Patellar MACI With Tibial Tubercle Osteotomy

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Background: Chondral pathology is frequently encountered during knee arthroscopies with a prevalence rate of 63% to 66%. Prior studies have demonstrated that unaddressed or excised fragments result in poor knee function and arthritis. As a result, chondral-related procedures have increased in popularity, and now more than 200,000 procedures are performed annually.

Indications: We present a case of an active 32-year-old woman, prior collegiate basketball player, with persistent left knee pain noted to have a full-thickness patellar articular cartilage defect and maltracking.

Technique: A patellar autologous matrix-induced chondrocyte is implanted with a concomitant tibial tubercle osteotomy (TTO) and lateral retinacular lengthening.

Results: At 9 weeks, the patient had no knee pain with full range of motion symmetric to the contralateral side while slowly progressing with quadriceps strengthening.

Discussion/Conclusion: Successful outcomes addressing large patellar chondral defects and maltracking can be achieved with matrix autologous chondrocyte implantation and concomitant TTO with lateral retinacular lengthening.

Keywords: MACI; patellar; articular cartilage; knee; autologous chondrocyte implantation

VIDEO TRANSCRIPT

Patellar MACI with Tibial Tubercle Osteotomy (TTO) presented by Dr John Matthews and co-authors Ryan Paul and Dr Kevin Freedman.

None of the authors have a disclosure to mention.

Chondral lesions can result from trauma, dislocations, and overuse, as well as osteochondritis dissecans and genetic or development abnormalities. Once damaged, articular cartilage has very limited capacity to heal due to its poor vascularity. Chondral pathology is frequently encountered during knee arthroscopies with a prevalence rate of 63% to 66%. Prior studies have demonstrated unaddressed or excised fragments can result in poor knee function and arthritis. As a result, chondral-related procedures have increased in popularity.

Articular cartilage lesions can result in pain, mechanical symptoms such as locking or catching, as well as recurrent effusions. Initial work-up should include weight-bearing anteroposterior and lateral radiographic view of the knee and Merchant and Rosenberg views. If there is any question regarding overall limb alignment, a full standing film is also obtained. A magnetic resonance imaging (MRI) should be obtained to visualize the lesion and evaluate for concomitant pathology. On rare circumstances, imaging studies may not reveal a clear lesion, but based on high clinical suspicion a diagnostic arthroscopy can be performed.

Treatment options include palliative for lesions <2 cm^2, reparative for lesions 2 to 4 cm^2, or restorative for larger lesions. Ultimately, treatment selection depends on lesion characteristics such as size, location, the presence of concomitant pathology, and overall host factors such as age and activity level.

Autologous chondrocyte implantation (ACI) is a 2-stage procedure, with the first entailing chondrocyte harvest which are then expanded in vitro. Typically, 5 to 9 weeks later, the chondrocytes are reimplanted into the host. There are 3 generations of ACI techniques, with matrix autologous chondrocyte implantation (MACI) currently the preferred method, since it avoids the pitfalls of patch hypertrophy encountered in the first generation and cell leakage with the second.

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When addressing patellar defects, we prefer MACI to osteochondral allografting because it has demonstrated superior outcomes. There are several unique factors to consider with patellar lesions, including malalignment and lesion location. We recommend performing a concomitant anteromedialization of the tibial tubercle to protect the implant by decreasing patellofemoral contact pressures. A prior systematic review demonstrated superior outcomes when this was performed in conjunction to ACI as opposed to ACI alone for patellar lesions.

For this case, the patient was an active 32-year-old woman, prior collegiate basketball player, who presented with persistent left knee pain despite an extensive nonoperative management.

On examination, she was 5′4″, 145 pounds. Visual inspection of the knee demonstrated a trace effusion and lateral patellar tilt with neutral alignment. She had pain with patellar grind and crepitation with range of motion (ROM). Her knee was stable to ligamentous examination.

