e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2023; 15(12); 903-910

Original Research Article

A Comprehensive Assessment of Clinical and Radiographic Outcomes Proximal Fibular Osteotomy in Osteoarthritis Knee

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Received: 03-07-2023 Revised: 11-10-2023 / Accepted: 25-11-2023
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Conflict of interest: Nil

Abstract

Introduction: Osteoarthritis, a common joint disease, causes discomfort and motion due to cartilage deterioration. Around the world, 22.9% of 40-year-olds have knee OA. Traditional treatments include non-pharmacological methods and drugs, although they have drawbacks. The surgery proximal fibular osteotomy (PFO) has shown promise in relieving knee OA pain and improving function. More study is required to compare its long-term efficacy to other surgeries.

Aim and objectives: The efficacy of this study of proximal fibular osteotomy in treating osteoarthritis of the knee should be thoroughly investigated by analysing its radiographic and clinical results.

Method: This prospective cohort study examines proximal fibular osteotomy for grades 1 and 2 medial knee osteoarthritis. Patients had thorough pre-operative evaluations approved by the Institutional Ethical Committee. Anaesthesia was used during surgery and recovery. Visual Analogue Scale, American Knee Society Score, and femorotibial axis examinations were performed up to 12 months post-surgery, utilising rigorous statistical analysis. The study's methodological merits make it promising, although biases and the lack of a control group should be considered.

Result: This research examines proximal fibular osteotomy for low-grade medial knee osteoarthritis. The findings show that there was a substantial decrease in pain ($p < 0.05$) and a persistent improvement in knee function ($p < 0.05$) up to six months after surgery, with a broad demographic (mean age 52.55, 55.2% males). A substantial increase ($p < 0.05$) was also seen in the Range of Motion. Restrictions guarantee consistent harshness, highlighting the procedure's potential effectiveness.

Conclusion: Proximal fibular osteotomy improved medial compartment osteoarthritis discomfort, knee function, range of motion, and tibio-femoral angle.

Keywords: Proximal, Fibular, Osteoarthritis, Knee, Knee Pain.

Introduction

Osteoarthritis (OA) is a prevalent joint condition characterized by cartilage degeneration, causing pain, stiffness, and limited mobility as bones rub together. It commonly impacts the hands, hips, knees, neck, and lower back, with most individuals displaying radiographic OA signs by age 65, affecting 80% of those over 75. While age, genetics, joint injury, and obesity contribute to OA, its onset can range from symptomless to profoundly disabling oligo or polyarthritis. Typically presented as mechanical pain, OA significantly impacts daily life, primarily affecting the hands, knees, and hips, yet potentially affecting any joint [1].

Osteoarthritis (OA) displays a global prevalence that diverges across age groups and regions. Studies suggest knee OA affects about 22.9% of individuals aged 40 and over, impacting roughly 654.1 million people worldwide in 2020. On a broader scale, knee OA occurs in about 16.0% of those aged 15 and above. The global prevalence of hip OA stands at approximately 0.85%, while hand OA has notably surged by 110% from 1990 to 2019. Notably, OA rates differ among countries and regions, showing an inclination to rise with age and a higher occurrence among females [2-6].

Therapeutic options for knee osteoarthritis encompass non-pharmacological strategies and pharmacological interventions. Non-pharmacological approaches emphasize exercises like walking, swimming, or cycling, fostering joint

function improvement and pain reduction. Weight management, vital in stress reduction on knee joints, aids in alleviating symptoms. Pharmacological interventions, including oral medications like acetaminophen, NSAIDs, and opioids, ease pain and inflammation. Topical treatments like NSAIDs and capsaicin creams offer localized relief. Intra-articular injections such as corticosteroids, hyaluronic acid, and platelet-rich plasma directly target knee inflammation, enhancing symptoms [7-12].

