Outcomes of combined proximal fibular osteotomy and arthroscopic intervention for treatment of medial compartment knee osteoarthritis

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Background
This study aimed to evaluate the outcomes of combined proximal fibular osteotomy (PFO) and arthroscopic intervention for the treatment of medial compartment knee osteoarthritis.
Patients and methods
This prospective study included 49 knees in 44 patients (34 females and 10 males). Their mean age was 48.4±5.4 years, and the mean BMI was 26.23±2.44. There were 11 knees with Kellgren–Lawrence grade II, 33 with grade III, and five with grade IV. There was varus deformity (range, 6.1°–9.5°) in 34 knees. Combined PFO with arthroscopic lavage and debridement were done.
Results
The mean follow-up was 19.48±2.45 months. There was significant improvement in the mean visual analog score (from 7.24 preoperatively to 1.7 at 12-month follow-up) and Knee Society Score (from 44.79 preoperatively to 72.95 at the final follow-up). There was significant increase in the medial knee joint space (from 1.9 preoperatively to 4.82 postoperatively). The varus angle improved significantly (from 7.8 preoperatively to 1.7 postoperatively). Till the final follow-up, there was no conversion to total knee arthroplasty.
Conclusion
In selected patients, PFO in combination with arthroscopic lavage and debridement could be an alternative option for treating medial compartment knee osteoarthritis through decreasing varus deformity and improving symptoms. These combined procedures could be a suitable surgical option in most developing countries that lack financial and medical resources. However, more multicentric comparative studies with long-term follow-up are required to extract more significant conclusions.
Level of evidence
This study was a level IV case series.

Keywords:
arthroscopic intervention, knee osteoarthritis, medial compartment, proximal fibular osteotomy, varus knee

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Introduction

The medial compartment of the knee is most commonly involved in knee osteoarthritis (OA), as it carries almost 60–80% of the load with normal knee alignment [1]. The established surgical options for the treatment of medial compartmental knee OA include arthroscopic lavage and debridement, high tibial osteotomy (HTO), unicompartmental knee arthroplasty (UKA), and total knee arthroplasty (TKA) [2–4]. Knee arthroscopy is indicated as a diagnostic and interventional procedure to determine a possible treatment pathway. Moreover, it may be used as a temporary pain relief procedure through lavage, debridement, and management of meniscal and cartilage lesions [5]. Although knee arthroplasty is a good option in terms of pain relief, correction of deformity, and improvement of function, joint-preserving surgeries are more appropriate for young and active patients with mild to moderate OA [6–8]. HTO is a technically demanding procedure that needs long rehabilitation period, with potential complications such as neurovascular injuries, iatrogenic fracture, and nonunion [3,9–12].

Proximal fibular osteotomy (PFO) has been proposed recently as an alternative option in the treatment of medial compartmental knee OA [2]. Yazdi *et al.* [13] were the first one who reported that partial fibulectomy might decrease the pressure in the medial compartment and increase it in the lateral compartment.

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Hvid [14] reported that there is more load on the medial compartment of the knee than the lateral compartment. The wear patterns in osteoarthritic knee are commonly in the anteromedial aspect of the medial compartment and posterolateral part of the lateral compartment [15,16]. There are various theories that are proposed to contribute to the outcome of PFO. The medial side settles down more than the lateral because of age-related trabecular resorption in the proximal tibia whereas the fibula contributes to supporting the lateral column of the proximal tibia [17,18]. So, when the support of the fibula is eliminated by PFO, the lateral side settles down with reduction in the varus deformity (the theory of nonuniform settlement) [19]. Moreover, the medial condyle is supported by one cortex, whereas the lateral condyle is supported by three cortices (the too-many-cortices theory) [20]. In addition, improvement of varus deformity after PFO may be owing to the concept of muscle competition [21] and dynamic fibular distalization theory, where the proximal fibula was no longer subjected to compressive forces of weight transmission from the distal fibula [22].

This study aimed at evaluating the outcome of combined PFO and arthroscopic intervention for the treatment of medial compartment knee OA.

Patients and methods

This prospective study was carried out from May 2018 to February 2020. Any patient with symptomatic isolated medial compartment knee OA with or without genu varus (<10°) was included in this study. Patients with bicompartmental or tricompartmental OA knee, genu varum more than 10°, genu valgus, ligament instability, a history of intraarticular steroid injections within 6 months, posttraumatic, postinfective, or inflammatory arthritis were excluded. The diagnosis of osteoarthritis was made according to the American College of Rheumatology criteria [23]. The radiological grading of knee OA was done as per Kellgren–Lawrence's criteria [24]. The study protocol was approved by the ethics committee of the university, and the procedures used in this study adhered to the tenets of the Declaration of Helsinki.

