

# Short-term Outcome Analysis of Proximal Fibular Osteotomy in Management of Osteoarthritis Knee

Thambusamy Gopi<sup>1</sup>, Vasudevan Thirunarayanan<sup>2</sup>, Karthikeya P Manimaran<sup>3</sup>, Senguttuvan Cheralathan<sup>4</sup>

## ABSTRACT

**Aim:** Proximal fibular osteotomy (PFO) for osteoarthritis (OA) knee is an emerging concept with good early results. This short-term study aimed to analyze the usefulness of PFO in Indian patients with OA knee with regard to pain relief and correction of deformity.

**Materials and methods:** This study involves a surgical technique where 2 cm of proximal fibular bone is resected, and patient is permitted full-weight-bearing walking as early as possible. Subjective and objective outcome analyses done using Lysholm knee scoring sheet and radiographs, respectively. Minimum follow-up time was 6 months.

**Results:** We had a total of 20 knees in 18 patients, with average age of 56.1 years. The average visual analog score reduced by 6.8 points, and the average Lysholm knee score improved by an average of 34 points at the end of follow-up. The mean alpha angle correction achieved was 3.738°. The calculation of Pearson's correlation coefficient between the amount of correction of alpha angle and reduction of visual analog scale during the immediate postoperative period was -0.186. Among the 20 knees, we had four cases of weakness of extensor hallucis longus.

**Conclusion:** Through our short-term prospective cohort study, we conclude that PFO helps in improvement of pain and function, in patients suffering from medial compartment OA knee. The effectiveness of proximal tibiofibular joint mechanism in immediate pain relief is evident in our study by subjective and objective means. A proper selection of case with regard to severity and duration of disease and patellofemoral involvement is vital in getting good results.

**Clinical significance:** Proximal fibular osteotomy is an emerging concept in the management of OA of knee and gives the patient, more years, with native knee to walk.

**Keywords:** Alpha angle correction after proximal fibular osteotomy, Femorotibial angle in varus knee, Knee medial compartment decompression, Proximal fibular osteotomy cohort study, Proximal fibular osteotomy in osteoarthritis knee, Proximal fibular osteotomy in varus knee, Proximal fibular osteotomy short-term study, Settlement phenomenon.

*Journal of Orthopedics and Joint Surgery* (2019): 10.5005/jp-journals-10079-1005

## INTRODUCTION

Osteoarthritis (OA) knee is the most common degenerative disorder involving the knee with multifactorial cause including age, post-trauma, occupation, lack of exercise, gender, ethnicity, genetics, obesity, diet, and bone density.<sup>1</sup> With regard to India, it is the second most common rheumatologic problem and is the most frequent joint disease with a prevalence of 22–39%.<sup>2</sup> In India, women are more commonly affected.<sup>2</sup> In women aged more than 65, 45% of them have symptoms of OA while 70% of them show radiological signs of the disease.<sup>2</sup> Current management options for OA knee are physiotherapy as first line, and if it gives no symptomatic relief, patients are offered total knee arthroplasty for tricompartmental OA or high tibial osteotomy for medial compartment OA with varus deformity. The acceptance rate of total knee arthroplasty as a treatment option is less among Indian patients considering the financial burden on the economically weaker sections of the society. High tibial osteotomy is technically demanding and is associated with a complication rate ranging from 8% to 55%.<sup>3</sup> Proximal fibular osteotomy (PFO) as a treatment option for patients with OA knee is an emerging concept with good early results.<sup>4</sup> This short-term prospective cohort study aimed to analyze the usefulness of PFO in Indian patients with OA knee with regard to pain relief and correction of deformity.

