period of 8.63 months (range 6 to 12 months).

Table 1: Patient’s sex distribution.

Variables	Male	Female	Total
No. of cases	15	23	38
Percentage	39.47	60.53	100

Table 2: Distribution of side of knee involved.

Variables	Left	Right	Both	Total
No. of cases	6	6	26	38
Percentage	15.8	15.8	68.4	100

The patients had moderate to severe knee pain on walking and on using stairs with a mean NRS score of 8.45±0.68 (range 7 to 9) and mean VDR score of 2.68±0.47 (range 2 to 3) with an average walking distance of 119.74 meters (range 50 to 200 meters) while after proximal femoral osteotomy (PFO) mean NRS score came down to 0.45±0.68 (range 0 to 2 [p<0.05]), mean VDR score came down to 0.37±0.58 (range 0 to 1 [p<0.05]), and the average walking distance increased to an average distance of 500 meters or more (Table 3).

Preoperative mean FTA left knee was 190.38⁰±3.3⁰ and FTA right knee was 190.03⁰±3.7⁰ (range 194⁰ to 182⁰), average ratio of M/L joint space was 0.66±0.11 mm for left knees and 0.68±0.12 mm for right knees, mean genu varum deformity was 8.74⁰±4.84⁰ for left knees and 8.45⁰±5.06⁰ for right knees and mean KSS was 53.79±4.72 only i.e. overall KSS was poor but after PFO at final follow

up all these parameters showed significant improvements vis-à-vis the preoperative ones, mean left knees FTA 190.38⁰±3.3⁰ improved to 189.06⁰±3.3⁰ while that of right knees improved from 190.03⁰±3.7⁰ to 188.59⁰±3.5⁰ with p<0.05 (Table 4).

Table 3: Improvement in NRS-VDR score.

Mean NRS ^{PREOP}	Mean NRS ^{POSTOP}	Mean VDR ^{PREOP}	Mean VDR ^{POSTOP}
8.45±0.68/10	0.45±0.68/10	2.68±0.47/3	0.37±0.58/3
range (7-9)	range (0-2)	range (2-3)	range (0-1)

Table 4: Improvement in femorotibial angle (FTA).

Variables	Mean preoperative	Mean postoperative
FTA left knee	190.38 ⁰ ±3.3 ⁰	189.06 ⁰ ±3.3 ⁰
FTA right knee	190.03 ⁰ ±3.7 ⁰	188.59 ⁰ ±3.5 ⁰

Average ratio of M/L joint space of left knees improved from 0.66±0.11 to 0.69±0.09 while that of right knees improved from 0.68±0.12 to 0.71±0.11 (Table 5).

Table 5: Improvement in medial joint space narrowing (MJSN).

Variables	Mean preoperative	Mean postoperative
MJSN left knee	0.66±0.11 mm	0.69±0.09 mm
MJSN right knee	0.68±0.12 mm	0.71±0.11 mm

Mean genu varum deformity of left knees showed improvement from 8.74⁰±4.84⁰ to 8.11⁰±4.74⁰ while that of right knees improved from 8.45⁰±5.06⁰ to 7.45⁰±4.57⁰ (Table 6).

Table 6: Improvement in genu varum deformity.

Variables	Mean preoperative	Mean postoperative
Genu varum deformity left knee	8.74 ⁰ ±4.84 ⁰	8.11 ⁰ ±4.74 ⁰
Genu varum deformity right knee	8.45 ⁰ ±5.06 ⁰	7.45 ⁰ ±4.57 ⁰

Table 7: Improvement in KSS.

Variables	Preoperative	Postoperative
KSS	53.79±4.72 (poor)	92.34±3.18 (excellent)

Finally, the overall KSS which was poor with a mean score of 53.79±4.72 became excellent with a mean KSS score of 92.34±3.18 with p<0.05 (Table 7).