Traditional approaches for knee osteoarthritis exhibit notable limitations. Studies reveal the substantial influence of the placebo effect on the perceived effectiveness of treatments like glucocorticoids and hyaluronic acid injections, masking their actual therapeutic impact. Moreover, these methods primarily manage symptoms without altering the disease course, lacking disease modification capabilities. Variability in efficacy among individuals remains a challenge, with responses ranging from significant relief to minimal improvement. Concerns about potential side effects with long-term use, such as gastrointestinal complications and increased cardiovascular risk from NSAIDs, alongside the risk of joint infection or tissue damage from corticosteroid injections, also persist. Additionally, accessibility issues and cost constraints, especially with expensive treatments like HA injections, add to the challenges patients may face when seeking specialized therapies [13].

Proximal fibular osteotomy, a surgical manoeuvre, involves repositioning the upper segment of the fibula bone situated on the outer side of the lower leg. Primarily employed for conditions like medial compartment knee osteoarthritis, this procedure aims to alleviate pain, enhance function, and stall the advancement of knee osteoarthritis. By redistributing forces within the knee joint and lessening pressure on the medial compartment, it aims to offer relief from pain and an improvement in knee functionality [14,15].

Proximal fibular osteotomy (PFO) stands as a novel surgical remedy for knee osteoarthritis (OA), targeting pain reduction and functional enhancement within the affected joint. This procedure, relatively recent, shows promising outcomes in specific cases of medial compartment knee OA. During PFO, a minute incision near the fibula's head leads to the removal or repositioning of a segment, effectively redistributing knee joint loads. Such redistribution alleviates pressure on the affected medial compartment, mitigating associated discomfort [16,18].

Reports indicate that PFO often yields lowered pain levels, enhanced knee functionality, and an improved medial-to-lateral knee joint space ratio. Patients frequently witness reduced pain scores, heightened knee function scores, and a more balanced joint space ratio within a year post-operation. In essence, PFO represents a hopeful surgical avenue for select knee OA cases, delivering relief from pain and a functional upswing within the affected joint. Nonetheless, further research is crucial to appraise its long-term effectiveness and compare it to other surgical interventions for knee OA [16-18].

Proximal fibular osteotomy (PFO) involves cutting a segment of the proximal fibula to alleviate knee osteoarthritis (KOA) symptoms. Theoretical explanations behind PFO propose various mechanisms. PFO aims to shift pressure away from the medial knee compartment, reducing varus deformity and alleviating pain. This redistribution may alter disease progression. By weakening the fibula's lateral support, PFO can slightly widen the lateral joint space, reducing compression on the medial compartment. PFO might induce fibular translation, widening the joint space and reducing varus deformity, contributing to pain relief. Altering alignment and load distribution could affect muscle forces around the knee, potentially reducing stress on the medial compartment. PFO may dynamically change the fibula's position during knee movement, impacting joint biomechanics. Modifying alignment might readjust the ground reaction vector, lessening stress on the medial compartment [19-21].

Method

Research Design

In this prospective cohort trial, proximal fibular osteotomy is tested as an alternate therapy for low-grade medial knee osteoarthritis. Patients who were determined to be in grades 1 and 2 of the Kellgren-Lawrence classification following comprehensive clinical and radiographic examinations are a part of the research. The Institutional Ethical Committee gave its approval after obtaining informed consent. The patients' pre-anesthetic fitness was thoroughly evaluated with a thorough history, clinical examination, and imaging work-up conducted before to the operation. Under either regional or general anaesthesia, the surgical method included proximal fibular osteotomy. Postoperative care and monitoring for problems were then part of the process. Results were evaluated at scheduled intervals up to 12 months after surgery using the Visual Analogue Scale (VAS) for pain severity, the American Knee Society Score (AKSS), and an examination of the femoro-tibial axis. The intervention's efficacy was rigorously evaluated using robust statistical techniques, such as paired t-tests or Wilcoxon signed-rank tests, for data comparison. The methodical methodology, standardised outcome measures, and prospective design of the study make it a strong contender for studying the effect of the alternative therapy on low-

grade medial compartment osteoarthritis of the knee. Results should be interpreted with caution, however, due to possible limitations such biases and the lack of a control group.

