

Patellofemoral Replacement With Tibial Tubercle Osteotomy



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Abstract: Patellofemoral arthritis that is due to patellofemoral instability or chronic patellofemoral maltracking can be a difficult treatment problem. Isolated patellofemoral arthroplasty (PFA) is a good option that preserves bone and can more accurately reproduce native kinematics when compared with total knee arthroplasty. Newer PFA designs have demonstrated improved survivorship, although survivorship has not shown equivalence with total knee replacement. It has been postulated that improving patellar tracking could potentially improve overall outcomes and survivorship for PFA. It follows then that optimizing patellar tracking in patients with patellofemoral malalignment by adding a tibial tubercle osteotomy to a PFA may improve the ultimate outcome of the procedure. The objective of this technical note is to describe our preferred method for the treatment of patients with chronic patellofemoral lateral tracking and end-stage arthritis.

Isolated patellofemoral arthritis can be found in 24% of women and 11% of men older than 55 years of age.¹ Women account for a majority of these patients, which is related to a greater incidence of patellofemoral malalignment and dysplasia.² Management initially consists of nonoperative treatment, including physical therapy, bracing, weight loss, injections, and activity modification. When nonoperative management fails, surgical management includes joint-preserving procedures including arthroscopic releases, chondroplasty debridement, microfracture, cartilage-restoration procedures, and tibial tubercle osteotomy. In patients with end-stage osteoarthritis, total knee replacement has classically been the “gold standard” of treatment, with good long-term results.³ However, in patients with isolated patellofemoral arthritis, PFA has become an

alternative to total knee replacement as a bone-preserving surgery that can more accurately reproduce native kinematics when compared with total knee arthroplasty (TKA).³

Historically, with first-generation patellofemoral replacements, there was a high failure rate that was largely due to the design that was dependent on the native femoral rotational anatomy and trochlea morphology.⁴ Second-generation designs were created to address design flaws related to maltracking and stability with a broader onlay design that had more proximal extension of the trochlear component and some with an elevated lateral flange.^{3,5} Newer implants are now available that seek to improve on earlier designs with improved kinematics. Survivorship of first- and second-generation patellofemoral arthroplasty using the Kaplan–Meier estimation is 91.7%, 83.3%, 74.9%, and 66.6% at 5, 10, 15, and 20 years, respectively.⁶ Although survivorship and revision rates have been improved with design, patients who are treated with an inlay PFA and patellofemoral maltracking may have improved results with the addition of a tibial tubercle osteotomy.

There are a variety of indications for a tibial tubercle osteotomy, with one of the main indications being patellofemoral maltracking and/or instability with an elevated tibial tubercle to trochlear groove distance >15 mm.⁷ Osteotomies of the tibial tubercle can serve a variety of purposes, either to offload the joint with an anteriorizing osteotomy, improve tracking with medialization of the tubercle, or a combination of both

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that would be an anterior medialization osteotomy or Fulkerson osteotomy.⁸ In addition, in patients with patella alta (Insall–Salvati index >1.2) also may need an additional distalization of the tubercle for improved stability. Many of the patients seen in our clinic ranging from 30 to 45 years of age have had a chronic history of patellofemoral maltracking and/or instability with severe patellofemoral arthritis. The objective of this technical note is to describe our preferred method for the treatment of patients with chronic patellofemoral lateral tracking with end-stage arthritis.

Surgical Technique (With Video Illustration)

Preoperative Positioning and Anesthesia

Induction with general anesthesia is used, and the patient is placed in the supine position on the operating table. A physical examination is then performed with the patient under anesthesia to evaluate patella tracking, crepitation, and Q angle. Once the physical examination is complete, the leg is prepped and draped and placed into a surgical knee positioner with no tourniquet used.

Arthroscopy

In cases in which there the patient has clinically important meniscus tears, we first perform a standard arthroscopy. Standard anteromedial, anterolateral, and superolateral portals are created and evaluation of all 3 compartments of the knee is performed and any significant concomitant pathology in the medial or lateral compartment is addressed at this time. In this case, the patella and trochlea demonstrated grade IV chondromalacia (Fig 1), and the lateral compartment



Fig 1. An arthroscopic view of the left knee from a standard anterolateral portal of the patellofemoral joint demonstrating grade IV chondromalacia of the patella and trochlea. A diagnostic arthroscopy is performed before beginning the procedure to ensure that there is isolated patellofemoral arthritis.