## MATERIALS AND METHODS

Since this study involved human subjects, we complied with Declaration of Helsinki and have obtained clearance from institutional ethical committee to carry out the study at the Department

<sup>1–4</sup>Department of Orthopaedics, Government Medical College, Omandurar Government Estate, Chennai, Tamil Nadu, India

**Corresponding Author:** Senguttuvan Cheralathan, Department of Orthopaedics, Government Medical College, Omandurar Government Estate, Chennai, Tamil Nadu, India, Phone: +91 9840428802, e-mail: cheravid4@gmail.com

**How to cite this article:** Gopi T, Thirunarayanan V, Manimaran KP, et al. Short-term Outcome Analysis of Proximal Fibular Osteotomy in Management of Osteoarthritis Knee. *J Orth Joint Surg* 2019;1(1): 5–10.

**Source of support:** Nil

**Conflict of interest:** None

of Orthopaedics, Government Medical College, Omandurar Government Estate, Chennai. The study period was between June 1, 2018, and June 30, 2019. After a discussion with a statistician, the sample size was determined to be 20 knees. The inclusion and exclusion criteria for the study are depicted in the Table 1.

All patients admitted to the orthopedic ward were subjected to standard preoperative investigations and anaesthetic assessment done. Preexisting medical comorbidities were brought under control making the patient fit for surgery. All patients were explained about the study, and those who volunteered and agreed to participate in the study were taken up for surgery after informed written consent.

**Table 1:** Inclusion and exclusion criteria

<i>Inclusion criteria</i>	<i>Exclusion criteria</i>
Bilateral or unilateral bicompartamental OA of knee	Tricompartamental OA of knee
With or without varus deformity	Inflammatory arthritis
Patients not improving with conservative management	Posttraumatic arthritis
	Previous septic arthritis
	Previous surgery in the knee

The surgical technique involved use of either epidural or spinal anesthesia. Patient positioned supine and draped, as per the requirement of either unilateral or bilateral procedure. A skin incision of 5–6 cm placed along the long axis of fibula over the proximal third—mid-third junction of leg. Subcutaneous and deep fascia opened in line with the skin incision. Plane developed between the soleus muscle and peroneus longus muscle. Care was taken not to damage the superficial peroneal nerve, which might cross the field. The fibular bone was reached and soft tissues covering it were stripped carefully. Hohmann retractors were avoided to prevent damage to deeper neurovascular structures. Langenbeck retractors were safe to use for tissue retraction. Osteotomy level was marked with diathermy, the proximal cut planned at a level of 6–8 cm below the fibular head. Another mark on the fibular bone 2–3 cm distal to the first mark was made. Osteotomy was done using Power saw with 10 mm blade ensuring not to damage the surrounding soft tissues. A careful stripping of the soft tissue attachments on the deeper side of the resected bone was done, and the segment was removed. Hemostasis was secured before wound closure in layers. Sterile dressing was done.

In patients, for whom the surgery was done under epidural anesthesia the patient was encouraged to do full-weight-bearing walking on the same day, if tolerated. For patients who underwent the surgery using spinal anesthesia, full-weight-bearing walking was started on first postoperative day. All patients were followed up for a minimum period of 6 months. Functional scoring was done using Lysholm knee scoring sheet (Fig. 1), which has an incorporated visual analog scale for pain grading.

This scoring was done preoperatively and during the 2nd postoperative day followed by another scoring done during 6th postoperative month. Patient was subjected to standing anteroposterior and lateral radiographs of both knees preoperatively. The radiograph was repeated on 2nd postoperative day. The radiographs were used to measure the alpha angle (lateral femoro-tibial angle) as shown in Figure 2. The lateral angle made between the anatomical axis of femur and tibia on a standing anteroposterior radiograph was taken as the alpha angle. The alpha angle was measured from the radiographs taken during the preoperative period and immediate postoperative period. All data collected from the patient case sheet were tabulated and subjected to statistical analysis using Microsoft Excel 365.

## RESULTS

We had a total of 20 knees of 18 patients of whom 12 were females and 6 were males. The average age of the study population was 56.1 years with an age range between 49 and 63. The Kellgren–Lawrence grading of the knees are shown in Table 2. The mean surgical time for single side from incision to closure was 24.75 minutes. There were two bilateral cases, which took 40 minutes in total individually.