Inclusion and exclusion

Inclusion

- Patients must have medial knee osteoarthritis grade 1 or 2 according to the Kellgren-Lawrence classification on full-leg standing anteroposterior radiographs.
- Patients who have gained Institutional Ethical Committee approval will be included, assuring ethical research.
- Participants must provide free, written, informed permission to participate.

Exclusion

- Patients with Kellgren-Lawrence grade 2 or higher osteoarthritis will be excluded from the trial to ensure severity uniformity.
- Proximal fibular osteotomy patients with coagulopathies, current infections, or other medical problems that preclude surgery will be excluded.
- Patients with cognitive impairment or other issues which cannot provide free, informed permission will be excluded.

Statistical Analysis

The mean and standard deviation were used for descriptive statistics on continuous variables. Categorical variables are expressed as percentages and absolute values. The statistical analysis was done using SPSS 23.1. Multiple means were compared using repeated measures Wilcoxon rank tests. Comparative data is collected from a single group or sample when results depart from the normal distribution. The researchers used a post-hoc test to evaluate study group differences. Group differences may be assessed using the post-hoc test. The "Paired or Dependent t-test" may compare mean values from the same sample or different groups when statistics follow a normal distribution curve.

Result

The participants' mean age was 52.55 years (SD = 10.193), ranging from 36 to 72. The majority (37.93%) were 51-60 years old, followed by 24.14% in 41-50 and >60 years old and 13.79% in 31-40 years old. The research contained 55.2% men and 44.8% women. This age and gender distribution shows the demographics of the study population and ensures a broad representation across age groups and genders for a complete research question analysis.

Table 1: Mean Age and Gender distribution

	Mean	**Std. Deviation**	**Minimum**	**Maximum**
Age	52.55	10.193	36	72
Age groups	**Frequency**	**Percent**		
31-40 years	4	13.79%		
41-50 years	7	24.14%		
51-60 years	11	37.93%		
> 60	7	24.14%		
Total	**29**	**100.00%**		
Gender	**Frequency**	**Percent**		
Male	16	55.2%		
Female	13	44.8%		
Total	**29**	**100.00%**		

Mean Visual Analogue Scale (VAS) scores at various research times are shown in the table 2. Pain severity decreased from pre-operative (Mean = 6.41) to immediate postoperative (Mean = 5.83), 3 months (Mean = 4.66) and 6 months (Mean = 3.03). T-tests showed significant differences ($p < 0.05$) across all pairings, indicating a steady decrease in pain with time. Proximal fibular osteotomy significantly reduced medial compartment osteoarthritis pain, indicating its efficacy.

Table 2: Mean VAS Score

VAS score	Mean	Std. Deviation	Minimum	Maximum	Range
Pre-operative	6.41	1.240	4	8	4
Immediate Postop	5.83	1.037	4	7	3
Follow up at 3 months	4.66	0.897	3	6	3
Follow up at 6 months	3.03	0.731	2	5	3
		Mean	**Std. Deviation**	**Mean Difference**	**P value**
Pair 1	Pre op VAS score	6.41	1.240	0.586	0.000
	Immediate post op VAS	5.83	1.037		
Pair 2	Pre op VAS score	6.41	1.240	1.759	0.000
	3 months VAS	6.66	0.897		
Pair 3	Pre op VAS score	6.41	1.240	3.379	0.000
	6 months VAS	3.03	0.731		
Pair 4	Immediate post op VAS	5.83	1.037	1.172	0.000
	3 months VAS	4.66	0.897		
Pair 5	3 months VAS	4.66	0.897	1.621	0.000
	6 months VAS	3.03	0.731		
Pair 6	Immediate post op VAS	5.83	1.037	2.793	0.000
	6 months VAS	3.03	0.731		

The mean American Knee Society Score (AKSS) at various study phases is shown in Table 3, suggesting knee function improvement. The patients' AKSS increased from pre-operative (Mean = 66.66) to immediate postoperative (Mean = 69.45) and then at 3 months (73.03) and 6 months (78.28). Paired t-tests showed substantial improvements in knee function ($p < 0.05$) across all pairings. The increasing AKSS scores indicate that proximal fibular osteotomy improved knee function significantly and sustainably, supporting its efficacy in treating medial compartment osteoarthritis.

