Surgical Options for Treating Knee Osteoarthritis - A Concise Review

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Abstract

Several options are available to manage osteoarthritis of the knee including arthroscopic joint debridement, high tibial osteotomy, proximal fibula osteotomy, Maquet osteotomy, joint distraction procedure, sub-chondroplasty, injection of platelet rich plasma, injection of stem cell, patellofemoral arthroplasty, unicompartmnet knee arthroplasty, and total knee replacement. The choice of surgery will depend on location and severity of the osteoarthritis, age, comorbidities, and body mass index of the patient. The aim of this review is to provide an overview of the available surgical treatments for knee osteoarthritis.

Keywords

Knee, Arthroplasty, Osteotomy, Osteoarthritis

Background

Osteoarthritis (OA) of the knee joint is an extremely common condition seen in our daily practice with reported prevalence of 30% in people over 60 years of age [1]. It is the fourth leading cause of disability the world-over [2,3].

The guideline for non-surgical management of OA was published in 2007 by OARSI (Osteoarthritis research society international), which have been refined based on systematic reviews [4]. There have been published pathways, evidence based guidelines and appropriate use criteria for surgical management of this condition [5-7].

But there are several surgical options not mentioned in these studies. The purpose of this article is to provide a comprehensive review of various surgical options available for management of knee OA.

The available options are broadly classified into four categories as mentioned in Table 1.

Arthroscopic Knee Surgery

It is one of the most controversial procedures performed for knee OA. It was thought to benefit patients by removing debris and cytokines along with wash [7]. However, randomized control trials did not show any benefit compared to placebo. The relief of symptoms may have been due to the natural course of the disease, effect of the co-interventions or a placebo effect [8-10].

Arthroscopic meniscectomy was found to be no better than sham surgery for degenerative meniscal tear [11]. British Medical Journal (BMJ) published clinical practice guidelines based on randomized controlled trials (RCT). They reported that there was only short term benefit in pain and function, and on the contrary it

Table 1: Classification of surgical options for management of knee osteoarthritis.

| Classification                              |
|--------------------------------------------|
| 1. Arthroscopic surgery                     |
| 2. Cartilage repair techniques              |
| 3. Realignment osteotomies                  |
| 4. Replacement                              |
was possible for patients to develop thromboembolism (0.5%) and infection (0.2%). They strongly recommended against arthroscopic knee surgery in patients with degenerative knee disease [12].

**Recommendation at present**

There is no role for routine lavage or debridement for patients with radiographic OA. However, patients with clicking or locking may be offered this procedure for improvement in mechanical symptoms only along with possible associated risks.

**High Tibial Osteotomy (HTO)**

This procedure was described by Jackson in 1958 and popularized by Coventry [13,14]. There was loss of interest in the procedure subsequently, but with improved surgical techniques, better implants, and fixation techniques, a renewed interest has been found in this procedure [15-17]. It is recommended for physiologically young and active patients meeting the criteria mentioned in Table 2. Presence of advanced degenerative changes, inflammatory arthritis, and large areas of exposed bone are contraindications to the procedure [18]. The aim of this osteotomy is to over correct the mechanical alignment to 3-5 deg of valgus [14,19,20]. The correction can be achieved by either a lateral closing, medial opening or dome shaped osteotomy [21,22]. The required amount of wedge to be removed is determined pre-operatively using a technique described by Fujisawa [23]. The osteotomy can be fixed using a spacer plate (Puddu), Locked plate (Tomofix) or a dual sliding compression plate (Figure 1) [22,24]. Good or excellent results have been reported in 68% to 77% with a survival of 90% at 15 years [25]. It is recommended to start with arthroscopy and address the lateral compartment pathology.

**Table 2: Indications for high tibial osteotomy.**

| Active young patient | BMI < 35 |
|---------------------|---------|
| Flexion contracture < 5 degrees | TBVA < 5 degrees |
| Knee ROM up to 90 degrees | Only one compartment affected |
| Competent ligament | Non smoker and compliant patient |

**Recommendation at present**

There is limited available evidence to recommend HTO for treating pain from knee medial compartment OA.