The data of preoperative and postoperative visual analog scale and Lysholm knee score are depicted in Table 3.

The average visual analog score was 8.9 points preoperatively, which improved to 3.0 points during the 2nd postoperative day and 2.1 points during the sixth postoperative month, which was a reduction in score by 6.8 points at the end of follow-up. The average score using the Lysholm knee scoring sheet was 53.5 points preoperatively, which improved to 78.9 points during the 2nd postoperative day and 87.5 points during the 6th postoperative month, which was an improvement in score by an average of 34 points at the end of follow-up. The patient data regarding measurement of alpha angle are depicted in Table 4.

The mean alpha angle was 184.649° preoperatively, which changed to 180.911° postoperatively with a mean correction of 3.738°. The calculation of Pearson's correlation coefficient between the amount of correction of Alpha angle and reduction of visual analog scale during the immediate postoperative period was –0.186.

Among the twenty knees, we had four cases of weakness of extensor hallucis longus and one case of numbness over the first dorsal webspace of feet. Among these, two cases resolved in 4 months' time and two cases have improved power by 1 grade but normal power was not achieved at the end of follow-up. The patient with numbness over the first dorsal webspace had not recovered at the end of follow-up. We had no cases of superficial or deep infection in our study group. Figures 3 and 4 are illustrative case examples.

## DISCUSSION

To appreciate the effectiveness of PFO in the management of OA, it is vital to understand the mechanism by which it works. The review of existing literature gives two mechanism by which PFO works. The first one described by Qin et al.<sup>5</sup> explains the mechanism by which PFO provides an immediate pain relief in patients following the surgery. This theory is built upon the concept that anatomically there are two variants of proximal tibiofibular joint depending on the obliquity of the articulating surfaces, as shown in Figure 5. The horizontal type with relatively less movement and the oblique type with more movement in the proximal tibiofibular joint.<sup>6</sup> The exact mechanism is depicted in Flowchart 1. This theory has been tested and proven to be effective in a biomechanical cadaveric study by Baldini et al., where sensors were inserted into the medial compartment of cadaveric knees and compartment pressures were measured before and after PFO and concluded that this procedure decreases medial compartment pressure.<sup>7</sup> In our study, we could witness the actual working of this theory objectively in radiographs that showed an immediate opening of the medial joint space. Subjective evidence for the same was through improvement in visual analog score and Lysholm knee score in the immediate postoperative period.

The second theory, namely, the nonuniform settlement theory, is based on the concept that in elderly and osteoporotic proximal tibia, the intact fibula provides a support to the lateral tibial condyle, while the unsupported medial side suffers a lack of support, leading to an excess settlement of the plateau on the medial side in comparison with lateral side.<sup>8,9</sup> The authors also hypothesized that the nonuniform settlement leads to a medial shift of the mechanical axis of lower limb leading to preferential degradation of joint in the medial compartment leading to varus deformity. The severity of nonuniform settlement is measured by calculation of settlement value.<sup>9</sup> Liu et al. in their study concluded

## LYSHOLM KNEE SCORING SCALE

**Instructions:** Below are common complaints which people frequently have with their knee problems. Please check the statement which best describes your condition.

