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Review Article

Role of Proximal Fibular Osteotomy in Medial Joint Osteoarthritis of Knee

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Abstract

The hypothesis is to review the existing evidence on the role of Proximal Fibular Osteotomy (PFO) in unicompartmental medial joint osteoarthritis of knee joint in relatively young patients. The procedure has been described as simple, cheap and effective in treating this condition.

Our observations are based on our unpublished experiences with a case series of the management of 30 cases with medial joint narrowing of knee in last one year. These cases are being followed every 3 months to assess the progress. We have been doing this procedure at our institutions under spinal anesthesia and a segment of 1 cm is excised from shaft of fibula through a lateral 4-6 cm long longitudinal incision about 10 com distal to the tip of head of fibula. The check x-ray soon after recovery showed opening of medial joint space and clinically relief from previous arthritic pain. Almost all of our patients had similar effects following PFO. Many patients have dramatic relief of pain and they were able to even squat and climb stairs easily after surgery, while they were unable to do so before. The preliminary results of our cases have encouraged us to continue this procedure and review the available resources. The correction of varus deformity, opening of medial joint space and the pain relief are the main results of PFO in our patients. In our opinion this procedure is simple, cheap and effective in the management of medial joint osteoarthritis of knee in relatively young patients.

The PFO is a suitable surgical option in most LMICs that lack financial and medical resources. The PFO is cost effective in the relatively young patients with early medial joint arthritis. The PFO can stand alone as an appropriate alternative to costly procedures like High Tibial Osteotomy (HTO) and unicompartmental or total joint replacement (TKA) surgery in the Low & Middle Income Countries (LMICs). Compared with TKA or HTO, the PFO is a simple, safe, fast and affordable surgery that does not require insertion of additional implants. However, large prospective study with long term follow up is needed for its wider application.

Introduction

Osteoarthritis (OA) of knee joint is a common disease that causes significant disability. Most patients can be managed conservatively in the outpatient setting. [1] The global prevalence of radio graphically confirmed symptomatic knee OA in 2010 was estimated to be 3.8%. It was higher in females (4.8%) than in males (2.8%). [2] In the USA, 33.6% people aged more than 65 years were found to have osteoarthritis of knees. [3] In south Asian region the prevalence of OA of knees is 1.8% in males and 3.1% in females. [2] With the aging of the world's population, especially in Low & Middle Income Countries (LMIC), the number of people living with knee OA is anticipated to increase substantially over coming decades.

Osteoarthritis management in the developed countries is focused on developing patient-specific surgical instrumentation for knee arthroplasty, post-operative supervised exercise programs, and other potentially expensive healthcare modality. In the LMIC, lacking of appropriate healthcare infrastructure or inability to fund expensive treatment of arthroplasty for osteoarthritis can hardly afford to benefit from such advanced method. In the high income country (HIC) treatment modalities often include arthroplasty techniques. Patient specific instruments are unproven and not widely used. Computer guided knee replacement is used in some centres but the benefit is not really proven. Unfortunately, ongoing registered trials, largely, are not being conducted to address the research gaps that could have a worldwide influence. However, this issue may not be the fault of individual orthopedic investigators [4]. The researchers in orthopaedics and related fields should heighten efforts to increase awareness and promote better screening of osteoarthritis, in the attempt to initiate treatment sooner and delay the progression of the debilitating effects of the disease [4].

Clinicopathological Features

A history of gradually worsening mechanical knee pain and deformity is typical of OA. In fact, knee pain is often the first symptom of knee OA [5]. The patients with clinically diagnosed knee OA report lower health-related quality of life than healthy controls across many dimensions of health, including pain, mobility, physical

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functioning, limitations in work and other daily activities, quality of sleep, emotional distress, social isolation, energy and depression [6-8].

Patients with osteoarthritis of knee usually present with major involvement in one compartment, with the medial compartment involved nearly 10 times more often than the lateral compartment. It may be because medial compartment of a normal knee joint bears approximately 70% of body weight whereas the lateral and patellofemoral compartment bears the remaining weight [9]. The medial compartment is predominantly loaded in a varus knee; a neutral mechanical axis slightly loads the lateral more than the medial compartment. In valgus alignment, the main load runs through the lateral compartment [10]. These changes of the mechanical axis lead to a stress concentration in the medial compartment and degeneration of the cartilage and meniscus, which are the major pathological manifestations of knee OA [11]. The medial part of knee has only a single cortex support in an otherwise fully cancellous bone, which tends to collapse with increasing age. The lateral part of the knee, however is supported by three cortices, one of tibia and two of fibula, making it rigid and un-collapsable. This leads to increasing varus with age and causes medial compartment OA of the knee with a gradually decreasing medial joint space [12]. The slope of medial tibial plateau, in a varus knee causes transverse shearing force, with the femoral condyle shifting medially during walking and sports [12]. Eventually, the medial plateau becomes significantly lower than the lateral and a varus deformity occurs in the lower extremity. The fibular strut effect may load the medial side, but first there is loss of medial cartilage and at a later stage wear of the medial bone.

