Original Research Article

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

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 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.

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 lavage and debridement.

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 suitable surgical option in most developing countries like Egypt that lack financial and medical resources. PFO may delay or even negate the need for total knee arthroplasty. PFO may be a promising alternative surgery for osteoarthritis of the medial compartment of the knee, 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

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.

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).

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

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 subscores 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, totaling 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.

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, mulitple 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.

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.

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

Table 1: The characteristic data and the mean Duration of unilateral PFO of the two study groups

	Group(A)	Group(B) (n=19)	p. value

	(n=18)		
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

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

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

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 with 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

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	**Preoperative**	182.3°±2.0°	181.2±.2.1°	<0.0001*

FTA	**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

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

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

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. Figure 1

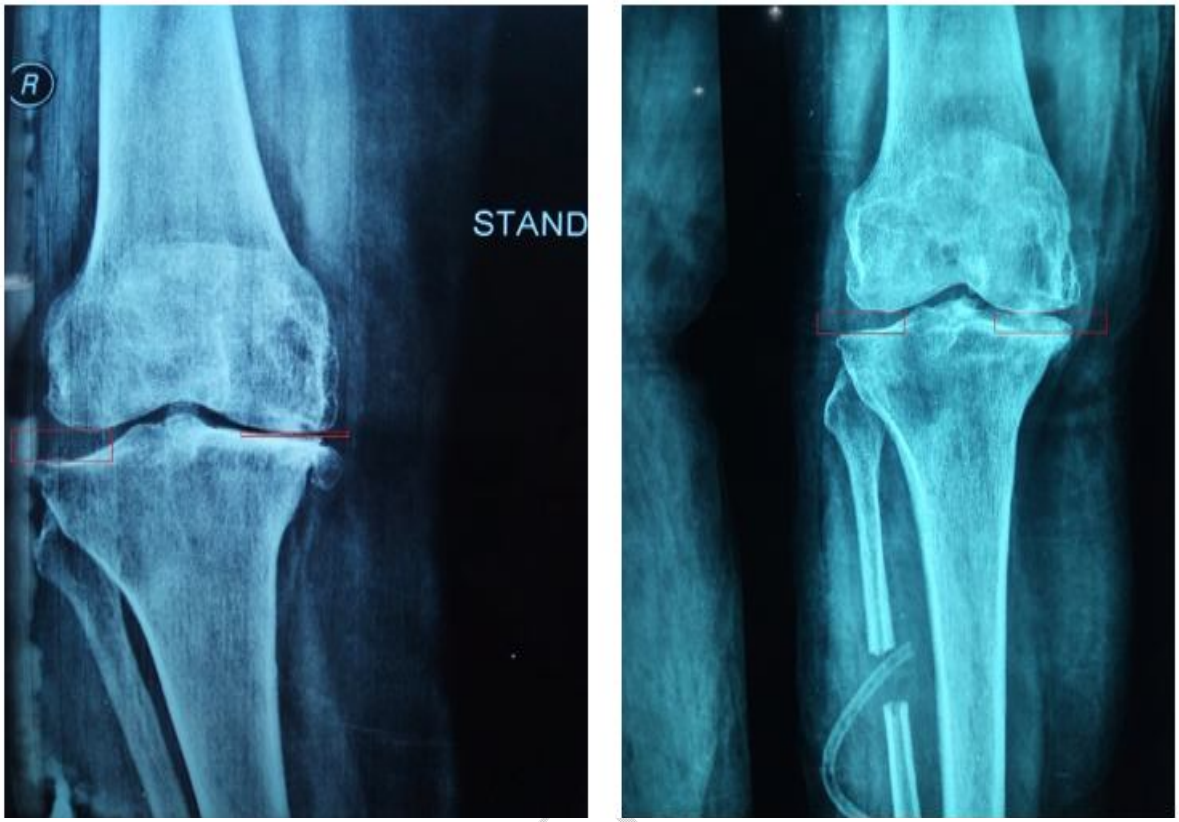
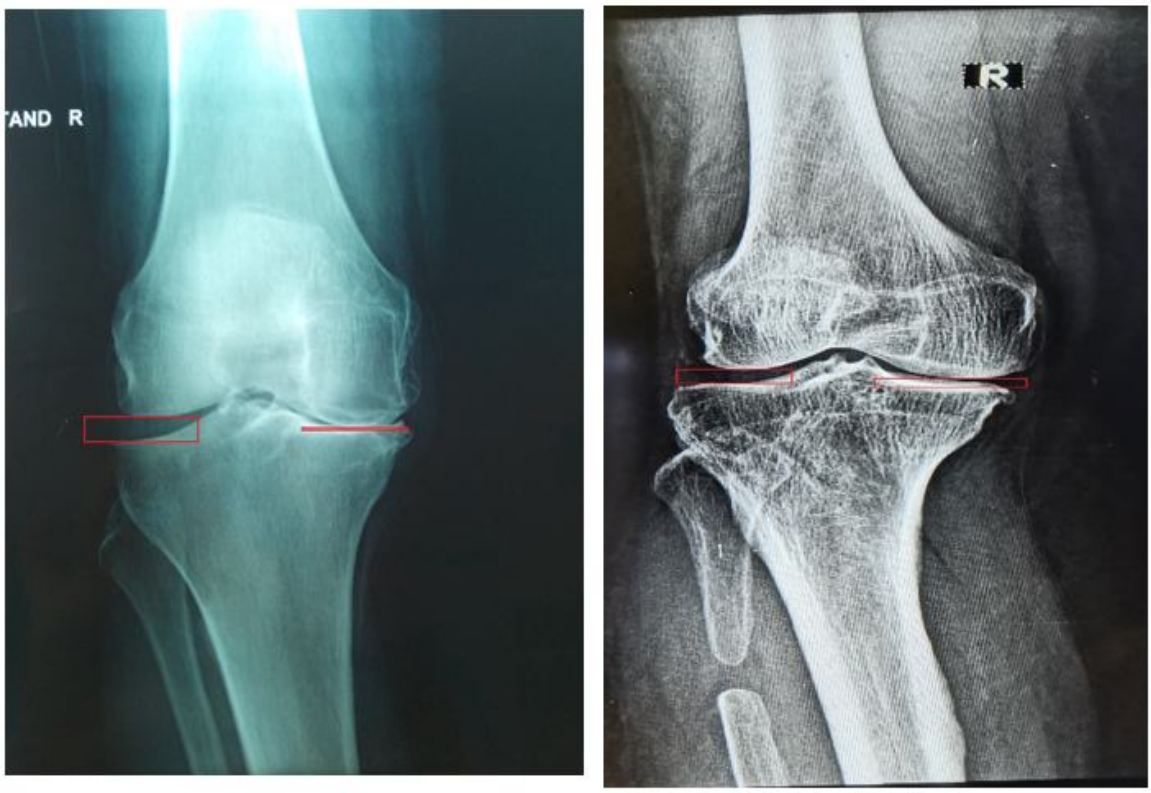
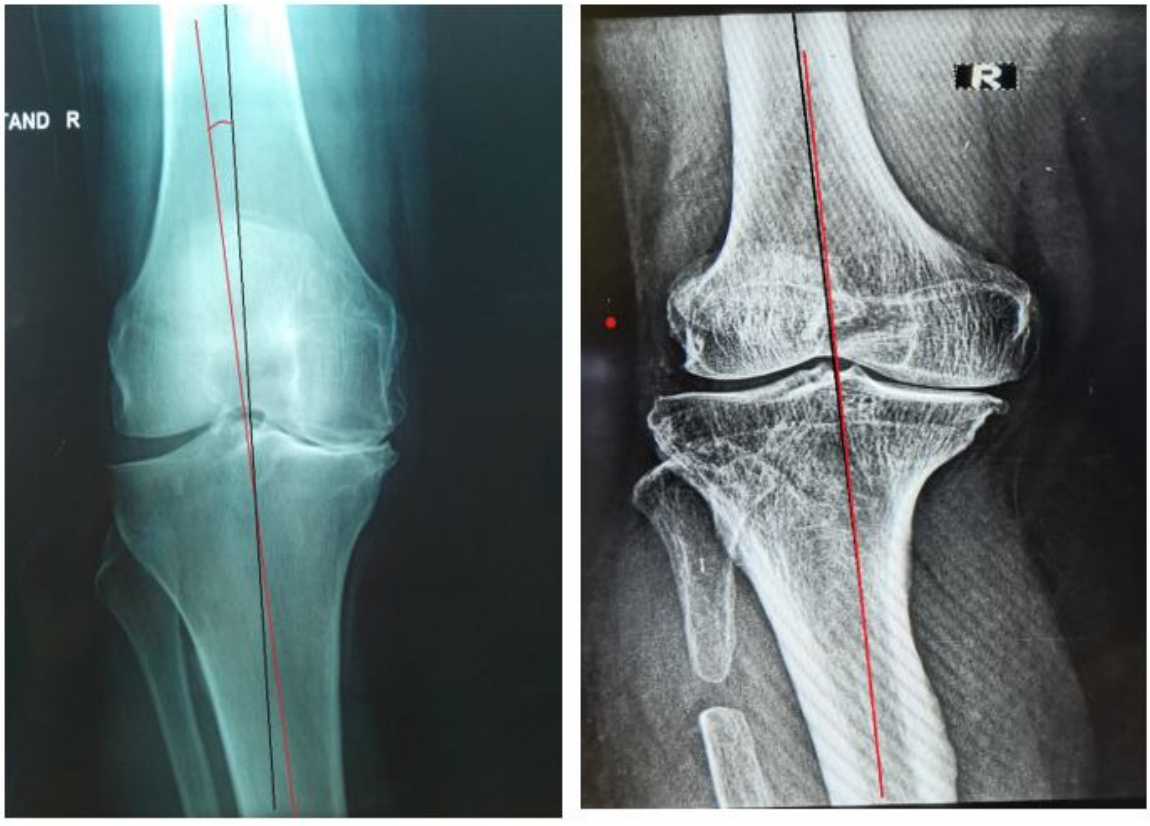