<p><b>I. LIMP:</b></p> <p>_____ I have no limp when I walk. (5)</p> <p>_____ I have a slight or periodical limp when I walk. (3)</p> <p>_____ I have a severe and constant limp when I walk. (0)</p> <p><b>II. USING CANE OR CRUTCHES</b></p> <p>_____ I do not use a cane or crutches. (5)</p> <p>_____ I use a cane or crutches with some weight-bearing. (2)</p> <p>_____ Putting weight on my hurt leg is impossible. (0)</p> <p><b>III. LOCKING SENSATION IN THE KNEE</b></p> <p>_____ I have no locking and no catching sensations in my knee. (15)</p> <p>_____ I have catching sensation but no locking sensation in my knee. (10)</p> <p>_____ My knee locks occasionally. (6)</p> <p>_____ My knee locks frequently. (2)</p> <p>_____ My knee feels locked at this moment. (0)</p> <p><b>IV. GIVING WAY SENSATION FROM THE KNEE</b></p> <p>_____ My knee never gives way. (25)</p> <p>_____ My knee rarely gives way, only during athletics or other vigorous activities. (20)</p> <p>_____ My knee frequently gives way during athletics or other vigorous activities, in turn I am unable to participate in these activities. (15)</p> <p>_____ My knee occasionally gives way during daily activities. (10)</p> <p>_____ My knee often gives way during daily activities. (5)</p> <p>_____ My knee gives way every step I take. (0)</p>	<p><b>V. PAIN:</b></p> <p>_____ I have no pain in my knee. (25)</p> <p>_____ I have intermittent or slight pain in my knee during vigorous activities. (20)</p> <p>_____ I have marked pain in my knee during vigorous activities. (15)</p> <p>_____ I have marked pain in my knee during or after walking more than 1 mile. (10)</p> <p>_____ I have marked pain in my knee during or after walking less than 1 mile. (5)</p> <p>_____ I have constant pain in my knee. (0)</p> <p><b>VI. SWELLING</b></p> <p>_____ I have no swelling in my knee. (10)</p> <p>_____ I have swelling in my knee only after vigorous activities. (6)</p> <p>_____ I have swelling in my knee after ordinary activities. (2)</p> <p>_____ I have swelling constantly in my knee. (0)</p> <p><b>VII. CLIMBING STAIRS:</b></p> <p>_____ I have no problems climbing stairs. (10)</p> <p>_____ I have slight problems climbing stairs. (6)</p> <p>_____ I can climb stairs only one at a time. (2)</p> <p>_____ Climbing stairs is impossible for me. (0)</p> <p><b>VIII. SQUATTING</b></p> <p>_____ I have no problems squatting. (5)</p> <p>_____ I have slight problems squatting. (4)</p> <p>_____ I can not squat beyond a 90 degree bend in my knee. (2)</p> <p>_____ Squatting is impossible because of my knee. (0)</p>
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**TOTAL** \_\_\_\_\_/100

**INSTRUCTIONS:** Please place an X on the line to indicate the amount of pain you have had in your knee(s) the past 24 hours. The scale ranges from “no pain at all” to the “worst possible pain”.

RIGHT KNEE \_\_\_\_\_

no pain worst possible pain

LEFT KNEE \_\_\_\_\_

no pain worst possible pain

**Fig. 1:** Lysholm knee scoring scale with the questionnaire for subjective scoring including visual analog score

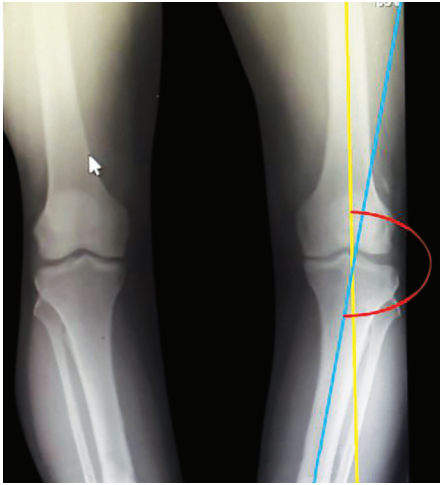
that the higher the settlement value preoperatively, the better is the prognosis after PFO as the lateral support of fibula–soft tissue complex is removed after surgery.<sup>10</sup>

In our study, we found that there is no strong correlation in-between the amount of alpha angle correction achieved

and the reduction of pain intensity in the patient, which was evidenced by Pearson's correlation coefficient between these two variables. This was clinically evident in some of our patients, who had a good improvement of pain scores in spite of minimal correction of alpha angle in the affected knee, postoperatively.