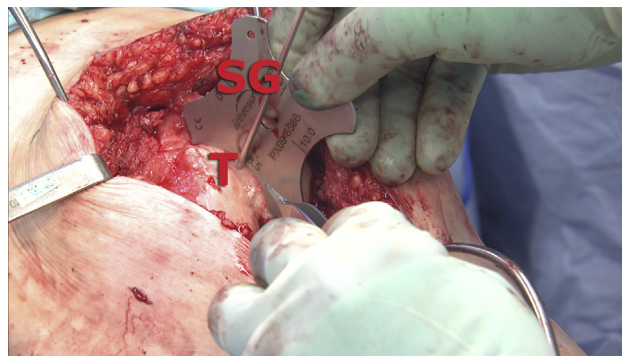


Fig 2. Shown is a left knee after a medial parapatellar arthrotomy has been performed. An anteroposterior sizing guide is placed onto the trochlea with the centering guide pin. The centering guide was placed with a specific guide that places the centering pin in place to match the sulcus and curvature of the native trochlea. This anteroposterior sizing guide is used to match the radius of curvature of the native trochlea. (SG, sizing guide; T, trochlea.)

demonstrated mild peripheral free edge tearing of the midbody of the lateral meniscus that was treated with partial meniscectomy to a stable rim. Once the arthroscopic portion of the procedure is complete, we then transition to the open portion of the case, placing the leg into the surgical knee positioner (Video 1).

Exposure and Medial Peripatellar Arthrotomy

Before proceeding with the open portion of the procedure, the knee is repped with chlorhexidine. An anterior longitudinal incision is used that extends from 3 cm proximal to the superior pole of the patella and extended distally to approximately 3 cm distal to the tibial tubercle. Medial and lateral skin flaps are then created, and a medial peripatellar arthrotomy is performed with care to leave a capsular layer both medial and lateral for later closure. Portions of the fat pad are excised and visualization of the trochlea and



Fig 3. The placement of the anteroposterior reaming guide. The reaming guide sets the depth of reaming for both the anterior and posterior aspect of the trochlea. (ARG, anteroposterior reaming guide.)

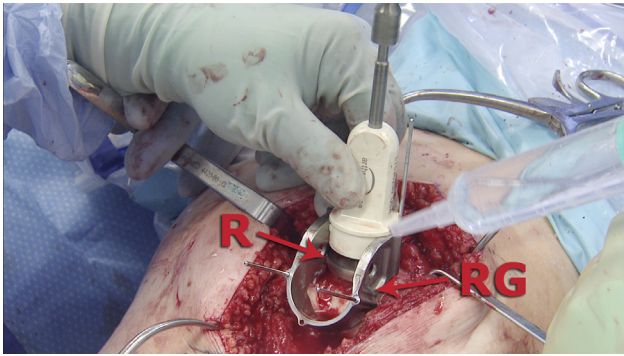


Fig 4. The reaming of the anterior aspect of the trochlea in a left knee. (R, reamer; RG, reaming guide.)

patella is obtained and the knee is flexed with the patella everted.

Patellofemoral Replacement

With the patella everted, we perform a small lateral facetectomy with a saw and a partial lateral release from the superior pole to the inferior pole of the patella. In this case, the patella thickness was measured with a caliper to be 18 mm. An 8-mm thick flat cut is then made using the Zimmer Bone Reaming System (Zimmer Biomet, Warsaw, IN). A 29-mm × 8-mm round, 3-peg onlay button is sized and slightly medialized. Three peg holes are drilled through the Zimmer guide and the Zimmer 3-peg patellar trial component is then placed into position.

