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Proximal Fibular Osteotomy in Treatment of Medial Unicompartmental Knee Osteoarthritis in Elderly Patients

Mohab Osama Hemeda [a*], Elsayed Mohammed Alforse [a], Abd Alhafiz Abd Alhafiz Mogahed [a] and Osama Ahmed Amin [a]

[a] Orthopedic Surgery Department, Faculty of Medicine, Tanta University, Tanta, Egypt.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: Osteoarthritis (OA) involves mainly the medial tibiofemoral joint of the knee as the stresses of weight bearing mainly involve the medial condyle of the tibia: thus, this is the primary site for knee OA. The work aimed to evaluating the results of proximal fibular osteotomy alone or conducted with arthroscopic lavage and debridement for treatment of medial unicompartmental knee osteoarthritis in elderly patients.
Methods: This study was carried out on 37 cases with knee pain with medial compartment knee osteoarthritis with varying degrees of genu varum. Patients grouped randomly into two matched groups regarding age, sex, BMI and degree of osteoarthritis. Group 1 (n=18) had undergone proximal fibular osteotomy alone and group 2 (n=19) had undergone proximal fibular osteotomy conducted with arthroscopic debridement and lavage.
Results: The mean VAS and mean knee sub scores improved in group (A) and (B) postoperatively than preoperatively (p-value <0.0001). Comparing the two groups according to mean (VAS) and mean knee sub scores, it was found that p-value was <0.001 which was statistically significant. The mean ratio of knee joint space it was found that p-value was <0.001 which was statistically significant.
Conclusions: PFO is a convenient surgical option in most developing countries like Egypt with low medical and financial resources. PFO may delay or even negate the need for total knee

**Corresponding author;*

arthroplasty. PFO may be A viable alternative procedure for medial compartment knee osteoarthritis, especially for patients who cannot undergo TKA because of certain medical co morbidities. Care must be taken to avoid common peroneal nerve injuries. Knee arthroscopic lavage helps in decreasing knee pain and knee improving joint function by washing of crystals and debris that may induce inflammation and pain.

Keywords: Proximal fibular osteotomy; knee osteoarthritis; elderly patients; arthroscopic lavage.

1. INTRODUCTION

Knee is the largest joint in the human body. It is a complex joint which is formed by articulations between the distal end of femur (femoral condyles) with proximal tibia (tibial plateau) and patella forming three joints: the medial and lateral tibiofemoral joints and patellofemoral joint. The tibia bears about (83-93) % of weight bearing loads while the fibula bears the remainder. Osteoarthritis (OA) involves mainly the medial tibiofemoral joint of the knee as the stresses of weight bearing mainly involve the medial condyle of the tibia: thus, this is the primary site for knee OA [1].

Osteoarthritis increases with aging: 80% of patients >65 years old have symptomatic OA of one joint at least and changes are present in x-ray radiographs in more than 50% of patients aged over 60 years old [2,3].

The condition involves degeneration and loss of articular cartilage, which is the bearing surface of synovial joints. The pathology is increased production of degenerative enzymes within the joint and not simply wear and tear mechanisms. Therefore, OA affects even the small joints of the hand and wrist but most commonly be symptomatic in large joints of lower limb (hips, knees) [4-6].

Signs are different according to the grade and extent of OA and joint affected: clinical examination shows restricted range of movement in all planes, pain, swelling, tenderness and crepitus on moving. By examining plain radiographs: narrowing of joint space, osteophytic lipping, bone cysts, subchondral sclerosis and deformity (genu varum) is seen according to grade of OA [7].

The keystones in management of knee OA are pain relief and maintenance of mobility. During the inflammatory stage OA can usually be effectively managed by non-steroidal anti-inflammatory drugs (NSAIDs); the underlying process cannot be reversed therefore most of patients may need surgical intervention [8].

Various surgeries can be done in OA treatment as: Arthrodesis (surgical stiffening of joint), arthroscopic surgery (lavage and debridement), osteotomy (realignment of the joint to ensure that pressure is spread equally across the joint) e.g. high tibial osteotomy for correction of varus deformity and unicompartmental or total knee arthroplasty [9].

Recently proximal fibular osteotomy alone or conducted with other procedures e.g. arthroscopic lavage and debridement proved its effectiveness in relieving pain, realign the joint deformity and increase medial joint space in comparison with other surgeries as total knee arthroplasty which is time consuming, expensive and invasive operation [10].

The aim of this work was to evaluate the results of proximal fibular osteotomy alone or conducted with arthroscopic lavage and debridement for treatment of medial unicompartmental knee osteoarthritis in elderly patients.

