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A Study of Functional Outcome of Osteoarthritis Knee Treated with Proximal Fibular Osteotomy

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ABSTRACT
The objective of this study is to evaluate the functional outcomes of proximal fibular osteotomy (PFO) in patients with osteoarthritis of the knee. A total of 30 patients diagnosed with osteoarthritis were selected for the study. Among these, 15 patients received PFO for the right knee, while the remaining 15 underwent the procedure for the left knee. Pain levels were assessed using the Visual Analog Scale (VAS) and functional activity was measured through the Knee Society Score (KSS). Radiological parameters, including medial joint space, lateral joint space, and the tibiofemoral angle (TFA), were evaluated both preoperatively and postoperatively, with follow-up conducted over a six-month period. The mean preoperative VAS score was 5.8±0.61, showing a significant reduction in pain postoperatively, with a final follow-up VAS score of 2.1±0.71. The mean preoperative medial joint space was recorded at 1.31±0.31, which improved significantly postoperatively to a mean of 4.5±0.28, indicating a widened medial joint space. The preoperative mean lateral joint space was 7.07±0.59, which decreased significantly postoperatively to 5.65±0.62. Additionally, the tibiofemoral angle improved from a mean of 184±1.81 preoperatively to 178.5±1.3 postoperatively. The mean functional knee score increased from 53.6 preoperatively to 74.5 at the end of the follow-up period. Patients demonstrated enhanced walking ability within two weeks following surgery, along with improved stair-climbing and ambulation capabilities. This procedure presents a promising alternative for managing medial compartment osteoarthritis and may postpone the need for total knee replacement (TKR).

INTRODUCTION

Osteoarthritis is a progressive degenerative condition consisting of the retrogressive sequel of cell and matrix changes that result in articular cartilage structural loss and function accompanied by cartilage repair and bone remodeling reaction[1,2]. All ethnic groups of people are affected in all geographic locations[3,4] and it is the most common cause of disability in old age[5,6]. Degenerative changes are not uniformly progressive and generally high in the medial compartment of the knee and the rate of joint degradation varies individually. Osteoarthritis is regarded as a whole joint disease with multifactorial etiology like alteration of biomechanical stress loading, ligament instability, cartilaginous degradation, muscular imbalance and insufficiency[7]. Risk factors of osteoarthritis knee Age, Obesity, Joint in congruency, Increased mechanical stress, Ligamentous injuries sequel and Intraarticular fractures. The cartilage shows diminished cellularity, proteoglycan concentration, elasticity and a decrease in breaking strength with advancing years. Tears of ligamentous structures that protect the joints, such as the anterior cruciate ligament and meniscus in the knee and labrum in the hip, susceptibility leading to premature Osteoarthritis knee. Meniscal tears increase with age, and chronic tears are often asymptomatic but lead to adjacent cartilage damage and accelerated osteoarthrosis (OA). Obesity and joint in congruency, and occupational repeated use can cause increased mechanical stress leading to early osteoarthritis knee. Proteoglycans are responsible for compressive stiffness and the ability to withstand loads of the tissues. The cartilage in early OA or after an injury is highly metabolically active. The stimulated chondrocytes synthesize proenzymes and new matrix molecules, causing the release of degraded aggrecan and type 2 collagen into cartilage and synovial fluid. Osteoarthritis cartilage is characterized by gradual depletion of aggrecan, an unfurling of the tightly woven collagen matrix, and loss of type 2 collagen. With these changes comes increasing the vulnerability of cartilage, which loses its compressive stiffness. OA is a highly heritable disease but varies by joint. 45% of the hand and hip OA in the community is attributable to inheritance, i.e., to the disease present in the family members. Emerging evidence has identified genetic mutations that confer a high risk of OA, one of which is a polymorphism within the growth differentiation factor 5 genes. This polymorphism diminishes the quantity of GDF5, which usually has anabolic effects on the synthesis of the cartilage matrix[8,9].

Aims: The aim of the study is to assess the functional outcome of osteoarthritis knee treated with proximal fibular osteotomy.

MATERIALS AND METHODS

A minimum of 30 patients were selected with Osteoarthritis in the medial compartment arthritis. The inclusion criteria were OA mainly involving: age from 30 years to 76 years, the isolated medial compartment of the knee joint, Medial space narrowing, patient with difficulty in walking and pain due to medial compartment knee osteoarthritis. Kallgren Lawrence grade <4.