This is in accordance with the existing literature that PFO leads to redistribution of joint forces by decompression of medial compartment of tibiofemoral joint, thereby providing pain relief to the patient.

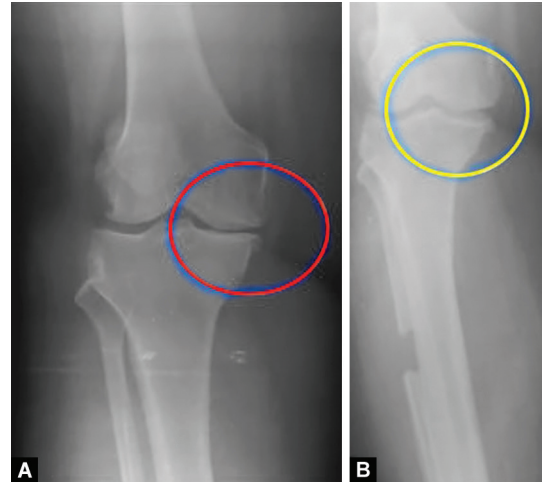


**Fig. 2:** Measurement of alpha angle (lateral femorotibial angle): Yellow line represents the anatomical axis of femur. Blue line represents the anatomical axis of tibia. The lateral angle made by these two lines represented by the red arc gives the measurement of alpha angle

**Table 2:** Kellgren–Lawrence grading of the knees in the study population

Grading	No. of knees (n = 20)
Grade 0	0
Grade I	0
Grade II	10
Grade III	8
Grade IV	2

We could list the following as other advantages of this procedure: no implantation, reduced surgical cost, reduced surgical time, reduced blood loss, immediate full-weight-bearing walking, and early return to work which may also be heavy manual labor. We did not need to perform total knee arthroplasty in any of our cases for continuation of pain. Yang et al. reported that 4 out of 110 patients (3.6%) who underwent this procedure needed total knee arthroplasty at an average of 12.4 months' time.<sup>8</sup> High tibial osteotomy, which is very much useful in the management of medial tibiofemoral arthritis with varus deformity, is reported to have difficulty, in conversion of failed high tibial osteotomy to total knee arthroplasty.<sup>11–13</sup> Such a disadvantage is not yet reported in PFO.



**Figs 3A and B:** Illustrative case 1: (A) Preoperative standing anteroposterior radiograph showing narrowing of the medial joint space highlighted by red circle; (B) 2nd postoperative day radiograph showing opening of medial joint space following proximal fibular osteotomy highlighted by yellow circle

**Table 3:** Patient data depicting visual analog score and Lysholm knee score preoperatively and postoperatively

S. no.	Patient name	Visual analog score			Lysholm knee score		
		Preoperative	2nd POD	6th month follow-up	Preoperative	2nd POD	6th month follow-up
1	Mrs M	8	2	2	54	80	86
2	Mrs R	8	4	2	58	86	94
3	Mr S	10	4	2	50	80	88
4	Mrs P	8	2	2	60	88	94
5	Mrs Pr	8	2	2	52	86	92
6	Mr Ra	10	4	4	50	72	82
7	Mr T	10	4	2	50	76	82
8	Mr AZ	8	4	2	54	80	90
9	Mr Mo	10	4	2	50	76	84
10	Mr Ri	8	2	2	54	60	86
11	Mrs Sh	8	4	2	54	84	92
12	Mrs N	10	4	4	50	74	82
13	Mrs G (right)*	8	2	2	52	80	86
14	Mrs G (left)*	10	2	2	50	76	82
15	Mr Md	8	2	2	50	74	82
16	Mrs Am	8	2	0	50	72	82
17	Mrs Sa (right)^	10	4	2	56	88	94
18	Mrs Sa (left)^	10	2	2	58	82	90
19	Mrs Ad	10	4	2	58	82	90
20	Mrs V	8	2	2	60	82	92

Note: The patient population involved 16 unilateral knees and 2 bilateral knees marked as \*,^; POD, postoperative day