2. PATIENTS AND METHODS

This study was carried out on 37 cases with ages start from 45 years old, knee pain with difficulty walking, with moderate to severe symptomatic medial compartment OA of the knee, who had an indication for a surgical procedure and unsatisfactory results with conservative treatment of osteoarthritis. Our patients were collected from the outpatient clinic of orthopedic surgery department in Tanta University Hospitals from (2018-2020).

Exclusion criteria were patients <45 years old, lateral knee joint ligament laxity, patients with posttraumatic knee OA or inflammatory joint disease, a history of previous knee operations or fractures, genu valgus, acute major trauma, malignancies or metastatic bone lesions and abnormal renal or liver function.

Patients grouped randomly into two matched groups regarding age, sex, BMI and degree of osteoarthritis. Group 1 (n=18) had undergone

proximal fibular osteotomy alone and group 2 (n=19) had undergone proximal fibular osteotomy conducted with arthroscopic lavage and debridement.

All patients subjected to complete history taking and clinical examination (General and local examination).

Anteroposterior and lateral weight-bearing radiographs of knee joint to assess the grade and ratio of joint space (medial/lateral) compartment.

The medial joint space was determined by a vertical line (A) between two horizontal lines (C and D) that were drawn from the lowest point of the medial condyle of the femur and medial plateau of the tibia, respectively.

The lateral joint space was determined by a vertical line (B) between two horizontal lines (E and F) that were drawn from the lowest point of the lateral condyle of the femur and lateral plateau of the tibia, respectively. The ratio of the knee joint space (medial/lateral) was determined by the ratio of A/B.

Whole lower limb radiographs for femorotibial angle (FTA) measurement.

Assessment of pain by VAS (Visual analogue scale).

Knee ambulation activities were recorded using the knee and function sub scores of the American Knee Society score (KSS) divided into two components. The first assesses the knee clinically through the physical examination (Clinical AKSS - "Knee Score"), and the second assesses the individual's functionality (Functional AKSS - "Function Score"), while both attain a total of 100 points each. The Clinical AKSS evaluates pain, in a total of 50 points, stability, 25 points, and range of motion, 25 points. The maximum score of 100 points is reached when there is no pain, with good alignment of the knee in extension, and at least 125° of range of motion, without any anteroposterior or mediolateral instability. The Function AKSS evaluates the walking distance, totalling 50 points, and the act of ascending and descending stairs, 50 points. The maximum score of 100 points is attributed to the individual capable of walking unlimited distances without walking aids, and of ascending and descending stairs normally.

2.1 Surgical Procedure

The patients were well prepared before surgery. The affected limb was marked with a marker pen. The site and level of incision was marked preoperatively about (6-10cm) below the fibular head. Under complete aseptic conditions the spinal anesthesia was given to the patient. A sandbag was placed under the buttock of the same side to allow freely movement of the leg in patients lie supine.

After anesthesia a thigh tourniquet was applied. Proper sterilization was done. The foot was well padded in a sterilized towel. A 3 to 5 cm lateral incision was made at the proximal third of the fibula to avoid injury to the common fibular nerve and the tibial attachments of the soft tissue structures crossing the knee joint. Incision of deep fascia was done in line with skin incision. The fascia was then incised parallel to the septum between the peroneus and soleus; the muscles were separated, and the fibula was exposed. Two retractors were used to open the wound gently.

The periosteum was incised longitudinally and stripped of in site of osteotomy. Two drilling hole pits were done to mark the site of osteotomy proximally and distally. About 2cm of bone was removed with an oscillating saw or T-saw. Bone wax was applied to the fibular cut ends which acts as a plug to control post operative bleeding. Wound was irrigated well to remove any bone fragments or any debris in the wound. The tourniquet was removed to ensure that there are no bleeding vessels. A surgical drain was applied. The incision was irrigated with a large volume of normal saline, the muscles, fascia, and skin were sutured separately. A sterile dressing was applied over the wound with bandage over it.