The trochlea is addressed next using the ArthroSurface WaveKahuna System (Anika, Franklin, MA). The first centralizing guide pin is placed and the curvature guides are used to determine the radius of curvature for the trochlear component (Fig 2). Central reaming is completed to the selected depth, and the anteroposterior reaming guide is pinned into position and anterior and posterior reaming is completed (Figs 3 and 4). To gain extra coverage proximally, we perform one

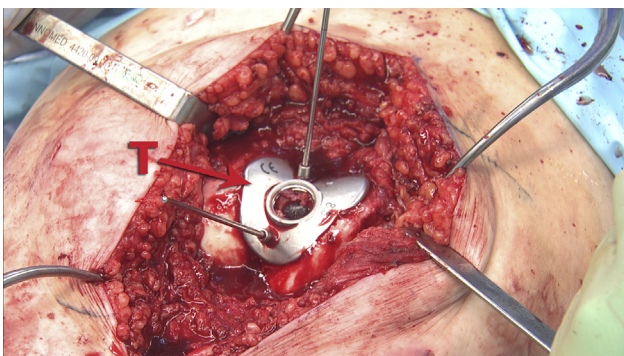


Fig 5. A left knee with a trochlear trial is placed to ensure appropriate reaming has been performed and that the implant will fit appropriately. This trial is pinned into place and central drilling and tapping is performed through the trochlear trial. (T, trochlear trial.)

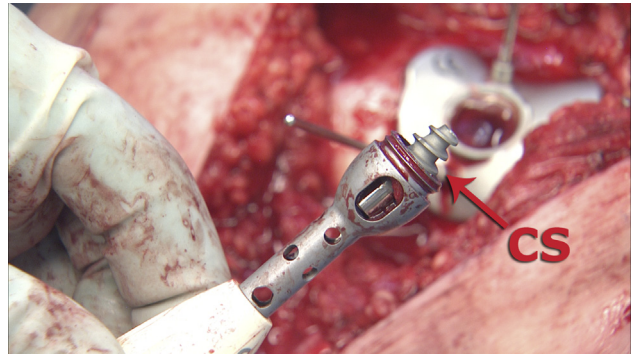


Fig 6. A central stem is placed for fixation of the final prosthesis of the left knee. A morse taper is on the superior aspect of the stem. The final prosthesis is then malleted onto the morse taper component of the stem for final fixation. (CS, central stem.)

further superior reaming step in preparation to place the WaveKahuna prosthesis (Anika) (Figs 5 and 6). The trial component is placed and the central stem preparation is completed through the trial with central drilling, tapping, and then placement of the stem component to the proper depth (Fig 7). Pulsatile lavage is used to prepare the reamed and cut bone surfaces before final implantation of the devices. The trochlear implant is affixed in a locked manner with the morse taper and set flush with the surrounding cartilage completely for an excellent fit. The 8-mm thick × 29-mm round Zimmer 3-peg polyethylene patellar component is then cemented into position (Zimmer Biomet) (Fig 2).

Exposure of the Tibial Tubercle

Once the patellofemoral replacement of the procedure is completed, we then expose distal to the tibial tubercle by extending the incision another 3 cm distal to the tibial tubercle. The exposure for the osteotomy site includes both the medial and lateral aspect of the proximal tibia and release of the lateral capsule to the patellar tendon.

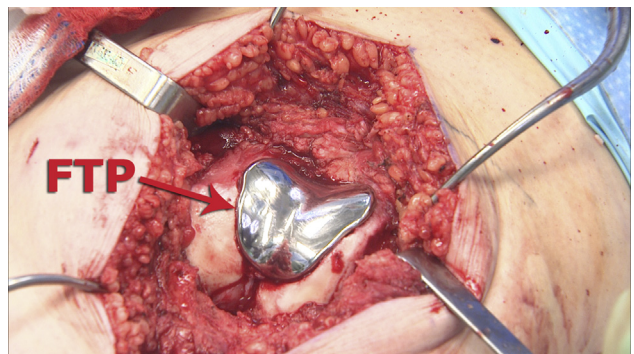


Fig 7. This figure shows the final placement of the trochlear prosthesis implanted into the reamed trochlea of the left knee. (FTP, final trochlear prosthesis.)