Mechanical factors are involved in the development and progression of osteoarthritis. If "loading" is a major cause in development and progression of osteoarthritis, then "unloading" may be able to prevent progression. There is evidence that unloading may be effective in reducing pain and slowing down structural damage. The unloading by bracing (nonsurgical), unloading by osteotomy (surgical) and unloading by joint distraction are the alternative methods of management of OA. Many reviews in these three fields have been published over the past few years. Recent studies argue for the usefulness of a biomechanical approach to improve function and possibly reduce disease progression in osteoarthritis [13,14].

The articular cartilage is thought to have limited regeneration potential. However, it has been observed that symptomatic pain relief and cartilage regeneration are possible in osteoarthritic joints that have been surgically pulled apart or distracted for prolonged periods of time. This might have been a clue that cartilage regeneration is possible in OA joints. However, the mechanism by which cartilage growth might occur in the distracted joint space is not well known [15]. Tiku and Sabaawy [16] reported that cartilage regeneration is possible in OA joints that has been surgically pulled apart ordistracted for a prolonged period of time. Koshino et al. [17] also documented regeneration of articular cartilageafter high tibial valgus osteotomy for medial compartment an osteoarthritis of the knee joint.

Nonsurgical Treatment

No pharmacological therapy has shown all the characteristic of an ideal treatment for osteoarthritis, and side effects have been reported at both systemic and local level [18]. Non-operative methods like bracing and lateral wedge insole are not effective for pain, stiffness, function and quality of life in the treatment of patients with medial compartment knee OA [19]. Visco supplementation has not proved beneficial in studies [20]. Intraarticular platelet rich plasma injection for knee OA has the potential to provide symptomatic relief for up to 12 months. There appears to be an increased risk of local adverse reactions after multiple PRP injections [21].

The treatment of osteoarthritis of knee with a polycentric brace can provide significant improvement in pain, stiffness and increased physical activity levels and no radiological deterioration with few complications. The polycentric knee brace can be a cost effective alternative to the other treatments of osteoarthritis of the knees. However, the knee brace should not be used alone, but in addition to other therapeutic modalities [22].

Surgical Treatment

Surgery is indicated and should be considered when a patient is refractory to non-operative treatment modalities. They should have been tried for a reasonable period (at least three months), and quality of life is notably compromised [23]. Arthroscopic surgery for osteoarthritis of the knee provides no additional benefit to optimized physical and medical therapy [24,25]. The American Academy of Orthopaedic Surgeons (AAOS) Board of Directors on December, 2016 have suggested three options for surgical Management of Osteoarthritis of the Knee: (1) Total Knee Arthroplasty (TKA), (2) Unicompartmental Knee Arthroplasty (UKA), and (3) realignment osteotomy (varus- or valgus producing femoral or tibial osteotomy) [26]. The arthroplasty is perhaps optimistic with some studies showing 20% have ongoing pain. It is also poorly tolerated in younger patients (<55yrs).

Nonetheless, for patients with severe and advanced knee OA, TKA may be the only option to resolve the pain and improve function. With the surgical techniques and surgeon skills available today, more than 90% of the patient population undergoing a TKA will continue to report satisfactory results 20 years after the surgery [27].

Arthroplasty results in painless and mobile knees, but is associated with known risks. Early postoperative complications include prosthetic infection, venous thromboembolic disease, arthrofibrosis, and pain. Late postoperative complications include infection, prosthetic aseptic loosening, and pain. All these complications can lead to a need for revision arthroplasty [26]. TKA is expensive and complex, and some patients need a second revision. It is not suitable for majority patients in the LMICs for socioeconomic reasons. These major advances of TKA which are relatively routine in developed countries have not been enjoyed by patients in developing countries stemming from unavailability of both financial and human resources [28].

If OA is limited to only one compartment of the knee joint, surgical techniques involving UKA or unloading osteotomy may be considered. UKA has numerous advantages over TKA and one disadvantage, the higher revision rate [29].

Medial UKA patients tend to require revision sooner, with a mean of 8.2 years compared to a mean of 9.7 years for valgus High Tibial

Osteotomy (HTO) patients. Valgus HTO provides better physical activity for younger patients whereas UKA is more suitable for older patients due to shorter rehabilitation time and faster functional recovery [30]. The HTO also has some disadvantages, including a delayed time to full weight bearing and risks of nonunion or delayed union, peroneal nerve paralysis and wound infection [31].

Particularly in younger patients, joint-preserving osteotomies can provide excellent and reliable relief while delaying the need for partial or total joint arthroplasty and subsequent revision [32].