The patient is allowed and encouraged to fully bear weight as soon as they can tolerate postoperatively with or without aid of crutches depending on patient tolerability. The patients were routinely ambulatory by the third postoperative day. In cases conducted with Arthroscopic lavage involves the introduction of saline solution into the knee joint and the removal of any debris such as free microscopic or macroscopic fragments of cartilage, calcium phosphate crystals, and others chemical products that may induce synovitis. In comparison, debridement consists of smoothing rough, fibrillated articular and removal of torn menisci, shaving tibial-spine osteophytes and loose body removal that interfere with the motion

of the joint and minor synovectomy removing inflamed synovium. Superficial abrasion performed to stimulate repair in the area of sclerotic lesions. Open surgical drilling procedures (Pridie drilling) have been advocated to reach the blood supply and the pluripotent stem cells to stimulate fibrocartilage growth. Rather than drill holes, multiple superficial dimples are created with a motorized burr. This abrasion of sclerotic bone leads to bleeding and formation of a blood clot that attaches to and fills the defect of abraded areas and will transform in fibrocartilage by 4 to 6 months.

2.2 Statistical Analysis

Statistical analysis was done by SPSS v24.0. (Armonk, NY: IBM Corp). Quantitative variables were presented as mean and standard deviation (SD) and were compared by paired Student's t-test for the same group and unpaired student t-test for the two groups. Qualitative variables were presented as frequency and percentage (%) and were compared by chi-square tests. A two tailed P value < 0.05 was considered significant.

3. RESULTS

There was no statistically significant difference regarding age, BMI, and HB concentration. The mean duration was statistically significant difference between them (p-value <0.0001) Table 1.

The mean VAS and mean knee sub scores improved in group (A) and (B) postoperatively than preoperatively (p-value <0.0001). Comparing the two groups according to mean (VAS) and mean knee sub scores, it was found that p-value was <0.001 which was statistically significant Table 2.

The mean function sub score of the (AKSS) in group (A) it was 47.47 ± 8.614, 73.79± 10.461 pre and post operatively respectively and p-value <0.0001 which was statistically significant, and in group (B) was 46.24± 7.849 preoperatively and 75.86± 11.33 postoperatively with p-value <0.0001 which was statistically significant. The mean FTA in group (A) and (B) was decreased preoperatively than postoperatively with p-value <0.0001 which was statistically significant. Comparing the two groups according to mean function sub score and mean FTA, it was found that p-value was <0.001 which was statistically significant Table 3.

The mean ratio between the (medial/lateral compartments) of the two study groups which increased post operatively for both of the study groups, in group (A) the mean ratio preoperatively was 0.43±0.27 which increased to 0.61±0.30 postoperatively with p-value <0.0001 which was statistically significant, while in group (B) the mean ratio increased from 0.44±0.33 to 0.60±0.32 pre and post operatively respectively with p-value <0.0001 which was statistically significant. Comparing the two groups according to mean ratio of knee joint space it was found that p-value was <0.001 which was statistically significant Table 4.

A plain standing knee AP. Radiographs shows pre and post PFO medial and lateral knee joint space width with obvious opening of the medial joint space and narrowing of the lateral joint space. A plain standing knee A.P. radiographs show pre and post PFO FTA with obvious correction of varus deformity post operatively Fig. 1.

A plain standing knee AP. Radiographs shows pre and post PFO medial and lateral knee joint space width with obvious opening of the medial joint space and narrowing of the lateral joint space. Radiographs shows pre and post PFO FTA with obvious correction of varus deformity post operatively Fig. 2.

A plain standing knee AP. Radiographs shows pre and post PFO medial and lateral knee joint space width with slight opening of the space in the medial joint and narrowing of the lateral joint space. Radiographs shows pre and post PFO FTA with minimal correction of varus deformity post operatively Fig. 3.

Table 1. The characteristic data and the mean duration of unilateral PFO of the two study groups

	Group(A) (n=18)	Group(B) (n=19)	p. value
Age (years)	55.32±4.29	52.88±3.74	0.701
BMI (kg/m^2)	28.40±1.29	27.46±2.85	0.141
HB concentration (gm/dl)	11.556 ±0.52	11.471 ±0.35	0.514
Mean Duration of Unilateral PFO in min	26.8 ± 3.29	49.83± 3.79	<0.0001*

*Data are presented as mean ± SD, BMI: Body mass index, BSA: Body surface area, Hb: hemoglobin, PFO: Proximal fibular osteotomy, *: significant P value*

Table 2. The mean Visual Analogue Scale scores (VAS) and mean knee sub scores of the two study groups during the period of the study

		Group (A) (n=18)	Group (B) (n=19)	p. value
Mean visual analogue scale	**Preoperative**	7.47 ± 0.614	2.59± 0.461	<0.0001*
	postoperative	2.59± 0.461	2.01± 0.33	
p-value		<0.0001*	<0.0001*	
Mean knee sub score	**Preoperative**	44.3 ± 7.914	43.24± 8.849	<0.0001*
	postoperative	69.79± 10.961	74.01± 10.33	
p-value		<0.0001*	<0.0001*	

