ABSTRACT
There are a variety of operative and non-operative modalities that can be used to address patellofemoral pain secondary to arthrosis. Patellofemoral Arthroplasty (PFA) is one of the latest alternatives designed to address the pain caused by severe, isolated osteoarthritis (OA) of the patellofemoral joint (PFJ). In the past, PFA has experienced variable success rates, and as a result many surgeons prefer Total Knee Arthroplasty. Arthrosurface, Inc. (Patellofemoral HemiCAP) has developed a new, minimally invasive, anatomic resurfacing technique with advantages to the performance of the traditional PFA components that may provide more consistent success rates. This paper outlines the surgical procedure for the patellofemoral HemiCAP for isolated PF arthrosis.

INTRODUCTION

History
Patellofemoral arthroplasty is a relatively new procedure with a legacy that dates back to 1955. At that time, McKeever and associates published the first account of patellar resurfacing as a better alternative to patellec-tomy and patellar shaving to ease the pain associated with patellofemoral OA.1,2 In 1973, Levitt compiled a study similar to McKeever’s that expanded the follow-up time. His conclusion reinforced McKeever’s initial conclusion that patellar resurfacing was indeed a better way to treat patellofemoral OA.3 Long term success of this procedure was established by Pickett and Stoll, who found satisfactory results in 39 of 45 patients with McKeever prostheses at 22 years of follow-up.4

In 1974, Richards Medical developed the Bechtol I system, which introduced the concept of resurfacing both sides of the PFJ.5 Richards subsequently introduced the Type II system in 1976. The updated design featured an extension of the trochlear component that extended toward the intercondylar notch.6 Following these developments, Blazina and associates published the first report of patellofemoral resurfacing.1 Recent developments include custom patellofemoral arthroplasty where computer software and tomography data are employed to manufacture implants to the exact specifications of the patient’s knee. The study, published by Sisto, had a follow-up time of 73 months, which makes it difficult to draw conclusions regarding the superiority of this method.7 From the time of Blazina’s first publication in 1979, published success rates of PFA vary from 44-90%.1

From the variable outcomes, at present, PFA remains a controversial treatment for advanced patellofemoral OA. Many surgeons perform total knee replacement for isolated advanced patellofemoral OA, rather than PFA, as means of achieving more consistent outcomes. Some of the current issues surrounding isolated PFA are the fact that extensive exposure is necessary, a lack of long term outcome studies, and the variable success rate of this procedure. To this effect, a minimally invasive, anatomic, joint preserving PFJ resurfacing component may provide some of the solutions required to succeed in this area.

Anatomy
PFA is primarily indicated for isolated degenerative arthrosis of the PFJ. This degeneration often occurs in an area called the trochlear groove, a recessed region between the lateral and medial condyles of the femur. The trochlear groove is essential for correct patellar tracking during movement and is a very important point as to why a less invasive, focal resurfacing may be advantageous to a complete joint replacement of the PFJ. Arthritis and chondromalacia of the patella, therefore, are common pathologies that may lead to advanced degeneration requiring PFA.

Alternatives to PFA
There are many non-surgical treatments of patellofemoral arthritis or chondromalacia which include rest, non-steroidal anti-inflammatory drugs, modification of activities which may aggravate the joint, and strengthening exercises.8,9,10 Physical therapy has been shown to alleviate patellofemoral pain in the short term. A randomized, double-blind study conducted by Crossley, et al. showed that patients who underwent a physical
therapy regime consisting of stretching and exercises reported greater patellofemoral pain relief than patients in the placebo group who were subjected to taping and sham ultrasounds.13

In addition to non-surgical modalities, there are also many surgical alternatives which include anterior advancement of the tibial tubercle, debridement with lateral release, chondrectomy, patellectomy, and facetectomy.

Anterior advancement, which was concluded to be a durable solution by Heatly, encountered four of 29 knees that degenerated in condition with only six years of post-operative follow-up.9 Karlsson observed degeneration over a 10 year time frame, and after encountering poor results in 27 of 71 cases (38%) went so far as to advocate that anterior advancement should not be used to treat patients with patellofemoral pain syndrome.10 Silvello, et. al. concluded that a long rehab regime could lead to satisfactory results in patients with chondromalacia but observed limited success in patients with osteoarthritis.11 Recently, a trend toward anteromedialization has emerged. Pidoriano observed mostly good results, however, all patients with central trochlear lesions had poor results with this procedure.12,13 There are also inconsistencies in the literature regarding the optimal elevation of the tubercle, incision and soft tissue approach, as well as the ideal surgical candidate.14