Exclusion Criteria Were: Posttraumatic knee OA, Genu valgus, Tricompartmental OA, Septic arthritis, inflammatory joint disease, malignant tumors. Patients who fit into the inclusion criteria will be selected and after taking surgical fitness from the anesthesiology department, proximal fibula osteotomy is performed.

Follow-up and Clinical Evaluations: Anteroposterior radiographs of the knee joint were obtained preoperatively and postoperatively at 1, 3 and 6 months. The severity of knee OA will be evaluated using the KL score. In this study, radiological factors included tibio-femoral angle (TFA), kellgren and Lawrence grading of OA knee, joint space width of both compartments, were made on AP radiographs preoperatively and postoperatively.

Knee Pain Will Be Assessed Using: Visual analog scale. Functional activity is measured by the knee society score. ROM of the knee joint is used to evaluate knee function in all patients at baseline and each follow-up visit. Functional activity is assessed at immediate postoperative day, at 14th postoperative day and 6 weeks, at 3 months and 6 months. This study includes 30 cases to be studied and followed up.

Surgical Technique: The surgery is performed with the patient in the supine position under spinal anesthesia with antibiotic cover. Tourniquet will be used routinely in our series. The fibular head is marked and the osteotomy site is taken as 7-9 cm from the fibula head. The rationale for choosing this level of osteotomy is that a higher level osteotomy would be likely results in injury to the common peroneal nerve. At the same time, that there will be a loss of effect of the osteotomy on the arthritis of the medial compartment if it is done any lower down. A 5-8 cm lateral incision is made overlying the chosen site of osteotomy and dissection is done through the skin and subcutaneous tissues. The peroneus muscle and soleus muscle are then separated to expose the periosteum of the fibula, which is then incised and a 1.5-2 cm of the fibula is then osteotomised with the help of an oscillating saw after placing a few drill holes at the osteotomy site. Too much stretch of the soft tissues is avoided in order

to protect the nerve from potential damage. Bone wax is used to seal the occasional profuse bleed from the fibula cut ends, which occurs after the osteotomy. After ensuring hemostasis and giving wound wash, closure is done in layers and sterile dressing and compression bandage applied. All patients are encouraged to stand and walk on the same evening of surgery and are discharged on the third postoperative day after the first wound inspection. Intravenous antibiotics will be given for three days and followed by oral antibiotics for a period of 5 days. The sutures are removed on the 12th postoperative day. Postoperative X-rays are then taken and the radiological parameters are evaluated and documented. The patients were reviewed at 1, 3, 6 months, where the VAS and the knee scores are evaluated and documented.

RESULTS AND DISCUSSIONS

In our study, 30 patients were selected with medial compartment osteoarthritis knee along the lines of inclusion criteria described., out of them, 17 were females and 13 were males. Medial compartment arthritis of the knee is more prevalent in middle age groups, i.e., 35-50 years in our study. Out of 30 patients, 15 patients underwent PFO for the right knee, and 15 patients underwent surgery for the left knee. Patients were assessed with a VAS scale for pain assessment and KSS knee society scores for functional activity and radiological parameters were evaluated using medial joint space and lateral joint space and tibiofemoral angle TFA preoperatively and postoperatively and followed up for at least for six months duration and baseline results were noted. Mean, the standard deviation was calculated and the same represented by the graphs. A paired t-test was used to calculate the significance between the variables. A p-value of <0.05 was taken as significant. Preoperative VAS SCORE Mean±SD 5.8±0.61 and there is a significant reduction in pain postoperatively, at the final follow up, the VAS score Mean±SD is 2.1±0.71. Preoperative mean medial joint space 1.31±0.31 and there is significant improvement postoperatively with mean medial joint space of 4.5±0.28 with widened medial joint space. The mean preoperative lateral joint space is 7.07±0.59 and there is a significant reduction in lateral joint space postoperatively with mean lateral joint space 5.65±0.62. There is an improvement in the tibiofemoral angle TFA from the mean TFA 184±1.81 preoperatively to the mean TFA 178.5±1.3 postoperatively. The mean functional knee score was 53.6 preoperatively and improved to 74.5 postoperatively at the end follow-up.