With regard to complications, we had 4 cases of weakness of extension of great toe. In three patients, the extension of other digits was not affected. This shows that deep peroneal was not injured in these cases but we presume that the segment of fibular bone removed must have been the primary area of origin of this muscle leading to isolated weakness. Further anatomical studies are need to confirm this idea. Among these 3 patients, 2 patients had complete recovery in 4 months' time. In one patient who also had numbness of first dorsal webspace showed a minimal recovery till final follow-up. This highlights the importance of care, during soft tissue dissection and retraction along with avoidance of Hohmann's retractors to avoid injury to deep peroneal nerve.

**Table 4:** Patient data depicting measurement of alpha angle preoperatively and postoperatively

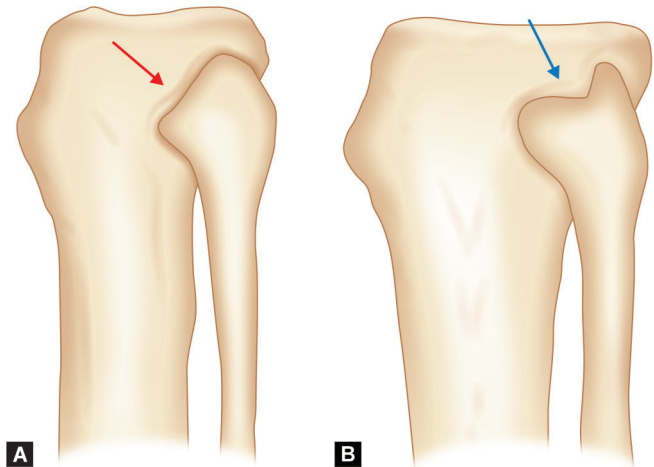
S. no.	Patient name	Alpha angle measurement		
		Preoperative	Postoperative	Correction
1	Mrs M	183.56	179.69	3.87
2	Mrs R	182.45	177.67	4.78
3	Mr S	192.41	189.63	2.78
4	Mrs P	180.16	175.71	4.45
5	Mrs Pr	181.78	177.91	3.87
6	Mr Ra	193.67	192.48	1.19
7	Mr T	180.46	177.24	3.22
8	Mr AZ	186.56	182.12	4.44
9	Mr Mo	187.34	183.78	3.56
10	Mr Ri	180.46	176.91	3.55
11	Mrs Sh	182.45	177.58	4.87
12	Mrs N	191.55	189.21	2.34
13	Mrs G (right)*	182.34	177.56	4.78
14	Mrs G (left)*	185.46	181.96	3.5
15	Mr Md	186.34	183.84	2.5
16	Mrs Am	184.55	181.65	2.9
17	Mrs Sa (right)^	180.11	174.99	5.12
18	Mrs Sa (left)^	181.21	176.54	4.67
19	Mrs Ad	187.45	184.31	3.14
20	Mrs V	182.67	177.44	5.23

Note: The patient population involved 16 unilateral knees and 2 bilateral knees marked as \*, ^

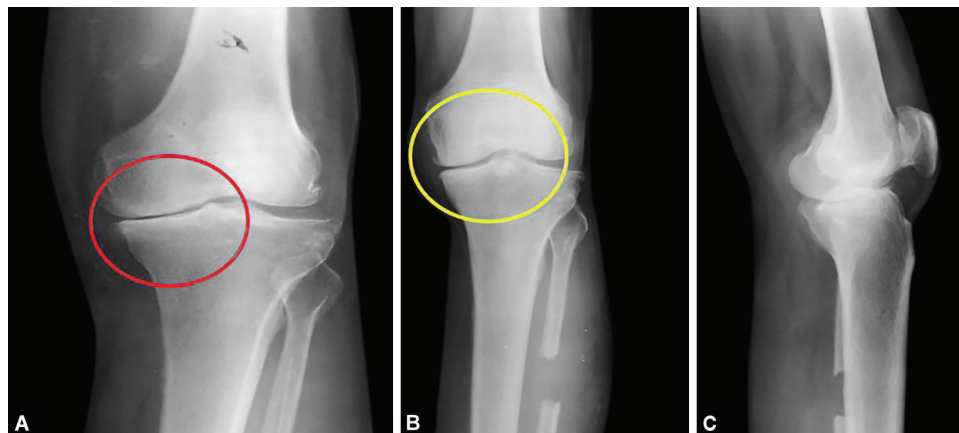
The limitation of this study is that there is no control group for comparison and there is no randomization of study population. Also, the placebo effect of the procedure cannot be ruled out. We need long-term follow-up studies, involving large numbers of test subjects with randomization to confirm the usefulness of this procedure.