*Data are presented as mean ± SD, , *: significant P value*

Table 3. The mean function sub score of the American Knee Society Score (AKSS) and the mean femorotibial angle of the two study groups during the period of the study

		Group (A) (n=18)	Group (B) (n=19)	p. value
Mean function sub score	**Preoperative**	47.47 ± 8.614	46.24± 7.849	<0.0001*
	postoperative	73.79± 10.461	75.86± 11.33	
p-value		<0.0001*	<0.0001*	
Mean function FTA	**Preoperative**	182.3°±2.0°	181.2±.2.1°	<0.0001*
	postoperative	178.6°±1.9°	178.3± 1.8°	
p-value		<0.0001*	<0.0001*	

*Data are presented as mean ± SD, *: significant P value, FAT: Femorotibial Angle*

Table 4. The mean ratio of the knee joint space (medial/lateral compartment) of the two study groups pre and post operatively

		Group (A) (n=18)	Group (B) (n=19)	p. value
Mean function sub score	**Preoperative**	0.43±0.27	0.44±0.33	<0.0001*
	postoperative	0.61±0.30	0.60±0.32	
p-value		<0.0001*	<0.0001*	

*Data are presented as mean ± SD, *: significant P value, FAT: Femorotibial Angle*

4. DISCUSSION

Total knee arthroplasty (TKA) reduces pain and improves knee function in people with end-stage osteoarthritis. Nevertheless, TKA is a costly and intricate treatment, and some patients require numerous modifications [11].

In this study, the contact stress on the lateral tibial plateau was increased by the PFO. There is possibility; the simple fibular osteotomy can improve the osteoarthritis knee function. However, we consider that the change of the contact pressure depends on the degree of varus alignment [12].

Utomo et al. [13] and Yang et al., [14] found “a significant difference in tibiofemoral angle before and after PFO ($p < 0.001$). The mean of tibiofemoral angle of the patient decreases significantly so that the varus deformity is reduced 227,228”. “There is also a statistically significant increase in joint space ratio in patients who had performed proximal fibular osteotomy ($p < 0.001$) procedures” [13] Because structural modifications of the deformity will reduce the patient's knee discomfort, the better radiological assessment results will result in a favourable clinical evaluation.

However, the mechanism for proximal fibular osteotomy fixation cannot yet be fully explained. It was reported that the joint space and the tibiofemoral angle improvement results from the removal of the fibula, which acts as lateral support. “The fibula that causes varus genus in this case has a role to support one-sixth of body weight. Proximal procedure of fibular osteotomy is effective for re-stabilization or distribution the load of the weight to the lateral and medial portions of the tibial plateau after surgery” [14].

In the present research, pain alleviation and an elevation in the ratio of medial to lateral joint space were observed. The majority of patients in our study experienced a significant relief from pain shortly after PFO, although the follow-up was short. Some patients reported no discomfort at the most recent follow-up, as pain management continued to improve. Ambulation (i.e., walking) was also improved postoperatively when compared with the preoperative state. PFO also improved the lower extremity axial alignment in some patients, especially in those with severe genu varus.

The fibula also plays a crucial supportive role for the lateral tibial plateau. In middle-aged and older individuals with osteoporosis, the supportive role may result in non-uniform settlement of the plateau, followed by knee varus and pressure overload in the medial compartment. The pressure overload may be a role in the advancement of medial compartment osteoarthritis and medial meniscal tears. After proximal fibular osteotomy, fibula support was decreased, and the knee force centre shifted laterally.

The medial compartment pressure decreased by 21.57%, according to cadaveric research. The pressure in the lateral compartment increased by a maximum of 12.92 percent after PFO. Varus deformity was corrected as a result of the decreased support and redistribution of knee load, which interrupted the non-uniform settlement of the plateau and advancement of medial compartment osteoarthritis. Meanwhile, the decrease in medial compartment pressure was also conducive to reducing inflammation in the medial compartment. And, the reduction of medial compartment inflammation, in conjunction with the trimming of the torn medial meniscus, assisted in relieving knee pain and enhancing knee function. Therefore, concurrent PFO and arthroscopic lavage and debridement may provide more knee pain and function relief than arthroscopic lavage and debridement or PFO alone.