Table 3: Mean AKSS Score

AKSS score	Mean	Std. Deviation	Minimum	Maximum	Range
Pre-operative	66.66	4.194	62	74	12
Immediate Postop	69.45	4.231	64	76	12
Follow up at 3 months	73.03	3.986	68	80	12
Follow up at 6 months	78.28	3.453	74	84	10
		Mean	**Std. Deviation**	**Mean Difference**	**P value**
Pair 1	Pre op AKSS score	66.66	4.194	-2.793	0.000
	Immediate postop AKSS	69.45	4.231		
Pair 2	Pre op AKSS score	66.66	4.194	-6.379	0.000
	3 months AKSS	73.03	3.986		
Pair 3	Pre op AKSS score	66.66	4.194	-11.621	0.000
	6 months AKSS	78.28	3.453		
Pair 4	Immediate post op AKSS	69.45	4.231	-3.586	0.000
	3 months AKSS	73.03	3.986		
Pair 5	3 months AKSS	73.03	3.986	-5.241	0.000
	6 months AKSS	78.28	3.453		
Pair 6	Immediate postop AKSS	69.45	4.231	-8.828	0.000
	6 months AKSS	78.28	3.453		

Table 4 shows that proximal fibular osteotomy improved knee joint mobility using Range of Motion (ROM) ratings at various study time points. The patients' ROM increased from pre-operative (Mean = 112.76) to immediate postoperative (Mean = 113.45) and 3 months (Mean = 114.14) and 6 months (Mean = 116.21). Pre-operative and immediate postoperative ROM, as well as pre-operative and later follow-up time periods, showed significant changes after paired t-tests ($p < 0.05$). These findings indicate that the surgery improved knee joint mobility and medial compartment osteoarthritis function.

Table 4: Group Comparison of AKSS Score

ROM score	Mean	Std. Deviation	Minimum	Maximum	Range
Pre-operative	112.76	6.209	100	120	20
Immediate postop	113.45	5.526	100	120	20
Follow up at 3 months	114.14	5.012	100	120	20
Follow up at 6 months	116.21	4.152	110	120	10
		Mean	**Std. Deviation**	**Mean Difference**	**P value**
Pair 1	Pre op ROM score	112.76	6.209	-0.690	0.043*
	Immediate postop ROM	113.45	5.526		
Pair 2	Pre op ROM score	112.76	6.209	-1.379	0.018*
	3 months ROM	114.14	5.012		
Pair 3	Pre op ROM score	112.76	6.209	-3.448	0.002*
	6 months ROM	116.21	4.152		
Pair 4	Immediate postop ROM	113.45	5.526	-0.690	0.043*
	3 months ROM	114.14	5.012		
Pair 5	3 months ROM	114.14	5.012	-2.069	0.003*
	6 months ROM	116.21	4.152		
Pair 6	Immediate postop ROM	113.45	5.526	-2.759	0.001*
	6 months ROM	116.21	4.152		

Advanced osteoarthritis beyond Kellgren-Lawrence grade 2 will be excluded from the research to guarantee severity uniformity. Those with coagulopathies, current infections, or other medical disorders that preclude proximal fibular osteotomy will not be included. Excluded patients have cognitive impairment or other issues that prevent them from giving informed consent.