Table 1: VAS Variation Between Pre-Operation and a Postoperative Final Follow Up

Pain	Preoperative Mean±SD	Postoperative Mean±SD
Vas score	5.8±0.61	2.1±0.71

Table 2: Table Showing the Medial Joint Space Variation Between Pre-Operation and a Postoperative Final Follow up. The Lateral Joint Space Variation Between Pre-Operation and a Postoperative Final Follow Up

	Pre-Op Mean+/-sd	Post-Op+/-SD
Medial Joint Space	1.31±0.31	4.5±0.28
	pre-op mean+/-sd	post-op+/-SD
Lateral Joint Space	7.07±0.59	5.65±0.62

Table 3: Tibiofemoral Angle Variation Between Pre-Operation and a Postoperative Final Follow Up

Tibiofemoral angle	Preoperative(mean±SD)	Postoperative (mean±SD)
TFA	184+/-1.81	178.5+/-1.3

Table 4. KSS Score Between Pre-Operation and a Postoperative Final Follow Up

Kss Score	Preoperative	Post-operative
Mean	53.6	74.5
SD	4.83	7

Medial compartment arthritis of the knee is a common disorder affecting lifestyle quality and functionality due to severe pain. Although various treatments like high tibial osteotomy, unicompartmental arthroplasty[10], and total knee arthroplasty were proposed and practiced for medial compartment osteoarthritis knee, they have significant complications following surgery relative to the proximal fibular osteotomy. A total knee arthroplasty TKA procedure, despite relieves pain and improves function even in end stages arthritis, is very complex and expensive and may even require revisions and chances of infections are relatively high, whereas high tibial osteotomy HTO was the surgery of choice which aims in correcting the varus malalignment in medial compartment OA knee in the young individuals and delays the TKA necessity, it comes with the disadvantages like prolonged non-weight-bearing, delayed union or nonunion risks, wound infection and peroneal nerve paralysis. Proximal fibular osteotomy is a relatively easy procedure with less surgical time and low complications in relation to other procedures like HTO and UKA and TKA that were described for medial compartment osteoarthritis knee[11,12]. PFO (proximal fibular osteotomy) is a novel surgery to treat medial compartment arthritis knee for pain relief and improvement of joint function. Patients who underwent PFO had significant pain relief and their medial joint space increased. The effects were seen immediately after PFO in the majority of the patients, and the patient can be mobilized and weight-bearing can be started on the immediate postoperative day. Although the exact mechanism of action of PFO is relatively known but felt, various theories have been proposed. The fibula bone density is relatively higher than the medial tibial plateau. With a condition like decreased bone density, the lateral side of the Tibia is not allowed to “settle” due to the support of the fibula to the lateral tibial plateau creating a varus deformity. This theory has been called non-uniform settlement .as the majority of the medial tibial plateau is unsupported, the medial side “settles” down with medial slippage of femoral condyles during playing and walking, further aggravating the non-uniform settlement. The PFO rationale is that with proximal fibular osteotomy, this support from the fibula to the lateral tibial plateau is removed, even the lateral side