Debridement with lateral release is primarily used to alleviate symptoms of early osteoarthritis, particularly with lateral tilt and lateral overload. With more advanced arthritis, this surgical procedure has unpredictable results, and may not alleviate pain. Debridement with lateral release may be useful as a precursor to more definitive procedures, if indicated.15

Chondrectomy is the removal of defective cartilage. Often this is accompanied by micro-drilling into the bone to stimulate new cartilage growth. Chondrectomy with drilling had diminished success in patients over 30 years of age. Four patients of the 29 in this series were over 30 years of age. Of these four, two experienced failures. This is significant because there were only three failures in the entire series.15

Patellectomy has been known to weaken the knee joint and usually requires a long rehabilitation scheme for success.7 This surgical procedure can also leave residual pain, especially if some of the trochlea has been degraded as part of the disease.16

Facetectomy is a good procedure for the middle aged and elderly.14 However, it appears to be a temporary solution as it deals with the pain but not the predisposing factors. Radiographic analysis of patients who underwent a facetectomy showed the reappearance of osteoarthritis at approximately eight years of follow-up.14 Partial lateral facetectomy does not jeopardize the results of future operations.14

Knowledge regarding autologous chondrocyte implantation is relatively limited. Brittberg encountered a 33% failure rate.15 Results improved, however, when realignment of the extensor mechanism and patellar tracking was addressed.16 In addition, a long period of rehabilitation is required following this procedure to allow the cartilage implantation to heal. Because little is known and the results of this procedure are unpredictable, it is recommended that the application of this procedure should be limited.15,16

Total knee arthroplasty (TKA) is generally not indicated for patellofemoral arthrosis in young patients, but many surgeons perform TKA for isolated PF arthrosis in the older patient.17 Patients over 55 were successfully treated and avoided realignment and osseous procedures like patellectomy.20

INDICATIONS

At this time, the most prominent contraindication for PFA is tibiofemoral arthritis. Leadbetter quantifies the degree of tibiofemoral arthritis as a contraindication to be Kellgren Grade I.1,2,5,6,21-23 Because PFA deals only with pain in the patellofemoral compartment, all other compartments of the knee joint are left intact, leaving any tibiofemoral arthritis unresolved. The localization of PFA has a disadvantage in that some patients who undergo PFA require revision to TKA upon the development of tibiofemoral arthritis.1,5 Therefore it is essential to ensure the tibiofemoral compartment is not contributing to the arthrosis and patient's symptoms.

Conversely, because PFA is a localized procedure, the original menisci, condylar surfaces, and cruciate and collateral ligaments are spared.24 This feature of PFA allows it to be indicated in younger and more active patients. Indeed, the mean age of subjects in the literature reviewed was around 50 years of age where TKA would be considered a more aggressive procedure.2,19,24 Many of these younger patients have had no previous history of arthritis, meaning their arthrosis is more likely to be isolated, and may be post-traumatic, a circumstance in which the results of PFA are better.5,19

It is also very important that the pain localized to the patellofemoral compartment is correctly identified as a result of joint degeneration. Chondromalacia or any superficial or partial cartilage injury is a contraindication for this procedure.5,6,23 In addition, any significant malalignment must be addressed before performing PFA.21

A trial of non-surgical modalities like stretching and strengthening exercises should be attempted and must have failed prior to PFA. In summary, the author’s indication for this procedure is patellofemoral pain secondary to isolated PF arthrosis that is not responsive to conservative treatment modalities, and is occurring in patients older than 40 years of age (Table 1).
The purpose of this paper is to describe a relatively new technique for a minimally invasive, anatomic resurfacing of the PFJ for isolated advanced degenerative OA. The technique described herein is unique in that the resurfacing components, developed by Arthrosurface, Inc. attempt to restore the anatomic contour of the trochlear groove and to minimize the area resurfaced to the area of the lesion only, by not making extensive bone cuts. This procedure affords immediate stability to begin rehabilitation.

A medial parapatellar incision is made in the usual fashion through the medial skin, retinaculum, and capsule into the PFJ. The medial tibiofemoral compartment, fat pad, and meniscus are left intact. The exposure should allow visualization of the trochlea, and allow eversion of the patella to a vertical position for resurfacing (Figure 1).

Once the PFJ is exposed, establish the working axis with the drill guide and guide pin. Place the drill guide on the trochlear lesion so that it is stable with four points of contact in the superior/inferior and medial/lateral axes. Having these points of contact is crucial in establishing a working axis that is normal to the articular surface which helps to optimize implant fit (Figure 2). The guide pin is then placed into the center of the lesion through the drill guide.