A written informed consent was obtained from all cases regarding study participation. This prospective study included 44 patients in whom 49 knees were operated [five cases with bilateral affection, and 39 cases with unilateral affection, with the right side affected in 24 (61.5%) patients and left side in 15 (38.5%) patients] (Table 1). There were 34 (77.3%) females and 10 (22.7%) males. The mean age was 48.4 ± 5.4 years (range, 42–55 years). The mean BMI was 26.23 ± 2.44 (range, 24–28). According to Kellgren–Lawrence's criteria for OA grading, there were 11 (22.44%) knees with grade II, 33 (67.34%) with grade III, and five (10.22%) with grade IV. There was varus deformity in 34 (69.4%) knees and ranged from 6.1° to 9.5°. The mean duration of the symptoms was 27 ± 4.3 months (range, 19–35 months).

Table 1 The patients' and disease characteristics

Parameters	
Age	
Mean±SD (range)	48.4 ± 5.4 (42–55)
Sex [*n* (%)]	
Male	10 (22.7)
Female	34 (77.3)
BMI	
Mean±SD (range)	26.23 ± 2.44 (24–28)
Side	
Unilateral (R/L)	39 (24/15)
Bilateral	5
KL grade [*n* (%)]	
II	11 (22.44)
III	33 (67.34)
IV	5 (10.22)
Varus deformity [*n* (%)]	34 (69.4)
Duration of symptoms (M)	
Mean±SD (range)	27 ± 4.3 (19–35)
Arthroscope grade [*n* (%)]	
I	15 (30.6)
II	20 (40.8)
III	10 (20.4)
IV	4 (8.2)
Follow-up (M)	
Mean±SD (range)	19.48 ± 2.45 (15–24)

KL, Kellgren–Lawrence; L, left; M, months; R, right.

Surgical technique

In all cases, the surgery was done under spinal anesthesia with the patient in the supine position and midthigh tourniquet inflated.

Arthroscopic knee assessment

The knee was approached through the anterolateral and anteromedial arthroscopic portals. Complete systematic arthroscopic examination of the knee was initially done, especially patello-femoral joint and lateral compartment of the knee, to assess integrity of the articular cartilage. Then, arthroscopic examination of the medial compartment of the knee was done with dealing with any cartilage or meniscal lesions. Articular cartilage degeneration was graded according to the Outerbridge's arthroscopic classification [25]. A total of 15 knees had arthroscopic grade I, 20 had grade II, 10 had grade III, and four had grade IV.

In all cases, arthroscopic lavage and debridement with cleaning of the synovial soft tissues and unstable

cartilage face were done. Posteromedial release for tight medial knee compartment was done in 31 knees. This was done by outside-in controlled multipoint pie-crusting release of the posterior part of medial collateral and posterior oblique ligaments using an 18-G needle. Partial medial meniscectomy was done in 15 knees, loose bodies were removed in 23 knees, and osteophytes were removed in 26 knees. Regarding the articular cartilage lesions, superficial abrasion, drilling, or microfracture techniques were done.

Proximal fibular osteotomy

A lateral incision was made (5–7 cm) overlying the planned site of osteotomy (7–9 cm from the fibular head) and then dissection was carried out through the subcutaneous tissues. The interval between peroneus and soleus muscles was then reached to expose the periosteum of the fibula, which was then incised and elevated. Curved retractors were placed behind the fibula with great care to avoid too much stretching of the soft tissues to prevent injury of the peroneal nerve. A small piece of proximal fibula (1.5–2 cm) was then resected with the use of an oscillating saw after placing drill holes at the osteotomy site. The thigh tourniquet was then deflated to ensure hemostasis. Closure of the wound was done in layers, and then sterile dressing and compression bandage were applied.

Postoperative follow-up and assessment

Cases where there were articular cartilage defects, partial weightbearing was allowed for 6 weeks. The other cases without articular cartilage defects were instructed to start weightbearing on the operated leg as tolerated. All cases were clinically assessed using the visual analog score (VAS) and Knee Society Score [26]. Radiographically, all cases were assessed by varus angle (the angle between the anatomic axis of femur and the anatomic axis of tibia in standing antero-posterior full-length lower limb radiograph) and joint space width of both compartments.

Statistical analysis

IBM SPSS Statistics for Windows, version 22.0 (IBM Corp., Armonk, New York, USA) was used for statistical analysis, with significant correlation considered when *P* value less than 0.05.

Results

The average duration of unilateral PFO was 21.33 ± 7.23 min (range, 17–30 min). The mean duration of follow-up was 19.48 ± 2.45 months (range, 15–24 months).

Notably, pain relief was observed in all cases after combined PFO and arthroscopic intervention (Table 2). The mean VAS score significantly decreased from 7.24 ± 1.3 preoperatively to 1.7 ± 0.87 at 12-month follow-up postoperatively (P<0.001). The mean Knee Society Score significantly improved from 44.79 ± 11.5 preoperatively to 72.95 ± 11.6 postoperatively at the final follow-up (P<0.001).