Even though PFO corrected varus deformity in a knee with osteoarthritis., The deformity repair was restricted, and the precise angle of correction cannot be estimated. The pathophysiology of the medial compartment necessitated arthroscopic intervention treat the biological and mechanical elements of osteoarthritis for a better clinical outcome. Degenerative medial meniscal tears are considered part of the spectrum of pathology seen in medial compartment osteoarthritis and a risk factor for additional articular cartilage degeneration in middle-aged and older patients. After failure of conservative treatment, the efficacy of arthroscopic lavage and debridement for symptomatic patients with medial compartment osteoarthritis and medial meniscal tears has been demonstrated. However, arthroscopic lavage and debridement were ineffective in slowing the progression of osteoarthritis when used alone.

In the current investigation, PFO combined with athroscopic lavage and debridement resulted in good clinical relief for medial compartment osteoarthritis and medial meniscal tears, with no patients experiencing radiographic progression of osteoarthritis. We believe that the pressure reduction of the medial compartment and the micromotion, which was achieved by PFO, may slow the osteoarthritis progression by inducing fibrocartilage regeneration. Degenerative tear of the medial meniscus, medial meniscus root tear, focal cartilage defect that included the medial femoral condyle or medial tibial plateau, and mild varus deformity around 5 may be ideal indications.

The site of PFO for medial compartment osteoarthritis is 6-10 cm below the fibular head. The integrity of the fibula is necessary for the stability of the ankle joint complex. Ankle stability has been said to depend on the distal 6 cm of the fibula. A more proximal partial fibulectomy would result in fewer ankle problems. The interosseous membrane's fibres are also oblique from the tibia to the fibula. The interosseous membrane pulls the fibula toward the tibia during weight bearing, resulting in load sharing between the two bones. Fewer stresses might be shared with the proximal fibular segment when PFO was done more closely, and the support from the proximal fibular segment to the lateral tibial plateau would be weaker. Close attention is needed to avoid potential peroneal nerve injury during surgery. In the present study, two of the 21 (9.5%) affected limbs showed superficial peroneal nerve injury of 1st group, and one (4.7%) of the 2nd group had common peroneal nerve injury. We advise the posterolateral approach, which exposes the proximal fibula by passing through the space between the soleus muscle and the fibula longus muscle, to reduce iatrogenic injury to the peroneal nerve. Our first experience with concomitant PFO and arthroscopic lavage

and debridement has been favourable. It's interesting to note that the pain management improved further, and some patients even reported no pain at the most recent follow-up. Comparing the pre-operative and post-operative states, walking was clearly better after surgery. Some patients' lower extremity alignment, particularly in those with significant genu varus, was also improved by PFO. This innovative operation has the potential to provide an alternate treatment for osteoarthritis of the medial compartment of the knee, particularly for patients who are ineligible for TKA due to medical complications. However, this study has numerous drawbacks that must be highlighted. First, although the short-term results are encouraging, the follow-up period was rather brief, and it is unknown whether these benefits will persist over a longer period of time. Consequently, a longer follow-up investigation is required.

For medial compartment osteoarthritis associated with medial meniscal tears, PFO and arthroscopic lavage and debridement offers a good option. It has the benefits of a simple procedure, little surgical trauma, little postoperative pain, quick recovery, affordability, and a low rate of complications.

PFO surgery is less complicated, safer, faster, and more affordable than TKA or HTO, and it doesn't include the placement of implants. PFO is a reasonable surgical choice as a result in the majority of developing nations like Egypt that have inadequate financial and medical resources.