**Proximal Fibular Osteotomy**

Fibula acts as a strut to load 1/6 body weight and prevents uniform settling of osteoporotic proximal tibia [26]. This contributes to increased stress on medial tibial plateau and development of varus osteotomy. Proximal fibular osteotomy redistributes the loading of tibial plateau and relieves pain (Figure 2) [26-28]. Only few short term studies are available [26,28,29]. The improvement in post-operative score depends upon inclination and OA of proximal tibiofibular joint, BMI and pre-operative knee function [28].

**Maquet Osteotomy**

First proposed by Maquet in 1963 and aimed to unload painful patellofemoral (PF) joint by tibial tubercle anteriorization [30,31]. Generally, patellofemoral pain from severe PF osteoarthritis not responding to non-operative treatment is the primary indication for this procedure.

The Maquet technique relieves anterior knee pain by decreasing contact load on the PF joint by elevating tibial tubercle [30-32]. A bone block, either autograft or allograft, inserted beneath the tibial tubercle to maintain crest elevation (Figure 3). It provides a good short and long term results in 80% of the cases [33,34]. Progressive anteriorization of the tibial crest is associated with progressive decrease in the PF compressive force [32]. However, only 1.5 to 2 cm of elevation is recommended as further elevation result in minimal compressive relief [35]. Reports of this procedure had good result; however, skin necrosis and graft nonunion are the main local
complications seen with this technique [34].

**Knee Joint Distraction - Arthrodiastasis**

It works on the principle of unloading of the medial tibial compartment. It was first described in 2010 as a case report and subsequently used for management of knee OA [36,37]. There was a study mentioning that the thickness of cartilage formed after this procedure was better than HTO [38]. A randomized control trial comparing knee joint distraction with HTO found no difference between the two techniques in regards to joint space widening and clinical outcome [39]. It may be considered as an alternate option for medial compartment OA in patients with minimal leg malalignment.

**Recommendation at present**

There is a lack of strong evidence on the efficacy of this procedure in treatment of knee OA. Well designed comparative trials in this subject are needed for evaluation of its benefit.

**Sub-Chondroplasty**

It is minimally invasive procedure described for knee OA patients with bone marrow edema (Figure 4). These patients have been shown to have accelerated progression to painful OA [40,41]. This technique involves fluoroscopic control and application of calcium sulphate based bone substitute. Early results (2-4 years) have shown relief in pain with improved structural quality and remodeling of bone [42-44]. Longer term studies and controlled trial are required before it can be included in the guidelines.
joint in patient older than 40 who exhausted conservative managements [56, 57].

The indications and contraindications for PFA are summarized in Table 3. Total knee replacement (TKR) with patellar replacement is the gold standard for treating advanced PFOA due to long term good result [58]. However, meta-analysis of 28 studies revealed comparable results in function and complications rate between TKR and modern generation PFA in short and mid-term results [59].

**Platelet Rich Plasma (PRP)**

Concentrates obtained from blood releases various cytokines which help in cartilage regeneration and reducing synovial inflammation [45]. Early results (1 year) of PRP injection are better than Hyaluronic acid/placebo without any additional risks [46, 47]. It is recommended to make shared decision with the patient [48].

**Recommendation at present**

There is inadequate evidence on the efficacy of this procedure in relieving OA knee pain. However, there is no known major harm of using PRP.

**Stem Cell**

Pleipotent mesenchymal stem cells help in replacing lost cells. They release trophic factors which help to reduce inflammation and stabilize matrix [49]. Randomized control trials comparing stem cells injection with conservative treatment have shown improved function at 12 months and a lot of future studies are anticipated in this modality of treatment [50-53].

**Patellofemoral Arthroplasty**

Patellofemoral arthroplasty (PFA) introduced by Mackveer in 1955, but initial design was associated with poor functional results [54]. However the current modern design has produced good results and outcomes with ten years survivorship of more than 80% [55]. Patient selection, implant designs, and surgical technique are the main factors for achieving better outcome. The main indication for PFA is advanced isolated OA of knee joint in patient older than 40 who exhausted conservative managements [56,57].

The indications and contraindications for PFA are summarized in Table 3. Total knee replacement (TKR) with patellar replacement is the gold standard for treating advanced PFOA due to long term good result [58]. However, meta-analysis of 28 studies revealed comparable results in function and complications rate between TKR and modern generation PFA in short and mid-term results [59].