Weightbearing radiographs of the lower extremity showed significant increase in the medial knee joint space from 1.9 ± 0.57 preoperatively to 4.82 ± 0.76 postoperatively (P<0.05). The lateral knee joint space decreased from 7.9 ± 0.67 preoperatively to 5.1 ± 0.49 postoperatively (Figs 1 and 2). Additionally, the varus angle improved from 7.8 ± 2.1 preoperatively to 1.7 ± 0.9 postoperatively.

There was a weakness of dorsiflexion of the big toe in five patients, which resolved spontaneously and fully in 3–5 months. There was superficial wound infection in two patients, which resolved with antibiotics and daily dressings in 2–3 weeks. There were no reported cases of fracture fibula intraoperatively or postoperative peroneal nerve palsy. Till the final follow-up, there was no conversion to TKA following combined PFO and arthroscopic intervention.

Discussion

PFO has emerged as an attractive option to relieve pain and improve joint function in patients with medial compartment OA of the knee [27,28]. This procedure has become popular especially in the Eastern world [27].

Compared with other alternative procedures such as TKA or HTO, PFO is simple, is less invasive, requires limited dissection, internal fixation is not required, has fewer complications, and has shorter rehabilitation period [29,30].

Brown *et al.* [31] concluded that both UKA and HTO are cost-effective procedures but UKA is more cheaper. The estimated quality-adjusted life-years for HTO, UKA, and total knee arthoplasty were 14.62, 14.63, and 14.64, respectively. Total direct medical costs for HTO, UKA, and total knee arthoplasty were $20,436, $24,637, and $24,761, respectively [32].

However, unlike HTO, PFO could not correct moderate or severe varus deformity. Moreover, in most developed countries, TKA has been deemed a successful operation for treatment of knee OA owing to bundled payments and insurance coverage of costs [33].

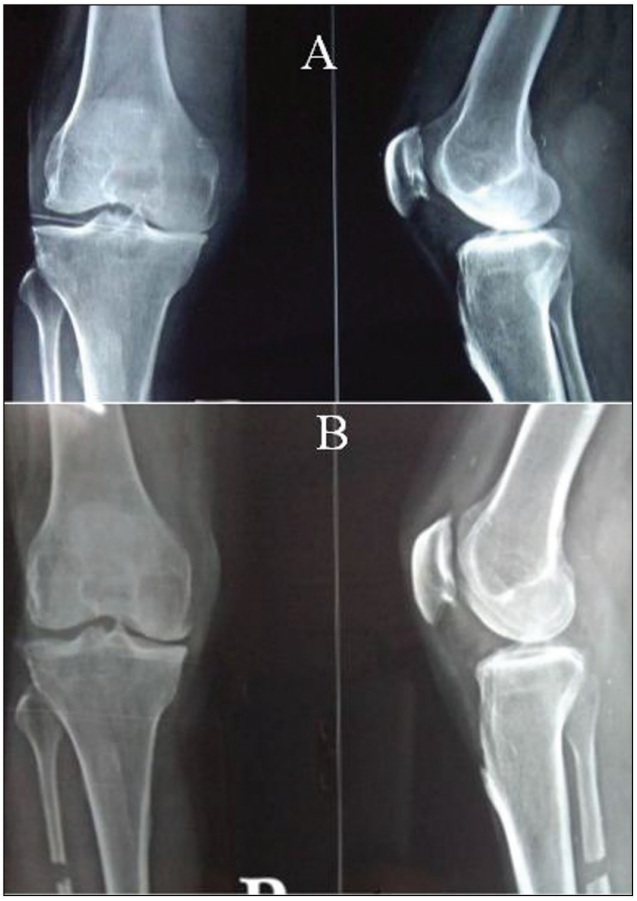
The role of arthroscopy in OA knee is to improve the mechanical symptoms and quality of regenerative articular cartilage, alleviate the knee pain, and slow down

Table 2 The clinical and radiological outcomes and complications

	Preoperative	Final follow-up	*P* value
Clinical scores			
VAS			
Mean±SD	7.24 ± 1.3	1.7 ± 0.87	<0.001
Range	6–10	0–4	
KSS			
Mean±SD	44.79 ± 11.5	72.95 ± 11.6	<0.001
Range	38–50	65–85	
Radiological parameters			
Varus angle			
Mean±SD	7.8 ± 2.1	1.7 ± 0.9	0.05
Range	6.1–9.5	0–3	
Medial knee joint space			
Mean±SD	1.9 ± 0.57	4.82 ± 0.76	0.05
Range	1.5–2.9	3.4–5.7	
Lateral knee joint space			
Mean±SD	7.9 ± 0.67	5.1 ± 0.49	0.05
Range	7.1–8.5	4.9–5.4	
Complications [*n* (%)]			
Weakness of big toe dorsiflexion		5 (10.2)	
Superficial wound infection		2 (4)	

KSS, Knee Society Score; VAS, visual analog score.