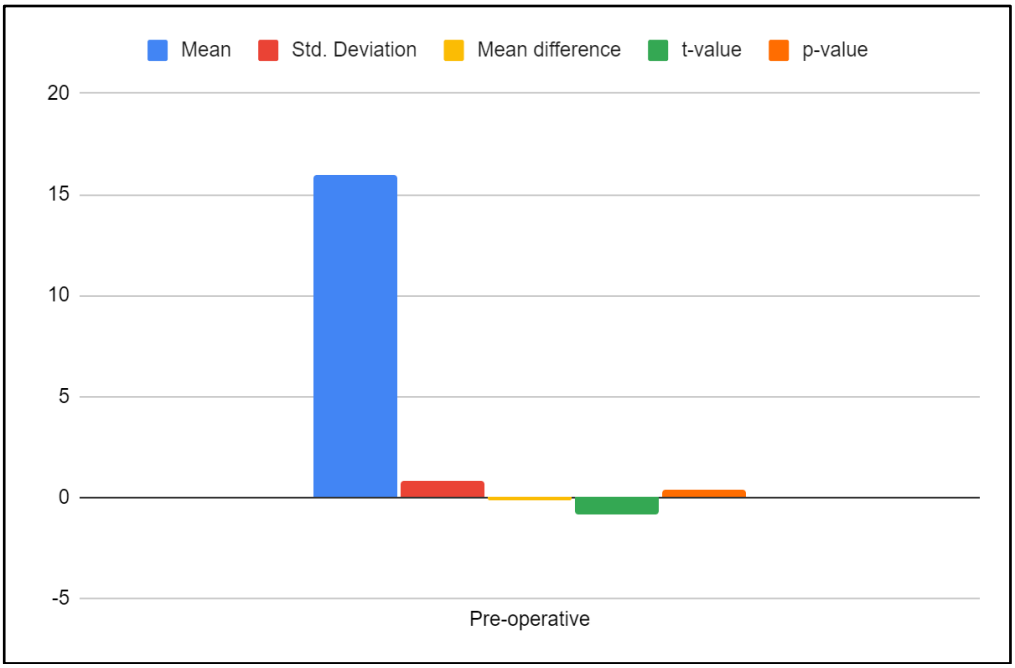

Figure 1: Tibiofemoral angle

Discussion

Between January 2018 and January 2020, an examination by chen et al. (2022) encompassed data from 12 knees (8 right, 4 left) belonging to 11 individuals with spontaneous osteonecrosis of the knee (SONK), predominantly women (9 women, 2 men), who underwent proximal fibular osteotomy (PFO). Their average age stood at 61.5 years. SONK diagnoses were confirmed through weight-bearing radiographs or MRI scans. Preoperatively and during follow-up, visual analog scale (VAS) scores, Oxford knee scores (OKS), femorotibial angle (FTA), medial, and lateral joint spaces were monitored. Over a 33-month average follow-up period, patients exhibited noteworthy improvements: VAS scores reduced from 6.6 to 3.6, and OKS increased from 24.7 to 35.6 at 24 months

post-surgery (P < .05). Notably, the medial joint space ratio significantly increased from 0.36 to 0.50 (P < .05). Additionally, two out of four patients who received follow-up MRI demonstrated a visible decrease in the osteonecrotic area [22].

A comprehensive meta-analysis by Sugianto et al. (2021) encompassing 907 patients and 1012 knees evaluated the efficacy of proximal fibular osteotomy (PFO) in treating knee osteoarthritis (KOA). The analysis revealed promising results: PFO notably improved knee function (Hedges' g 1.90; 95% CI 1.62-2.18; I2 = 67%) and alleviated pain (mean difference in visual analog scale: -4.13; 95% CI: -5.29 to -2.97). Minimal complications were observed, predominantly comprising peroneal nerve paresthesia (5.93%; 95% CI: 2.15-11.25%), followed by peroneal nerve palsy (2.25%; 95% CI: 0.14-6.14%), fracture (0.56%; 95% CI: 0-1.74%), and recurrent deformity (0.54%; 95% CI: 0-1.74%). Additionally, PFO led to improvements in the medial/lateral joint space ratio (MD 0.17; 95% CI: 0.15-0.19) [23].