Figure 1: A plain standing knee AP. Radiographs shows pre and post PFO medial and lateral knee joint space width with obvious opening of the medial joint space and narrowing of the lateral joint space.

A 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. Figure 2



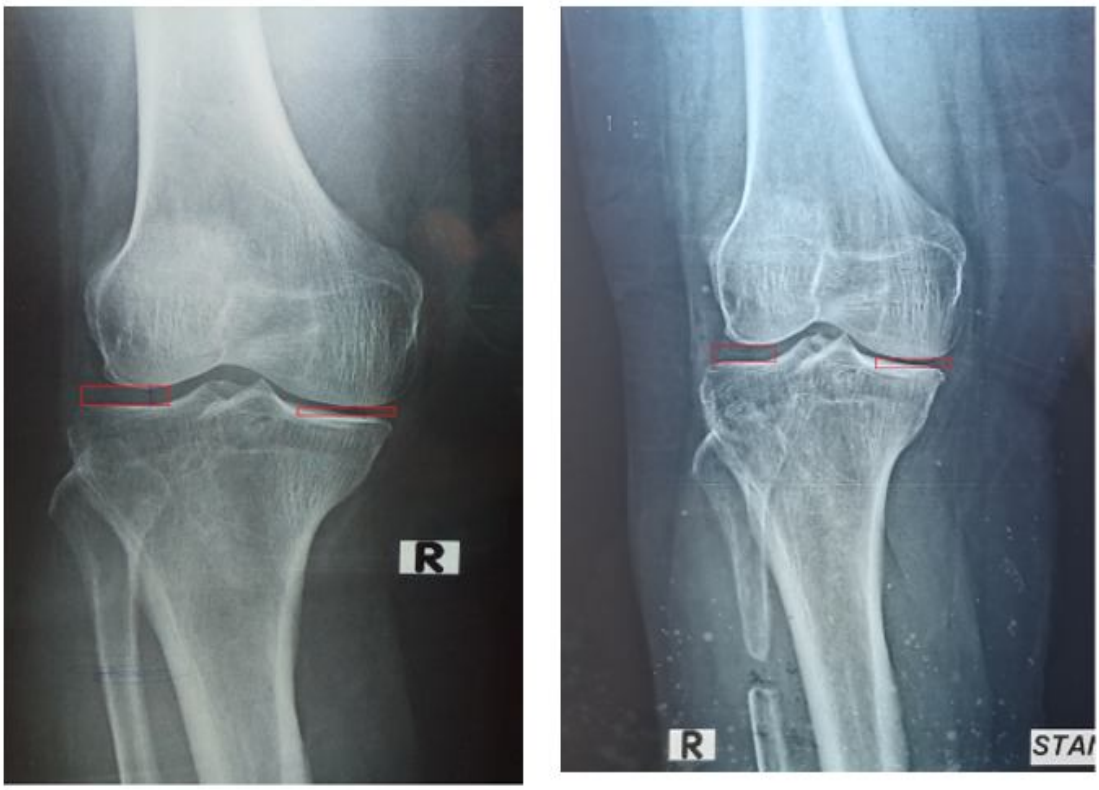
(A)