Figure 1



Plain radiograph of right knee AP and lateral views; (a) preoperative, (b) postoperative at the final follow up. AP, antero-posterior.

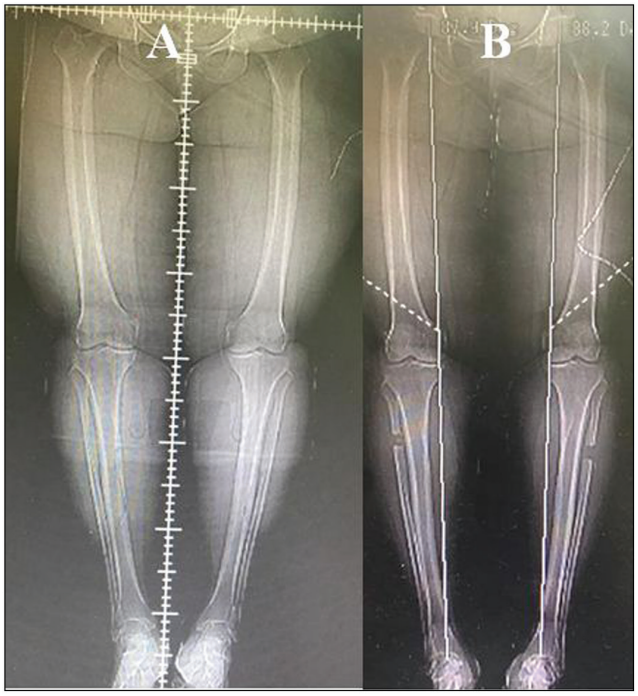
the OA evolution. This occurs through arthroscopic lavage (acts by cooling effect, dilution of the inflammatory mediators, and adjusting the osmotic pressure of the synovial fluid), removal of the intraarticular irritating factors (loose bodies, cartilage debris, proliferated synovium, and osteophytes), and procedures for the diseased cartilage (superficial abrasion, drilling, or microfracture techniques). However, this improvement is temporary, and this technique is ineffective in advanced OA and malaligned knee joint [34,35].

Combination of PFO with arthroscopy techniques might lead to stopping or at least slowing of OA progression. Jaheer *et al*. [35] reported improved outcomes of PFO when combined with arthroscopic cartilage regeneration. They reported a significant improvement in the Knee Injury and Osteoarthritis Outcome score, Lysholm score, VAS scale, and varus angle with these combined procedures. Although the follow-up period was only 6 months, they recommended PFO and cartilage regeneration procedure as a standard operation for treatment of medial compartmental knee OA with mild varus deformity [35].

Zuber *et al*. [36] reported that combined PFO with arthroscopic debridement and lavage could effectively relieve pain and correct the varus deformity for patient with Kellgren and Lawrence grades I–III. They also reported that these combined procedures could be an alternative treatment option in countries with limited health care resources [36].

Combined PFO with knee arthroscopic intervention may be a suitable surgical option in patients with medial compartment OA knee with mild varus knee deformity in most developing countries that lack financial and medical resources and also for low-

Figure 2



Plain radiograph of both lower limbs long film AP view; (a) preoperative, (b) postoperative at the final follow up. AP, antero-posterior.

income patients who cannot afford expensive treatment methods [2,29,33].

It was reported that conversion TKA after failed HTO has predictable surgical challenges and less successful outcomes compared with those without prior osteotomy. Conversion to TKA after PFO would be the same as those without prior osteotomy. However, more comparative studied are needed to provide us with more conclusions [37].

In our study, there was no conversion to TKA following combined PFO and arthroscopic intervention after 19-month mean follow-up. Lu *et al.* [38] in their study reported no conversion to TKA following PFO. However, Yang *et al.* [17] reported conversion to TKA following PFO in four cases after 12 months of follow-up.

The limitations of this study were relatively low number of patients, relatively short follow-up period, and absence of a control group. Although the short-term outcomes are encouraging, it is unclear that these improved outcomes will remain unchanged at a longer follow-up period. Moreover, it is practically impossible to include a control group to exclude a placebo effect.

Conclusion

In selected patients, PFO in combination with arthroscopic lavage and debridement could be an alternative option for treating medial compartment knee OA through decreasing varus deformity and improving symptoms. These combined procedures could be a suitable surgical option in most developing countries that lack financial and medical resources. However, more multicentric comparative studies with long-term follow-up are required to extract more significant conclusions.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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