**Unicompartment Knee Arthroplasty**

There has been more interest in this technique recently, although it was described initially in 1970 [60]. Medial compartment is more commonly involved and unicompartment knee arthroplasty (UKA) comprises 11% of total arthroplasty cases of knee joint (UK joint registry). It was classically indicated for elderly > 60 years low demand and thin patients (weight < 82 kg) [61]. The indications have been extended to younger patients by oxford group (Cite - oxford knee) as a result of better surgical technique, better prosthesis design and improved polywear [60-62]. Historically ACL deficient knees have shown early failure after UKA due to eccentric loading and polywear. Recent studies have divided ACL deficient knees into two subgroups; traumatic and degenerative. UKA should not be done in patients with traumatic, symptomatic ACL rupture. Although satisfactory results have been reported in these by combining ACL reconstruction with UKA [63,64]. The other group of patients with degenerative tear of ACL should have a posterior slope < 7 degrees [65].

UKA has been successful in middle aged patients with > 90% survival at 10 years, with excellent function (Figure 5) [66,67]. In comparison to total TKR, UKA provides faster rehabilitation and quick recovery, less morbidity, and less blood loss. It also preserves normal kinematics of the joint. This procedure should be avoided in conditions shown in Table 4.

**Table 3:** Indications and contraindications for patellofemoral arthroplasty.

| Indications                                                                 | Contraindications                                                                 |
|----------------------------------------------------------------------------|----------------------------------------------------------------------------------|
| Severe isolated or posttraumatic PFOA                                      | Tibiofemoral OA or menisci injuries                                               |
| Age more than 40.                                                          | PF or limb malalignment                                                              |
| Patellar subluxation or patellar tilt                                      | Knee instability                                                                     |
| Trochlear dysplasia                                                        | Acute infection or CRPS                                                              |
| Failure of patellar unloading procedures (e.g Maquet osteotomy)            | BMI > 30 or quadriceps atrophy (relative contraindications)                         |

Figure 4: Coronal T-2 MRI shows medial tibial subchondral oedema.
has shown no difference in RCT [68]. It can be safely said that a conventional knee can be performed by an approach familiar to surgeon, using standard well established components, with or without tourniquet and without drains to achieve good long term results [68].

**Conclusion**

Surgical option should be considered to manage OA knees only after exhausting conservative options. The treatment offered should be modified based on patient age, demands and symptoms. HTO and UKA are considered in single compartment disease and total knee should be reserved for end stage disease. A realistic expectation should be offered to the patient based on available evidence to have a satisfied patient.

**Declarations**

**Ethical consideration**

This is a review article that does not involve patients or patient’s information.

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**Conflicts of interest**

There are no conflicts of interest.

**Authors’ contributions**

JSL conceived and designed the article’s outlines and wrote the initial and final draft. SAH contributed with draft writing, organized and prepared the figures, and was the corresponding author. SUG: Reviewed the final

**Table 4:** Contraindications for unicompartment knee replacement.

| Condition                          |
|-----------------------------------|
| Inflammatory arthritis            |
| ACL deficiency                    |
| Fixed valgus > 5 degrees          |
| Fixed varus > 5 degrees           |
| ROM < 90 degrees                  |
| Flexion contracture > 10 degrees  |
| Tricompartmental OA               |

**Total Knee Replacement**

TKR is indicated for end stage OA (Figure 6). A 25 year survival rate of 82% has been reported (95% CT - 83-83.2) [68]. But despite this, one out of five patients are still not satisfied after surgery [69]. The aim of the procedure is to restore mechanical alignment, joint line, and achieve normal balanced ligaments with restored angle. The joint can be approached using either a medial parapatellar, mid vastus or subvastus approach. Better early outcomes were reported subvastus and midvastus approach but in long term there was no difference between two groups [70-72]. Coronal plane alignment is achieved by precise bone cuts, releasing of tight medial ligaments and tightening of lax lateral side. The sagittal plane alignment is achieved by tackling tibia in symmetric gap mismatch and femur in asymmetric gap mismatch. There is no difference in clinical results between posterior cruciate retaining and stabilized implants [73,74]. The implant fixation (cemented/uncemented) bearing surface (mobile/fixed) and alignment

![Figure 5: Unicompartment knee replacement- AP and lateral radiographs.](image1)

![Figure 6: Total knee replacement- AP radiograph.](image2)
manuscript.

All authors read and approved the final manuscript. All authors have critically reviewed and approved the final draft and are responsible for the manuscript’s content and similarity index.

Statement of equal authors’ contribution

All authors have contributed equally.

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