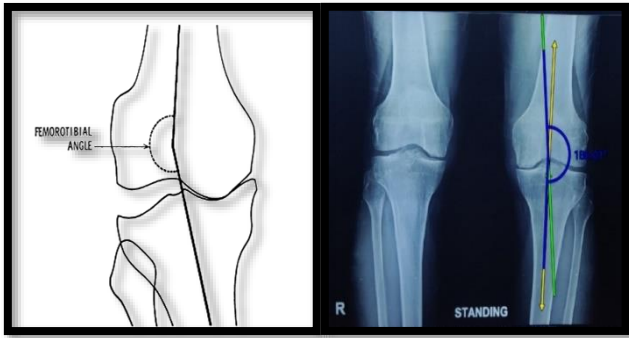


Figure 1: Method of measurement of FTA on sketch diagram and frontal skiagram of knee in standing position.

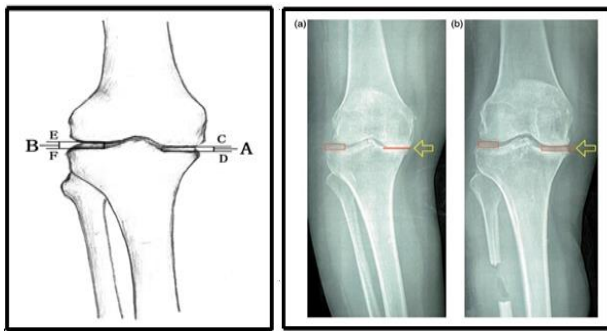


Figure 2: Method of measurement of medial/lateral joint space ratio on sketch diagram and pre and postoperative standing skiagram of knee.

Postoperatively 3 (7.89%) patients developed great toe drop, however, all recovered fully within 2-3 weeks, 1 (2.63%) patient developed surgical site infection (SSI) which was controlled with regular dressings and antibiotics per culture and sensitivity reports.

DISCUSSION

Once the conservative treatment for OA becomes unresponsive, surgical intervention becomes inevitable. In young patient's high tibial osteotomy (HTO) is often performed. However, despite good results osteotomies are technically more demanding and are often fraught with complications like neurovascular injuries, iatrogenic fractures, infection and nonunion.^{18,19}

Another common surgical intervention is either unicompartmental (UKR) or total knee replacement (TKR), which offer good results but are not free from complications, moreover, UKR/TKR may not be the treatment of choice for younger patients or for moderate OA.²⁰

Proximal fibular osteotomy (PFO) innovated by some authors provides immediate pain relief probably due to offloading of the medial compartment following fibular cuff resection that abolishes the lateral support to tibia as conceptualized by Zhang.²¹ Proximal fibular osteotomy

offers a middle path between the non responsive conservative treatment and the high end surgeries like UKR/TKR.

In this study, 38 patients (15 [39.47%] males and 23 [60.53%] females) of medial compartment OA knee with a mean age of 53.08 years (range 30-80 years) were treated with proximal fibular osteotomy and were followed for a mean period of 8.63 months (range 6 to 12 months). Left knee was affected in 6 (15.8%), right knee also in 6 (15.8%) while both knees in rest of the 26 (68.4%) patients. Conservative treatment tried for about 3 years by 28(73.68%) patients while rest of the 10 (26.32%) for more than 3 years. Ten (26.32%) patients had Kellgren Lawrence grade-II while rest 28 (73.68%) had grade-III OA. Only 1 (2.63%) patient developed surgical site infection and 3 (7.89%) patients developed great toe drop which however recovered completely within two to three weeks.

Preoperative mean NRS score of 8.45 (range 7-9) and mean VDR score of 2.68 (range 2-3) dropped to 0.45 (range 0-2) and 0.37 (range 0-1) respectively postoperatively that persisted till the final follow up ($p < 0.005$).

Preoperative walking distance of 50 to 200 meters (average 119.74) only improved to an average distance of 500 meters or more than 500 meters.