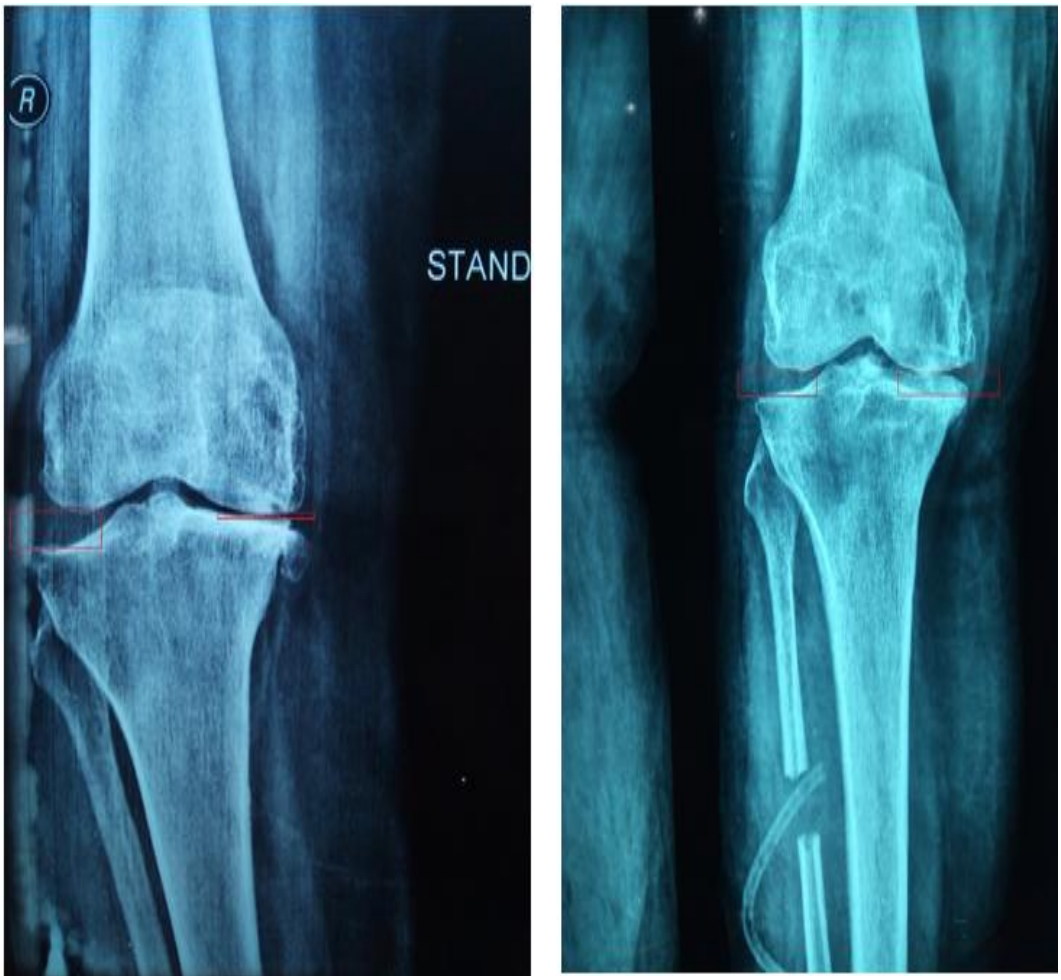
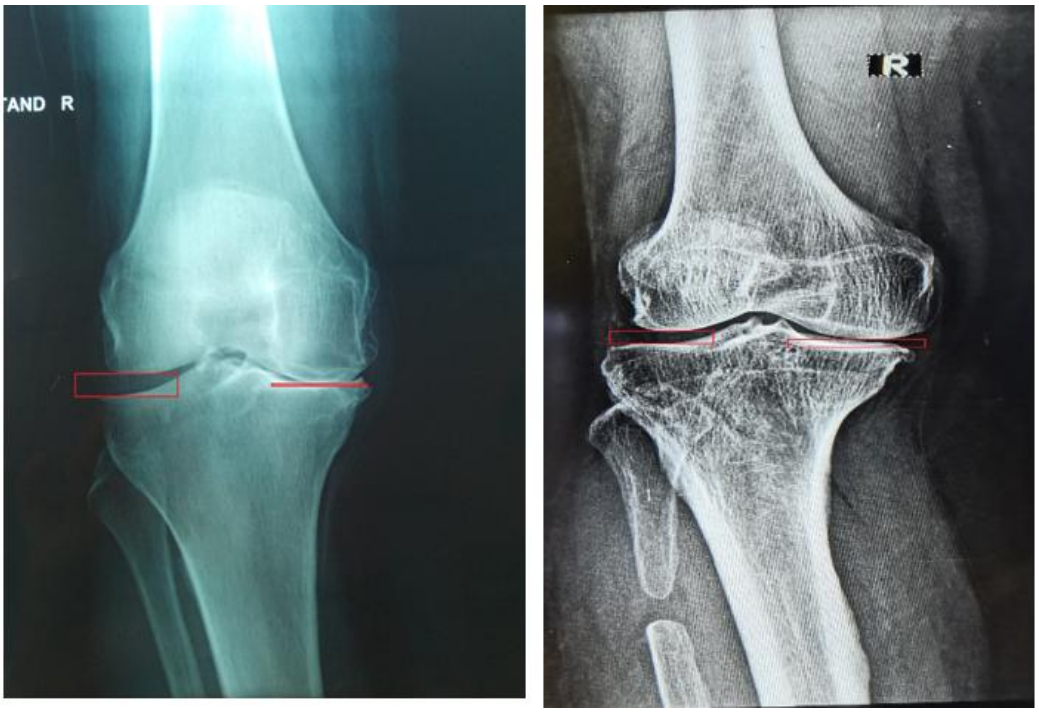
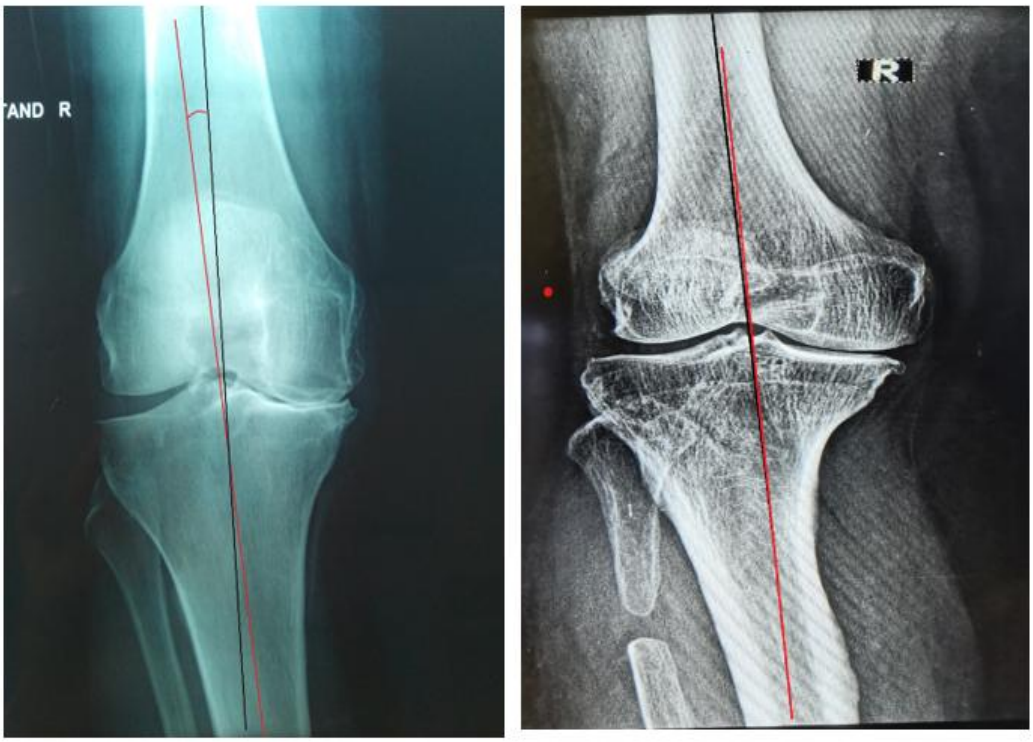