Van der Woude et al. [25] did a study of joint distraction using a spanning external fixator for medial compartment OA. Distraction treatment resulted in prolonged clinical benefit, potentially explained by an initial boost of cartilaginous tissue repair that provides a long-term tissue structure benefit as compared to natural progression.

Due to concerns over limited function and early failure of TKR in younger and more active patients, treatment alternatives are being explored that would allow the delay, or avoidance, of arthroplasty in younger patients with symptomatic early OA. The HTO has traditionally played a prominent role in this patient population [33].

Proximal Fibula Osteotomy (PFO)

The procedure involves removing a 10 mm piece of fibula six to nine cm below the fibular head, to relieve medial compartment pressure, and realign the knee. The distance from fibular head tip should be closest to the knee joint, without damaging the lateral popliteal nerve. The formula is 6 cm below in 5 feet tall, 7 cm in 5.5 feet, and 8 cm in six feet tall patients [34].

The exact mechanism of the efficacy of PFO is unclear. One possible explanation of why PFO relieves pain and improves the joint space is that it removes the fibula support that may cause genu varus. The fibula supports one-sixth of the body weight; thus, PFO may rebalance or redistribute the load on the lateral and medial tibia plateau after surgery [35]. Joint unloading and joint motion with normalized gait offer potential, clinical, biomechanical, and biological benefits and predict exciting future treatment options for pre-arthroplasty patients with early knee OA [33].

A case report of a 51 year male has demonstrated a sharp increase of approximately 5° to 7° in femoral abduction and a 5° to 8° increase in femoral external rotation and 2 to 5 mm distal translation of the joint line after proximal fibula osteotomy. This alteration in the kinematics of knee by increasing valgus, femoral external rotation, and distal translation of the knee may help reduce knee pain and improve early functional recovery [36].

A study on 110 patients followed up for 2 years found that proximal fibular osteotomy can significantly improve both the radiographic appearance and function of the affected knee joint and also achieve long-term pain relief. This procedure may be an alternative treatment option for medial compartment OA [37].

A study of 47 patients with medial knee pain who underwent PFO demonstrates that PFO effectively relieves pain and improves joint function at a mean of 13.38 months postoperatively. This new surgery is simple, safe and affordable. Pain relief after surgery occurs in almost all patients. PFO may delay or replace TKA in a subpopulation of patients with knee osteoarthritis [38].

A comparative study of arthroscopic debridement *versus* proximal fibula osteotomy combined with arthroscopic debridement found better pain relief and improved Knee Society Score in the second group. Proximal fibula osteotomy combined with arthroscopic debridement can treat knee malalignment and the disease in knee, it is an effective and safe method to treat the medial knee osteoarthritis with varus [39].

Ideal indications of PFO are: Predominantly medial compartment arthritis with varus knees, good lateral joint space in weight bearing films, at least 2mm gap in AP stress Varus X-rays, a motivated patient, who understands that this is a procedure that buys time, and delays knee replacement surgery and patients with BMI less than 23 [40].

Compared with TKA or HTO, PFO is a simple, safe, fast and affordable surgery that does not require insertion of additional implants. As such, PFO is a suitable surgical option in most LMICs that lack financial and medical resources [38].

Complications related to removal of proximal fibula are few. The rate of symptomatic knee instability was 3.9%. Although transient motor dysfunction was not uncommon, the incidence of persistent peroneal nerve motor dysfunction was 2.6% [41].

Recently a biomedical cadaveric study was conducted in Canada with a purpose to determine what effect proximal fibular osteotomy had on knee joint and ankle pressures and tibia strain. Ten matched pairs of cadaver legs were tested in compression to 1.1 times body weight comparing intact and with proximal fibular osteotomy at 0°, 15°, and 30° of flexion. Sensors were inserted into the knee and ankle joint to measure pressure, force, and contact area. Proximal fibular osteotomy decreases the pressure in the medial compartment of the knee, which may reduce knee pain and improve function in patients with medial compartment knee osteoarthritis [42].

Summary

The PFO is a suitable surgical option in most LMICs that lack financial and medical resources [38]. The PFO is cost effective in the relatively young patients with early medial joint arthritis. The PFO can stand alone as an appropriate alternative to costly procedures like High Tibial Osteotomy (HTO) and unicompartmental or total joint replacement (TKA) surgery in the Low & Middle Income Countries (LMICs). Compared with TKA or HTO, the PFO is a simple, safe, fast and affordable surgery that does not require insertion of additional implants. Currently short term results from a few reporting centres suggest that PFO would be a suitable procedure for early OA knees. However, a prospective study with clear inclusion criteria and reporting pre-surgical and post-surgical PROMS; and longer follow up periods with Pre and post surgical gait analysis would also be interesting to study.

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