Preoperative FTA mean value of $190.38^{\circ} \pm 3.3^{\circ}$ for left and $190.03^{\circ} \pm 3.7^{\circ}$ for right knees improved to a mean value of $189.06^{\circ} \pm 3.3^{\circ}$ for left and $188.59^{\circ} \pm 3.5^{\circ}$ for right knees postoperatively at final follow up. Similarly, the preoperative average ratio of M/L joint space of left knees improved from 0.66 ± 0.11 mm to 0.69 ± 0.09 mm while that of right knees from 0.68 ± 0.12 mm to 0.71 ± 0.11 mm as assessed at the final follow up.

The mean genu varum deformity of $8.74^{\circ} \pm 4.84^{\circ}$ in left knees and $8.45^{\circ} \pm 5.06^{\circ}$ in right knees improved after PFO to $8.11^{\circ} \pm 4.74^{\circ}$ and $7.45^{\circ} \pm 4.57^{\circ}$ respectively and finally the preoperative overall KSS was poor with a mean score of 53.79 ± 4.72 became excellent with a mean KSS score of 92.34 ± 3.18 ($p < 0.005$) postoperatively.

The results of our study are comparable with the results of other available studies like that of Wang et al who evaluated 47 patients of medial compartment osteoarthritis treated by proximal fibular osteotomy (PFO) with a mean age of 69.96 years (range 48-78 years) being little more than the mean age of 54.46 years in this series.²² These authors found significant relief of medial joint pain post PFO with the mean visual analogue scale (VAS) improving from a preoperative value of 8.02 ± 1.50 to a postoperative value of 2.74 ± 2.34 which is quite comparable with our study values of mean preoperative NRS value of 8.45 ± 0.68 improving to 0.45 ± 0.68 postoperatively. At final follow-up, the mean FTA of their patients improved from preoperative $182.7^{\circ} \pm 2.0^{\circ}$ to

179.4⁰±1.8⁰ while in this study the preoperative FTA improved from 190.38⁰±3.3⁰ to 189.06⁰±3.3⁰ and from 190.03⁰±3.8⁰ to 188.59⁰±3.5⁰ for left and right knees respectively postoperatively. The mean ratio of medial/lateral joint space in their series improved from 0.40±0.28 mm preoperatively to 0.58±0.30 mm postoperatively while in this series the preoperative values improved postoperatively from 0.66±0.11mm to 0.69±0.09 mm and from 0.68±0.12 mm to 0.71±0.11 mm for left and right knees respectively, the improvement in both series are quite comparable.

The authors in their series evaluated American knee society score in two sub-scores of knee and function separately which improved from preoperative value of 44.41±8.90 and 41.24±13.48 respectively to the value of 69.02±11.12 and 67.63±13.65 respectively but in this series the American knee society score is evaluated comprehensively which improved from a preoperative mean value of 53.79±4.72 to a value of 92.34±3.18 postoperatively.

In their series, these authors did not observe any postoperative complications including neurovascular injury, infection, or wound dehiscence while in the present series 3 (7.89%) patients developed great toe drop post PFO which though recovered fully in all the three patients within a span of 2-3 weeks in addition to that 1 (2.63%) patient developed surgical site infection which however got resolved with regular dressings antibiotics as per culture and sensitivity report. These authors followed their patients for a mean period of 13.38 months (range 12-18 months) while in this study patients were followed for a mean period of 8.63 months (range 6-12 months) only.

The results of the present study and study carried out by authors Wang et al appear quite comparable in terms of pain relief, functional outcome, and radiographic evaluations, however, there are few discrepancies regarding incidence of complications, follow-up duration, and range of age of patients.

CONCLUSION

PFO appears a viable alternative for the treatment of medial compartment OA in young patients as it provides immediate dramatic relief of medial joint pain, carries minimal risk of complications, postoperative bed rest or immobilization is not required as patient are allowed full weight bearing ambulation without support from the day one. PFO is safe, simple, and minimally invasive procedure and appears attractive option between conservative and total replacement to give instant relief to the patient, moreover even if it fails the option of replacement surgery always remains open. However, despite the excellent short term results in terms of dramatic relief in medial joint pain, it is still not established how long the pain relief will survive as the present study is of short duration with limited number of patients and

therefore more and more multicentric studies need to be conducted for validation of this procedure.

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