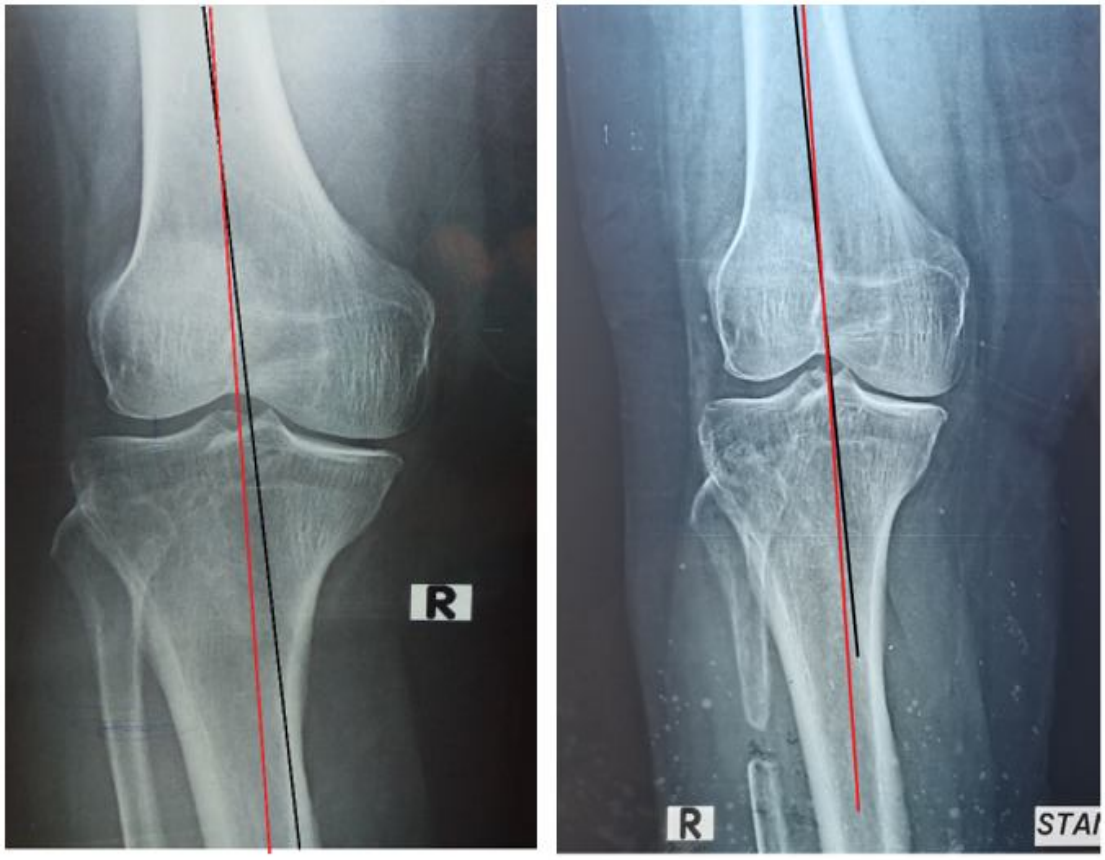
(B)

Figure 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.

A plain standing knee AP. 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. Radiographs shows pre and post PFO FTA with minimal correction of varus deformity post operatively. Figure 3



(A)



(B)

Figure 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.

Discussion

Total knee arthroplasty (TKA) is an effective therapy in reducing pain and improves knee function in patients with end stage osteoarthritis. However, TKA is an expensive and complex procedure, and some patients require multiple revisions [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, [11] 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]. The improved radiological evaluation results will provide a good clinical evaluation because of the structural improvements of the deformity will decrease the pain of the patient's knee.

Nevertheless, the proximal fibular osteotomy fixation mechanism cannot yet be fully explained. One theory holds that the improvement of the joint space and the tibiofemoral angle occurs because the fibula that serves as the support of the lateral part is removed. The fibula that causes varus genus in this case has a role to support one-sixth of body weight. Proximal procedure of fibular osteotomy re-stabilizes or distributes the load to the lateral and medial portions of the tibial plateau after surgery [14].