The third step is the preparation of the femoral implant bed. Drill the pilot hole until the proximal shoulder of the drill bit is flush with the articular surface. After drilling the pilot hole, advance the tap into the pilot hole to the depth specified by the etch marking on the tap. The fixation stud is then advanced into the pilot hole to the depth specified by the colored line on the hex-driver. The fixation stud should be flush with the contour of the native articular cartilage at the superior and inferior poles.

Once the correct depth of the fixation stud has been established, a contact probe is used to take measurements of the superior/inferior and medial/lateral offsets of the trochlea. This measurement determines the curvature of the femoral or trochlear component. The measurements are taken by reading where the graduations on the contact probe match with an etch on the centering shaft; higher numbers indicate a higher radius.

### TABLE 1
Indications for Patellofemoral Arthroplasty

| 1. Failure of conservative treatment modalities |
| 2. Absence of symptomatic tibiofemoral arthritis |
| 3. Patient has no malalignment (or has been corrected) |
| 4. Surrounding menisci, and cruciate and collateral ligaments are intact and stable |

![Figure 1. The incision and exposure of the patella and trochlea prior to any surgical work. Focal areas of wear on both the patella and trochlea.](image1)

![Figure 2. The working axis is established by centering the drill guide over the defect with four points of contact on the trochlear articular surface.](image2)
of curvature (Figures 3B, C). Superior/inferior offsets are positive and medial/lateral offset values are negative. These values are recorded by marking the maximum between the superior/inferior measurements and the minimum between the medial/lateral measurements (Figure 3A). These values tell which trial cap and femoral resurfacing component will be the best fit and will be used later in the procedure.

The circular scalpel is used to score the edge of where the implant is to lie, followed by drilling the implant bed with the appropriate color-coded femoral reamer. Advance the femoral reamer over the guide pin until the reamer contacts the top of the fixation stud, creating the femoral component surface. The trial cap is selected based on the offset values measured earlier. The femoral implant bed is now prepared and a trial implant is inserted to ensure congruity (Figure 4A).
The fourth step involves the preparation and fixation of the patellar implant. Place the alignment guide so that the pin fits in the taper of the femoral fixation stud. While observing the range of motion of the knee, the needle of the alignment guide will transfer the central axis of the femoral fixation stud. This betrays the target placement of the patellar component. Then, in a fashion similar to the femur, use the drill guide to assess the size and location of the lesion. Place the central axis of the drill guide over the indentation made by the alignment guide, making sure of four points of contact in the superior/inferior and medial/lateral directions. These four points of contact are crucial in obtaining the correct working axis and proper implant fit. With the centering shaft secure in the patella, place the contact probe over it and measure the superior/inferior and medial/lateral offsets. Record the maximum superior/inferior measurement and the minimum medial/lateral on the patellar sizing card. These measurements indicate which patellar trial cap and patellar resurfacing component to use. The patellar component is aligned based on the superior and inferior orientation of the patella. The patellar resurfacing component is cemented into place in the usual fashion (Figures 5A, B).

The final step is seating the femoral implant. The femoral resurfacing component is aligned in two planes to ensure a proper fit. Assuring proper implant positioning in the holder and with the anatomic offsets will afford a proper implant orientation and fit. The final implant is shown in Figure 4B.

Figure 4. (A) The trochlea is prepared with the appropriate reamer, and the trial implant is shown in place with the desired offset values and (B) then the final trochlear implant.

Figure 5. (A) The same procedure is followed for the patella. The initial appearance of the patellar defect and (B) the post resurfacing with the cemented patellar button.
The advantage of this technique is to perform an anatomical resurfacing by minimizing the amount of bone resection, replacing the degenerative component of the joint and maintain the normal mechanics of the joint. The post operative x-ray (Figure 6) demonstrates the congruent resurfacing implant in place, which restores the patellofemoral anatomy.

Postoperative rehabilitation is straightforward, with local modalities and compression to control swelling. Early ROM is encouraged, muscle exercises, and weight bearing as tolerated immediately after surgery. Initially crutches can be used, but the patient can progress off the walking aids as tolerated.

DISCUSSION AND CONCLUSION

This paper describes a novel technique for the anatomical resurfacing of the focal degeneration of the PFJ. Isolated PF degeneration continues to be a significant and common problem in the older active adult. In these patients that are generally younger and more active than the traditional arthritic population, it does make some sense to limit the surgical reconstruction to the area involved in the degeneration. The Arthrosurface HemiCAP provides a limited resurfacing technique that allows immediate rehabilitation, and a return to activity as tolerated. If there is progression of tibiofemoral arthrosis and a TKA is required, this implant can be easily revised as a primary procedure without compromise of the bony preparation for the TKA.

REFERENCES