Fig. 1. A plain standing knee AP. Radiographs shows pre and post PFO medial and lateral knee joint space width with obvious opening of the medial joint space and narrowing of the lateral joint space

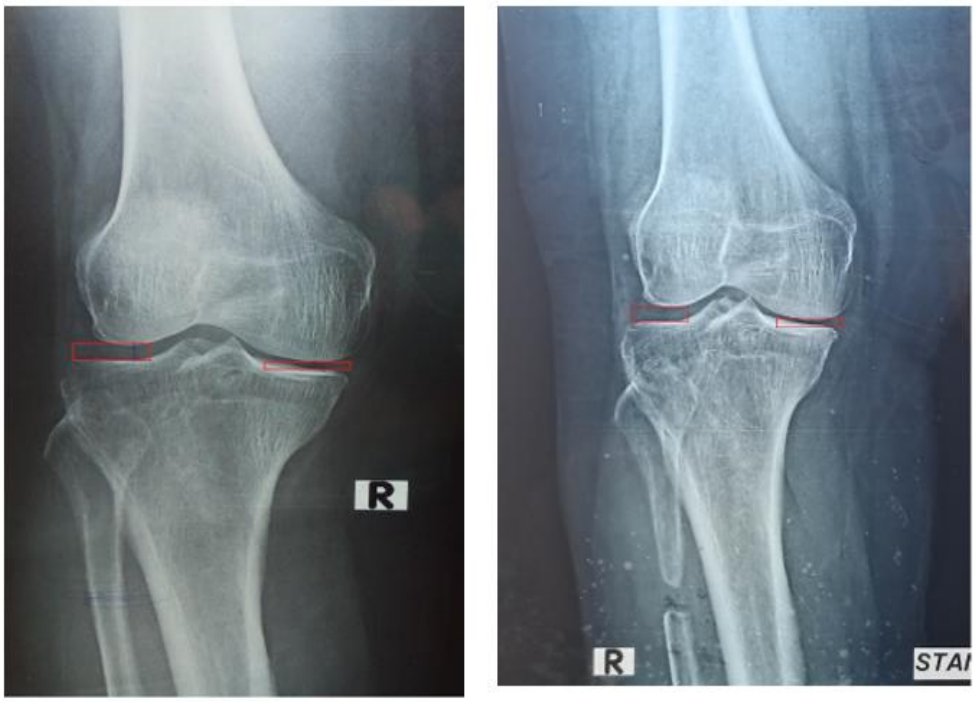


(A)