The findings in the present study included pain relief and an increase in the medial/lateral joint space ratio. Most of patients in our study had significant pain relief immediately after PFO, although the follow-up was short. pain relief continued to improve, and some patients even reported no pain at the last follow-up. 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 has an additional important supporting role for lateral tibial plateau. When osteoporosis is present in middle-aged and elderly persons, the supporting role may lead to the non-uniform settlement of the plateau, followed by knee varus and pressure overload of the medial compartment. The pressure overload could be responsible for the progression of medial compartment osteoarthritis and a factor for medial meniscal tears. After proximal fibular osteotomy, the support from the fibula was weakened, and knee force center was transmitted laterally.

A cadaveric study showed that the pressure of medial compartment decreased by 21.57% at most and the pressure of lateral compartment increased by 12.92% at most after PFO. The weakened support and the redistribution of knee load halted the non-uniform settlement of the plateau and progression of medial compartment osteoarthritis and led to a correction of the varus deformity. Meanwhile, the pressure reduction of the medial compartment was also conducive to lessen the medial compartment inflammation. And, the lessening of the medial compartment inflammation, together with the trim of torn medial meniscus was conducive to relieve the knee pain and improve the knee function. Hence, concomitant PFO and arthroscopic lavage and debridement might offer further improvement of the knee pain and function as compared with arthroscopic lavage and debridement alone or PFO alone.

Even though PFO improved varus deformity of osteoarthritic knee, the correction for deformity was limited and the precise correction angle cannot be estimated. Therefore, for

better clinical result, the pathology of medial compartment warranted arthroscopic intervention, to treat the biological and mechanical aspects of osteoarthritis. In middle-aged and elderly patients, degenerative medial meniscal tears are considered part of the spectrum of the pathology seen in medial compartment osteoarthritis and a risk factor for further articular cartilage degeneration. The efficacy of arthroscopic lavage and debridement for symptomatic patients with medial compartment osteoarthritis and medial meniscal tears after conservative treatment failure has been confirmed. However, arthroscopic lavage and debridement alone was not effective at delaying the progression of osteoarthritis.

In the present study, PFO combined with athroscopic lavage and debridement offered satisfactory clinical improvement for medial compartment osteoarthritis and medial meniscal tears, and no patients had radiographic osteoarthritis progression. 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 medial meniscus, root tear of medial meniscus, focal cartilage defect involving medial femoral condyle or medial tibial plateau, with 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 stability of the ankle joint complex depends on the integrity of the fibula. It has been suggested that 6 cm of the distal fibula is essential for ankle stability. There would be fewer ankle complications if partial fibulectomy is performed more proximally. In addition, the fibers of interosseous membrane are oblique from tibia down to fibula. During weight-bearing, the interosseous membrane pulls the fibula towards the tibia that result in load sharing between the two bones. When PFO was performed more proximally, fewer loads could be shared with the proximal fibular segment, 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. To reduce iatrogenic injury to the peroneal nerve, we recommend the posterolateral approach, which passes the space between the fibula longus muscle and the soleus muscle to expose the proximal fibula.

Our initial experience with concomitant PFO and arthroscopic lavage and debridement has been favorable. Interestingly, the pain relief continued to improve, and some patients even reported no pain at the last follow-up. Postoperative ambulation (i.e., walking) was also obviously improved when compared with the pre- operative state. PFO also improved the axial alignment of the lower extremity in some patients, especially in those with severe genu varus.

This novel surgery can potentially become an alternative treatment method for osteoarthritis of the medial compartment of the knee, especially for patients who cannot undergo TKA because of medical comorbidities. However, several limitations to this study must be noted. First, although the short-term results are encouraging, the follow-up time was relatively short, and whether these outcomes will remain unchanged at a longer follow-up time is unclear. Therefore, a longer follow-up study is warranted.

PFO and arthroscopic lavage and debridement offers a good option for medial compartment osteoarthritis accompanied by medial meniscal tears has the advantages of simple operation, minimal surgical trauma, little postoperative pain, fast rehabilitation, affordable and low rate of complications.

Compared with TKA or HTO, PFO is a simple, safe, fast and affordable surgery that does not require insertion of implants. As such, PFO is a suitable surgical option in most developing countries like Egypt that lack financial and medical resources.

Conclusions:

PFO is a suitable surgical option in most developing countries like Egypt that lack financial and medical resources. PFO may delay or even negate the need for total knee arthroplasty. PFO may be a promising alternative surgery for osteoarthritis of the medial compartment of the knee, especially for patients who cannot undergo TKA because of certain medical comorbidities. 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.

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