Examining the clinical impact of periarticular knee osteotomy (PKO) in knee osteoarthritis (KOA) treatment, a study by Han et al. (2021) engaged 180 KOA patients, dividing them into a study group (treated with PKO) and a control group (undergoing joint replacement). The study identified superior outcomes in the control group for preoperative bleeding, surgical duration, and complications incidence. Conversely, the study group exhibited enhanced long-term knee joint function and quality of life (P < 0.05). PKO displayed substantial improvements in joint pain, knee function, and KOA symptoms, emphasizing its safety and potential clinical applicability [24].

Numerous investigations exploring proximal fibular osteotomy's (PFO) impact on knee osteoarthritis (OA) have delved into radiographic assessments. Research by Yang et al. (2015) evidenced PFO's substantial reduction in the femorotibial angle (FTA) and lateral joint space among patients with medial compartment OA [25]. Similarly, Xie et al. (2018) observed decreased FTA and enhanced patellofemoral congruence angle post-PFO [26]. Deng et al. (2021) revealed PFO's effect on diminishing FTA and medial tibial platform settlement values [27]. These collective findings underscore PFO's potential for positively influencing radiographic knee OA parameters [19,25-27].

Several investigations have scrutinized proximal fibular osteotomy's (PFO) efficacy when juxtaposed with various knee osteoarthritis (OA) treatments. In a separate study by Chen et al. (2019) PFO demonstrated superior pain alleviation, functional enhancement, and gait amelioration among individuals with early-stage knee OA when contrasted with drug conservative treatments [28]. Primarily, conservative strategies encompassing weight management, physical therapy, and medication stand as initial knee OA management as studied by Allaeys et al. (2020). However, the efficacy of these conservative approaches can fluctuate depending on individual patient attributes and the severity of the ailment [29]. For advanced knee OA cases, total knee replacement (TKR) serves as a prevalent surgical recourse as concluded by a study done by Ronn et al. (2011) [30]. A study by Skou et al. (2018) comparing post-TKR and non-surgical interventions to solely non-surgical measures evinced greater enhancements in pain mitigation and functional improvement with the former [31]. In conclusion, while head-to-head comparisons are limited, PFO exhibits promising outcomes concerning pain alleviation, functional enhancements, and gait amelioration in knee OA management [28-31].

The selection of patients for proximal fibular osteotomy (PFO) in knee osteoarthritis (OA) hinges on multiple factors. PFO is typically recommended for individuals exhibiting varus deformity and medial compartment OA, evaluated through radiographic tools like the Kellgren-Lawrence (KL) score. Assessment of variables such as the distance between the fibular head and tibial plateau, body mass index, and knee function scores, such as the Hospital for Special Surgery knee score, is pivotal. Considerations like age and symptom duration impact patient suitability, with younger age and shorter symptom duration correlating with better outcomes. Preoperative evaluations encompassing measures like VAS score, American Knee Society score, HKA angle, and settlement value provide insight into short-term prognosis and postoperative results. Although PFO offers a minimally invasive approach for selected patients, comprehensive long-term studies and multicenter randomized trials are warranted to ascertain its efficacy and disease progression [32-34].

Osteoarthritis (OA) imposes a significant burden due to cartilage breakdown and chronic pain. Novel treatments known as disease-modifying OA drugs (DMOADs) target inflammatory markers and enzymes to counter OA progression. Alongside, regenerative approaches aim to stimulate cartilage repair. These advancements offer hope for improved OA management, showcasing potential in preclinical and clinical trials [35].

Conclusion

This prospective research on proximal fibular osteotomy for medial compartment osteoarthritis improved pain, knee function, range of motion, and tibio-femoral angle. The technique significantly reduced pain, as shown by VAS ratings. American Knee Society Score (AKSS) and Range of Motion

(ROM) ratings showed significant knee function improvement. The Tibio-femoral Angle also improved sharply. Although the research showed encouraging results, its limitations must be considered, including a short follow-up time, a small sample size limiting generalizability, and no comparison to alternative treatment methods. Longer follow-ups and bigger cohorts are needed to confirm the continued effectiveness of proximal fibular osteotomy and permit rigorous comparisons with other treatments. Despite these limitations, the research shows that this surgical method may help medial compartment osteoarthritis patients.

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