Plain radiographs were obtained and demonstrated a neutral alignment with well-maintained joint spaces. She did have a small lateral patellar osteophyte.

An axial T2 MRI demonstrated full-thickness cartilage defect along the lateral patellar facet with small subchondral cystic changes, as well as focal cartilage loss and edema in the opposing lateral trochlea. The sagittal and coronal T2 MRI demonstrated similar findings with edema along the inferior/lateral pole of the patellar and lateral trochlea.

Surgical intervention was recommended for this patient due to her age, activity level, defect characteristics, and failed nonoperative management.

The first stage arthroscopy was performed, which demonstrated a full-thickness defect in the lateral patellar facet with extension to the ridge measuring approximately 2 cm $\times$ 1.5 cm as well as grade 3 chondral changes in the trochlea seen in the top 2 images. The patellar was also noted to track laterally on the bottom left image. The bottom right image demonstrates the lateral aspect of the femoral notch after the chondrocytes were harvested. For harvesting, a gauge is used along the medial and lateral margins of the intercondylar notch. Care should be taken to avoid skiving onto the weight-bearing surface when performing the harvest. The reimplantation procedure was scheduled for 8 weeks later.

The patient was taken to the operating room and positioned supine. The operative limb was exsanguinated and tourniquet inflated and then positioned in a surgical leg holder. The medial and lateral aspects of the patellar and tibial tubercle were marked, and a midline knee incision was made. The subcutaneous tissue was then cut down to patellar paratenon and skin flaps were created. Hemostasis was achieved with the use of electrocautery.

The medial and lateral aspects of the patellar tendon were then identified. Next, the anterior lateral compartment was identified and the proximal aspect of the fascia was incised with a scapel. A Cobb Spinal Elevator (Novo Surgical Inc.; Oak Brook, IL) was used to elevate the underlying musculature off the anterior-lateral tibia until the tibial metaphysis was exposed and a hooked retractor placed along the posterior aspect of the tibia.

Following this, an arthrotomy was performed lateral to the patellar tendon, and the underlying fat pad was excised. The patellar tendon was then mobilized off of the fat pad to fully visualize the insertion site and proximal tibia.

An arthrotomy along the medial aspect of the patellar tendon was then performed and any exposed fat pad removed prior to placement of a “Z” retractor. At this point, the patellar tendon should be fully exposed and the proximal aspect of the tibia visualized prior to placement of the cutting guide.

The external guide was then positioned to perform an anteromedialization of the tibial tubercle. The distal hole was drilled bicortically and a pin placed. It is important to evaluate the trajectory of the drill bit to ensure the exit point is posterior lateral into the retractor. Next, the proximal hole was drilled bicortically setting the slope of the osteotomy. The slope can be adjusted more vertically if there is normal patella tracking to purely unload the graft or a lower angle to both anteriorize and medialize to address patellar maltracking. All the subsequent holes were then drilled bicortically, making sure they all exited anterior to the lateral retractor. A saw was then used to connect the pilot holes along the osteotomy site, and then the external guide was removed.

An osteotome was then used to complete the osteotomy distally, as well as proximally and finally laterally. This completed the tibial tubercle osteotomy and allowed for easy anterior/medial translation.

The lateral arthrotomy was extended proximally to expose the patellar defect. The lateral retinaculum was carefully elevated off the lateral joint capsule to allow for a lengthening repair at closure. Following this, the lateral joint capsule and arthrotomy are extended proximally for easier patellar eversion.

After this was performed, the patella is everted and any remaining distal bands are cut. The defect rim is sharply dissected with a scapel until a healthy rim of cartilage tissue is present. The base is prepared using a ringed curette. A burr can also be used to remove any sclerotic bone taking care not to violate the subchondral surface. Next, the defect is sized. The trochlea was also evaluated and noted to have grade 2 chondral changes with no full-thickness defects and thus did not require treatment.