settles down, leading to varus deformity correction and reducing pain and other symptoms. Dong *et al.* studies settlement value and proposed that settlement to be inversely related to the hip-knee angle(HKA) and directly related to the KL grading of OA of the knee. Still, the lateral Condyle is supported by three cortices, i.e.by, two fibular cortices, one tibial cortex and balance loading is thus difficult when the medial side collapses in a varus- deformed knee with an intact fibula. Whereas with the PFO, the fibular strut support is removed and neutralized and load-bearing capacity becomes equal and strut effect of the fibula is interrupted and varus thrust is eliminated. Non-uniform settlement leads to varus settlement, which makes the femur to slide to the medial side. This phenomenon of sliding towards the medial side is called the slippage phenomenon. Huang *et al.* stated that following PFO, i.e., proximal fibular osteotomy, there exists a competition between biceps femoris and peroneus of muscles[13]. He also found that there is a decrease in muscle activity in the peroneus Longus on the side operated and increased muscle activity in the long head of biceps femoris immediately after proximal fibular osteotomy. This could explain the immediate improvement in tibiofemoral angle from a significant varus to a more neutral alignment immediately following the high-fibular osteotomy. Despite the mechanism of PFO remains unclear, With many theories proposed, it has been seen that proposed theories are complementary to each in the working mechanism with the evident results. The long term side effects of PFO on the other joints like the ankle, knee, hips are unknown yet. Hence it requires further study on the biomechanics of the PFO knee, its mechanism of pain relief and the widening of joint space medially. Zou[14] in their study, observed that in proximal fibula osteotomy, the fibular head is distally pulled through the peroneus longus and soleus muscle to form a lever structure, with the fulcrum being lateral tibial plateau used to pry the medial femoral Condyle to reduce the stress of medial plateau. The success of Proximal Fibular Osteotomy greatly depends on the correct level of the osteotomy. The ankle joint complex stability depends on the fibula's integrity and well known that six centimeters of the distal fibula are essential for ankle stability. Hence, performing partial fibulectomy more proximally is preferred, avoiding complications in the ankle. With the interosseous membrane, fibers are oblique from Tibia down to fibula., on weight-bearing, the fibula is pulled towards the Tibia by the interosseous membrane resulting in load sharing between the two bones. On performing the partial fibulectomy more proximally, lesser loads are shared by the proximal fibular segment, and its support to the lateral tibial plateau becomes weaker. The most commonly reported complication of PFO is related to the injury to the peroneal nerve and its branches due to its proximity and an anatomical course about the fibula. Hence, it is mandatory to understand its anatomical location and make all the efforts to prevent neurological injury during the PFO. The common peroneal nerve (CPN) is formed by the bifurcation of the sciatic nerve in the popliteal fossa. It then enters the lateral compartment of the leg after wrapping around the fibular head and neck, near the peroneus longus muscle and terminates in two branches known as superficial peroneal nerve and deep peroneal nerve. Superficial peroneus nerve runs over the anterolateral surface of fibula, and the deep peroneal nerve runs in interosseus space. It is imperative to remember that the muscular and cutaneous nerve supply of the deep peroneal nerve (DPN) and Superficial Peroneal Nerve (SPN). The DPN supplies muscles of the anterior compartment of the leg, which include the tibial anterior, extensor digitorum longus, extensor hallucis longus and peroneus tertius and gives cutaneous innervation to the web space between the first and second digit. SPN supplies the muscles of the lateral compartment of the leg, which include peroneus longus and peroneus brevis and gives cutaneous innervation to the anterolateral aspect of the leg and dorsum of the foot. At the proximal fibula, the region from 40 mm to 60 mm distal to the fibular tubercle is safe for motor branches of the deep peroneal nerve during proximal fibulectomy. However, the superficial peroneal nerve travels along the lateral border of the fibula and the deep peroneal nerve is on the anterior border for almost the whole proximal one-third fibula. Therefore, the incision of proximal fibulectomy should be made over the posterolateral surface of the fibula and the soft tissue on the fibular surface should be detached immediately on the fibular cortex with caution. Hence the ideal distance of the fibula osteotomy site should be between 8-10 centimeters from the tip of the fibula, depending upon the height of the patient. Close attention is needed to avoid potential peroneal nerve injury during surgery. To reduce iatrogenic injury to the peroneal nerve postero-lateral approach is ideal, which passes between the Peroneus longus muscle and the soleus muscle to expose the proximal fibula. The pain is the hallmark of the Osteoarthritis of the knee throughout its course of the disease, it is the main reason for the debilitation of the functional activity and decrease in quality of walking. Wang *et al.* stated that there is a significant improvement in the pain relief with preoperative 8.02±1.50 to the postoperative 2.74±2.34 vas score[15]. In our present study, the preoperative mean vas score is 5.8±0.61 to the postoperative mean vas score 2.1±0.71. Similarly, all the others reviewed above should provide excellent pain relief. Wang *et al,* in their study, has shown improvement from preoperative 44.41±8.90 (AKSS SCORE) to the postoperative 67.63±13.65. The present

study has shown improvement from preoperative 53.6±4.83 (kss score) to the postoperative 74.5±7. The complications of the study clearly attributed to the approach of the surgery and the level of the osteotomy., the commonly encountered complications are due to the neural injury to the common peroneal nerve and its branches, injury to the superficial peroneal nerve injuries. In our present study, almost all the patients have shown improvement clinically with medial knee pain relief immediately following surgery. Patients exhibited improved walking within two weeks of surgery and improved stair-climbing capability knee ambulation activities.

CONCLUSION

In our study, it is observed that PFO is a relatively simple, safe and affordable surgery for pain relief, correction of varus malalignment and to improve joint function in medial compartment osteoarthritis knee. It is a promising alternative procedure for medial compartment osteoarthritis. This procedure delays the requirement of TKR. Care should be taken to avoid injuries to peroneal nerves. The postoperative vas score, KSS knee score and medial joint space and lateral joint space and tibiofemoral angle in comparison to the preoperative vas score, KSS knee score and medial joint space and lateral joint space and tibiofemoral angle are significant as the P-value is <0.05 and hence the test is significant.

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