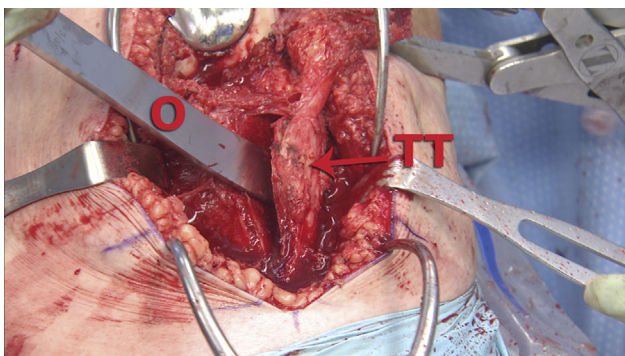


Fig 8. Completion of the tibial tubercle osteotomy on the left knee. An osteotome is used to complete the cut and free any remaining attachments of bone to the tubercle. (O, osteotome; TT, tibial tubercle.)

Osteotomy of Tibial Tubercle

A small oscillatory saw is used to create an oblique osteotomy 2.5 inches in length angled from anteromedial to posterolateral in a 30° plane for anteromedialization of the tibial tubercle. As the osteotomy is progressed distally, care is taken to thin the cut toward the anterior tibial cortex. The osteotomy is completed laterally with straight and curved osteotomes to prevent potential fracture to the tibial tubercle (Fig 8). The amount of medialization is determined based on our preoperative plan using the tibial-tuberosity to trochlear groove distance (TT-TG) measurement. For this patient, the TT-TG measurement was 20 mm and the tibial tubercle was then transferred medially approximately 1 cm and slightly anteriorized (Fig 9). Preoperatively, the patient was assessed for patella alta using the Caton-Deschamps index and was found to be within normal range. Distalization can be added to the procedure if the patient presents with patella alta in addition to an abnormal TT-TG.

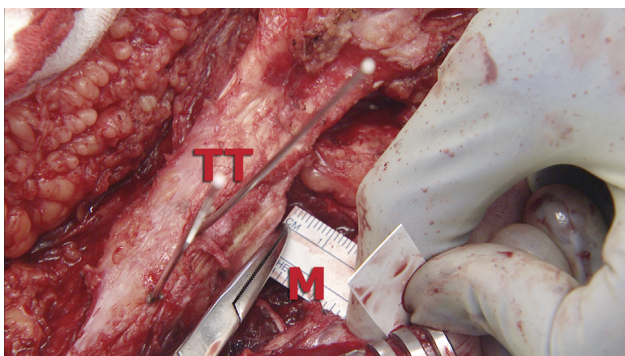


Fig 9. Medialization of 1 cm of the tibial tubercle in a left knee. Two K wires are pinned into place to hold the tibial tubercle. Once appropriate medialization has been obtained, final fixation is obtained with cannulated screws. (M, medialization; TT, tibial tubercle.)

Table 1. Indications and Contraindications for Patellofemoral Replacement With Tibial Tubercle Osteotomy

Indications*	Contraindications
Severe primary patellofemoral arthritis	Absolute
Post-traumatic patellofemoral arthritis	Tibiofemoral OA
Trochlear dysplasia	Inflammatory OA
Age >40 y	Ligamentous instability
Patellar maltracking	Coronal malalignment (valgus >8° or varus >5°)
	Extensor mechanism injury
	Acute infection
	Relative
	BMI >30
	Patella baja
	Quadriceps atrophy

BMI, body mass index; OA, osteoarthritis; TT-TG, tibial-tuberosity to trochlear groove distance.

* All of the indications in addition to an abnormal TT-TG >15 mm or patella alta (Caton-Deschamps ratio >1.2).

Fixation of the Tibial Tubercle

Once the knee is placed in a position of flexion, the arthroplasty is positioned in a well-centralized position within the trochlear groove. The tibial tubercle is provisionally fixed with two 4.5-mm Kirschner wires. Once overall alignment is deemed to be satisfactory, 3 Acumed 5.5-mm cannulated screws are placed in bicortical fashion with lag technique (Acumed, Hillsboro, OR). After the screws are in place, appropriate alignment and fixation is confirmed under fluoroscopy. The knee is reduced and placed through several trials of flexion and extension to verify excellent alignment and congruency of the components. The indications and contraindications associated with this technique are listed in Table 1, and pearls and pitfalls are shown in Table 2.