(B)

Fig. 2. A plain standing knee AP. (A) Radiographs shows pre and post PFO medial and lateral knee joint space width with obvious opening of the medial joint space and narrowing of the lateral joint space. (B) Radiographs shows pre and post PFO FTA with obvious correction of varus deformity post operatively



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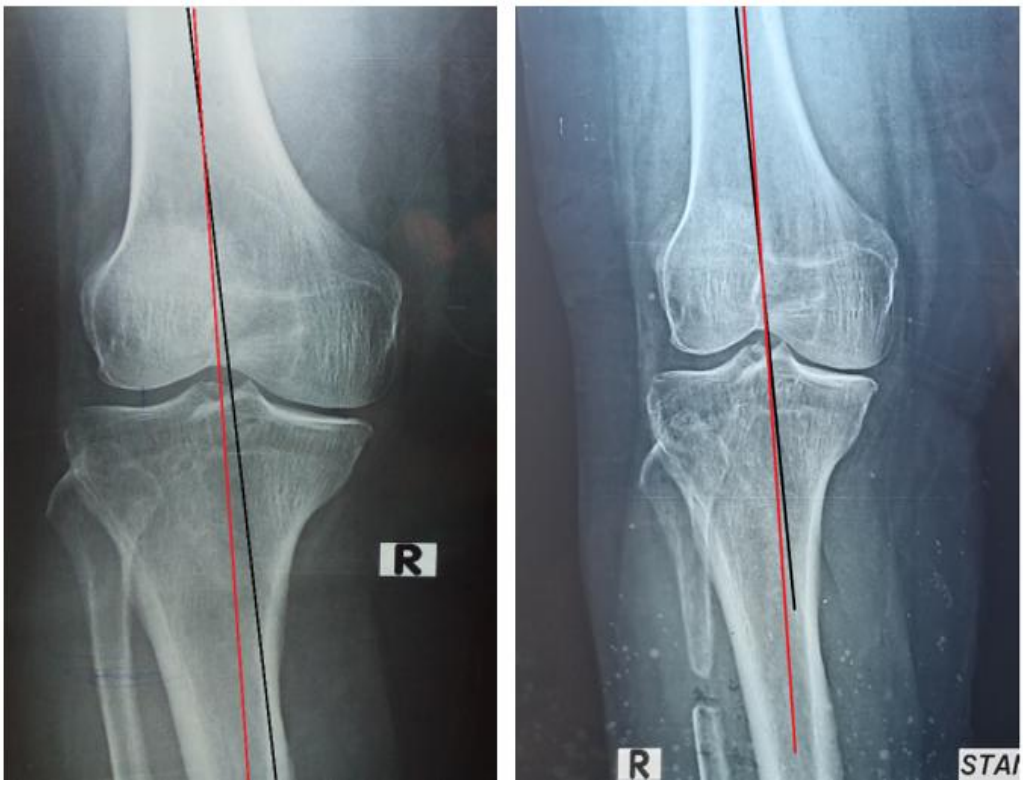

(B)

Fig. 3. A plain standing knee AP. (A) Radiographs shows pre and post PFO medial and lateral knee joint space width with slight opening of the medial joint space and narrowing of the lateral joint space. (B) Radiographs shows pre and post PFO FTA with minimal correction of varus deformity post operatively

5. CONCLUSIONS

PFO is a suitable surgical treatment in the majority of underdeveloped countries like Egypt that lack financial and medical resources. PFO may delay or even negate the need for total knee arthroplasty. For individuals who are unable to have TKA due to certain medical comorbidities, PFO may be a promising alternative treatment for osteoarthritis of the medial compartment of the knee. Care must be taken to avoid common peroneal nerve injuries. Knee arthroscopic lavage helps in decreasing knee pain and knee improving joint function by washing of crystals and debris that may induce inflammation and pain.

CONSENT AND ETHICAL APRPROVAL

The study was done after approval from the Ethical Committee Tanta University. An informed written consent was obtained from the patients.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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