We use the tissue paper from a glove pressed into the defect and outlined with a marking pen because it is easier to contour as opposed to the aluminum foil. The cut sterile glove paper is then placed on the aluminum foil from a suture package and held firmly in place to be cut to match the template. We do mark the aluminum foil with a “p” to represent the proper orientation for proximal location. The foil is then placed into the defect and any final cuts to obtain a perfect template are made.

The wound is then irrigated and tourniquet deflated. Thrombin gel foam is placed into the defect and held firmly in place for several minutes to achieve hemostasis.

During this time, the matrix chondrocyte is prepared. It is important to note the location of the cells. With the notch facing the bottom left, the cells are known to be facing up. The pre-cut template foil is then placed over the top of the and membrane and cut to match. Using this technique, it is

easy to remember the cells are facing the yellow side of the template foil.

Once this is completed and hemostasis obtained, the fibrin sealant is applied into the defect. The chondrocyte matrix is then placed into the defect taking care to note the cell should be facing the subchondral bone to allow for integration. The membrane position is adjusted to completely fill the defect and gently pressed down to the defect floor using a dry peanut. The fibrin sealant is reapplied to the membrane and allowed to dry for 3 minutes. If there is any concern regarding implant stability, 6-0 Vicryl suture (Ethicon, Inc.; Cincinnati, OH) can be used to attach the membrane to the associated cartilage, which is demonstrated here. This is followed by one more application of fibrin sealant.

The tibial tubercle osteotomy is then reduced and held in place while the knee is gently flexed and extended to ensure implant stability. The patella is then re-everted and the membrane reinspected visually to ensure it is stable and has not migrate during knee cycling.

Next, the tibial tubercle is reduced and translated anteromedially approximately 1 cm. Electrocautery is used to mark the location of the 3 fully threaded screws and remove the overlying periosteum. The most proximal screw hole is drilled bicortically with a 2.5 drill bit, paying particular attention to avoid overdrilling and injury to the neurovascular structures. The 2.5 drill bit is left in place to prevent rotation of the osteotomy, while the second drill hole is performed.

After the second hole is drilled, a depth gauge is used to measure the appropriate screw size. Prior to screw placement, a 3.5 drill bit is used to overdrill the anterior cortex and allow for a lag technique. Gentle counter sunk is also performed. The screw is then placed and noted to have great purchase. The same steps are repeated for the remaining screws.

Once all 3 screws are placed, the knee is flexed and extended to ensure adequate fixation of the tibial tubercle, and a lateral intraoperative fluoroscopy image is taken.

The anterior-lateral compartment is then pie-crusted to allow for a tension-free closure. The wound is then thoroughly irrigated and appropriate hemostasis obtained. The lateral lengthening procedure is then closed. This is done using a #1 Vicryl in a running fashion that also closes the lateral arthrotomy. After this is closed, the anterior-lateral fascia is closed using #1 Vicryl in an interrupted figure 8 fashion. Once again, after all the compartments are closed, the wound is irrigated and hemostasis obtained. The subcutaneous tissue is then closed using interrupted 2-0 Vicryl. After this is done, the skin is then closed with a running 3-0 Monocryl (Ethicon Inc.; Cincinnati, OH). Dermabond (Ethicon Inc.; Cincinnati, OH) is applied followed by dry dressing.

The operative limb is then placed in an ACE wrap (3M; St. Paul, MN) and in ROM knee brace locked in extension.

Postoperatively, the patient is non-weight-bearing for 6 weeks and the brace is locked in extension when upright. Passive ROM from 0 to 90° is allowed when supine.

After 6 weeks, weight-bearing is progressed as tolerated and brace discontinued at 8 weeks.

Jogging is allowed at 6 months, and most patients return to sport by 9 months.

Outcomes following MACI have demonstrated favorable results, with majority patients being satisfied with their ability to return to daily activities and sport, which lasts over 5 years.

Treatment failure is fairly low; however, up to 11% of patients may require a subsequent procedure.

These are the references.

Thank you.

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