Rehabilitation

The patient is placed into a hinged knee brace locked in extension for 6 weeks following surgery. The first 2 weeks after surgery the patient is partial weight bearing and progressed to full weight-bearing at the end of 6 weeks. A continuous passive motion device is used and range of motion is progressed from 0 to 45° the first 2 weeks then progressed to 90° by 6 weeks. Starting on postoperative day 1, patellar tendon mobilizations, quadriceps reactivations, and hip abduction/extension are emphasized. At week 6, phase 2 of the rehabilitation begins with progressive range of motion and early strengthening that focuses on closed chain exercises and vastus medialis oblique function. At this point, we encourage normalizing gait, beginning the stationary bike, as well as a pool therapy program. Over the next 6 weeks, we increase intensity on all of these modalities to our final goal of full range of motion while transitioning to the third phase, which

Table 2. Pearls and Pitfalls

Pearls	Pitfalls
Addressing the patellar replacement first ensures that the implant is positioned in the correct alignment after the osteotomy	Sizing of the trochlea is important to reproduce the radius of curvature as well as proximal coverage
When sizing the patella, it is important to restore the native thickness to not overstuff the joint	Too much distalization can lead to patella baja
Adequate exposure of the patellar tendon and protection is important to protect from iatrogenic injury	After final fixation, it is important to trial the component through full flexion and extension to ensure appropriate alignment with no instability
Following a progressive weight-bearing protocol with a hinged knee brace is important to allow the osteotomy to heal while also increasing range of motion in a controlled fashion	

focuses mainly on strengthening. At week 20, the patient can begin a gentle jog or running program if desired. A return to full activities is dependent on each patient’s goals but typically is seen around 24 weeks. During the postoperative course, radiographs are obtained at the 2-week, 6-week, and 12-week clinic appointments.

Discussion

Patients with isolated severe patellofemoral arthritis with chronic maltracking may benefit from a tibial tubercle osteotomy in conjunction with a PFA. Many of these patients are young and have severe symptoms but are not ideal candidates for a TKA. Improving the biomechanical environment for these patients may improve overall outcomes and limit complications associated with residual coronal plane maltracking. Evaluating these patients with a careful history and physical examination can aid in preoperative planning by determining the reason for their isolated arthritis along with signs of deformity seen on examination. Once it has been established that the pathology is localized to the patellofemoral joint, but there is concern for underlying maltracking, a computed tomography or magnetic resonance imaging scan is obtained. Computed tomography/magnetic resonance imaging can help to determine whether there is an elevated TT-TG, patella alta, and also is helpful to evaluate the medial and lateral compartments. For these patients, our goal is to restore the TT-TG to within a normal value of <10 mm as well as to ensure that there is no patella alta (Caton–Deschamps <1.2).

Historically, evidence of patellar maltracking has been a relative contraindication for a patellofemoral replacement. Some have hypothesized that unaddressed malalignment can serve as a factor for some of the poor outcomes that have been seen in a subset of these arthroplasty patients. Although replacement has demonstrated improved survivorship with newer designs, survivorship has not shown equivalence with total knee replacement. Improving the tracking of the patella has been postulated as a potential intervention

to improve overall outcomes and survivorship for patellofemoral replacements. By optimizing the underlying biomechanical environment and improving alignment, we believe there can be improved outcomes in this subset of patients. There is a very selective group of patients who fit the inclusion criteria for PFA with a tibial tubercle osteotomy. Ideally, this procedure is for patients that are too young for a TKA who have severe end-stage isolated patellofemoral arthritis with a maltracking patella.

Patients who present with the combination of patellofemoral maltracking with isolated patellofemoral arthritis are a relatively rare combination. Due to the historically greater failure rate of PFA when compared with TKA, it is not recommended to perform the combination of a tibial tubercle osteotomy with a PFA without extensive experience with both of these procedures.⁹ Risks involved with this surgery include the following but are not limited to infection, arthrofibrosis, tibial tubercle nonunion, residual patellofemoral maltracking as well as dislocation, and progression of arthritis in the tibiofemoral joint leading to revision TKA.

In conclusion, treating a patient with isolated patellofemoral arthritis with deformity can be a challenging condition to treat with multiple variables that may affect the overall outcome. By addressing the underlying patellofemoral malalignment with a tibial tubercle osteotomy, there may be improved biomechanics for patellofemoral replacement and restoration of the patellofemoral joint to a more anatomic alignment.

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