## CONCLUSION

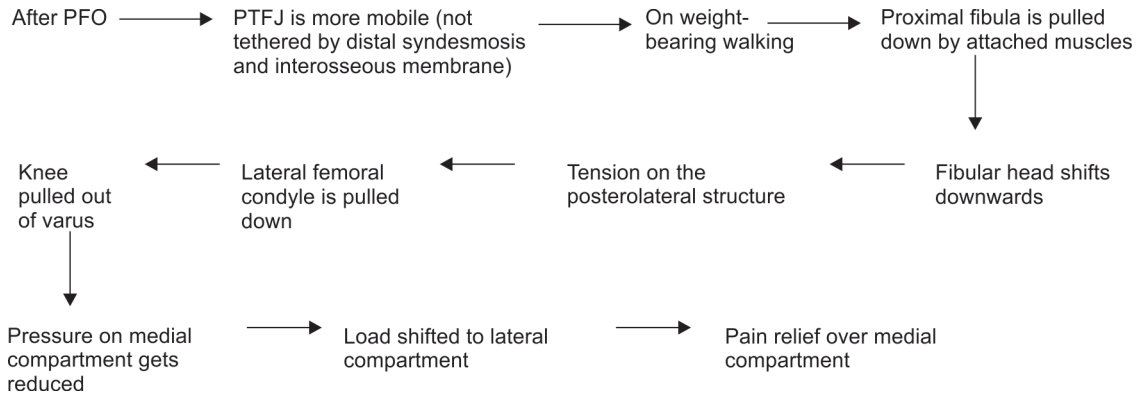
Through our short-term prospective cohort study, we conclude that PFO helps in improvement of pain and function, in patients suffering from medial compartment OA knee, in concurrence with existing literature favoring PFO. The improvement in pain score and functional score is evident in the immediate postoperative period and also improves further till our follow-up time of 6 months. The effectiveness of proximal tibiofibular joint mechanism in immediate pain relief is evident in our study by subjective and objective means. Proximal fibular osteotomy helps in patients who do not respond well to conservative management and at the same time do not opt for total knee arthroplasty. A proper selection of case with regard to severity and duration of disease and patellofemoral involvement is vital in getting good results following PFO. More long-term prospective randomized control studies are needed to substantiate its usefulness in the management of OA knee.



**Figs 5A and B:** Anatomical types of proximal tibiofibular joint as described by Ogden et al.: (A) Oblique type; (B) Horizontal type



**Figs 4A to C:** Illustrative case 2: (A) Preoperative standing anteroposterior radiograph of a patient with medial joint space narrowing; (B) 2nd postoperative day standing anteroposterior radiograph of the same patient after proximal fibular osteotomy. Though this patient has minimal medial joint opening, the patient had significant improvement in pain following procedure; (C) Lateral view of the same knee

**Flowchart 1:** Mechanism of medial compartment decompression by PFO.

PFO, proximal fibular osteotomy; PTFJ, proximal tibiofibular joint

## CLINICAL SIGNIFICANCE

Proximal fibular osteotomy is an emerging concept in the management of grade II and grade III medial compartment OA of knee and gives the patient, more years with native knee to walk, before opting for total knee arthroplasty as the definitive procedure of management.

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