Surgical Technique: Autologous Osteochondral Grafting for Capitellar Osteochondritis Dissecans

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Introduction

As participation in youth sports continues to increase, so too does the incidence of overuse injuries of the elbow.[1,2] Most commonly seen in young throwers and gymnasts, osteochondritis dissecans (OCD) of the capitellum is one condition that may result from repetitive compressive and shear forces across the elbow.[3,4] Repetitive microtrauma to the developing capitellum during throwing, overhead, or upper extremity weight-bearing activities may result in subchondral bone necrosis, articular cartilage failure, and ultimately loose body formation. Given that the natural history of the condition is one of progressive impairment and joint degeneration, efforts have been made to improve both nonoperative and surgical management of capitellar OCD.[5,6] An operative technique that has been increasingly utilized is osteochondral autologous transplantation surgery or OATS.

Clinical Evaluation

Over 90% of patients with OCD of the elbow present with lateral elbow pain and often have a long history of throwing or overhead weight-bearing activity.[3,7] Importantly, mechanical symptoms such as locking, catching, or giving way may be reported in the setting of osteochondral fragment instability or loose body formation.

Careful examination of the affected elbow will reveal that the location of elbow pain is at the capitellum and not in other structures. In any young throwing or overhead athlete presenting with lateral elbow pain, it is imperative that specific palpation of the capitellum be performed via hyperflexion of the elbow (Figure 1). Cursory palpation of the lateral aspect of the elbow may miss this characteristic tenderness. Evaluation of both elbow and forearm range of motion should be performed, with flexion contractures of greater than 20° suggestive of more advanced OCD.[8] Importantly, concomitant pathology in other elements of the kinetic chain, such as glenohumeral internal rotation deficiency (GIRD), should be identified via a thorough upper limb examination.

Figure 1*. Direct palpation of the capitellum via hyperflexion of the elbow*
Images courtesy of Children's Orthopedic Surgery Foundation

Plain radiographs, including anteroposterior (AP) and lateral views of the elbow, should be obtained in young athletes with elbow pain and reproducible capitellar tenderness (Figure 2). Flexion oblique views of the elbow may also be useful to bring the OCD lesion into profile.[8] In advanced disease, radiographs may reveal lucent areas within the capitellum as well as unstable in

situ lesions or intra-articular loose bodies. Additionally, these studies provide important information about physeal status and may rule out other bony sources of elbow pain. While radiographs provide helpful diagnostic information, magnetic resonance imaging (MRI) is the imaging modality of choice and provides a superior ability to characterize OCD lesions and guide treatment. Images should be carefully inspected for OCD size, location, articular cartilage integrity, and status of subchondral bone. Axial, coronal, and sagittal reconstructions are all utilized to identify possible loose bodies and characterize the OCD location and containment. T2-weighted sequences are particularly useful when assessing for articular cartilage breech and fragment instability, as fluid may easily be visualized tracking behind the affected area. However, T2-weighted sequences may overestimate the area of subchondral bone involvement; for these reasons, we also utilize double echo steady state (DESS) or multi-echo in steady-state acquisition (MENSA) sequences to more accurately quantify the amount of bony disease.

Nelson MRI Classification of OCD	
0	Normal
1	Intact articular cartilage; subchondral signal changes
2	Breech in articular cartilage; non-displaced fragment
3	Thin, high-signal rim behind OCD fragment (unstable in situ); attached by flap of articular cartilage
4	Displaced intra-articular loose body

Table 1*. Nelson classification of osteochondritis dissecans*

Classification

Several classification systems have been developed for elbow OCD. Most attempt to characterize articular cartilage integrity and fragment stability, with the intention of providing prognostic information and guiding treatment. The authors' preference is to utilize the ICRS and Nelson classification schemes (Table 1).[9,10]

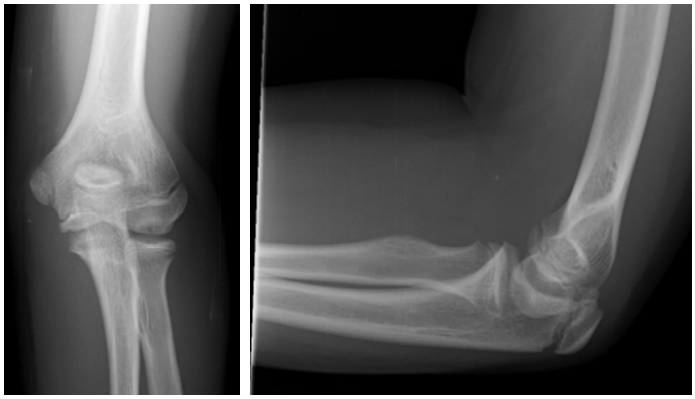

Figure 2. *AP and lateral radiographs of the elbow demonstrating areas of capitellar lucency consistent with osteochondritis dissecans*

Treatment

A host of nonoperative and surgical options are available for the treatment of capitellar OCD. All these methods aim to facilitate subchondral bone healing, preservation of articular congruity and joint stability, resolution of pain, and return to activities. Nonoperative treatment consists of rest and cessation of throwing, or avoidance of functional loading of the elbow. These strategies may be effective for intact, stable OCD lesions in which the articular surface is preserved and without fragment instability.

Operative intervention is indicated for continued pain and functional limitation in the setting of unstable OCD lesions, and in those who fail nonoperative treatment. Several surgical techniques are utilized, including drilling, microfracture, fixation, and osteochondral grafting.[11-17] The choice of procedure must be individualized based on clinical and radiographic findings, patient expectations, and surgeon comfort with available techniques. Osteochondral grafting via the OATS procedure replaces diseased bone and cartilage in the elbow with healthy tissue taken from a less important donor site, such as the non-weight bearing portion of the lateral femoral condyle. For larger, deeper, and/or laterally uncontained lesions, early reports suggest that OATS may provide superior outcomes when compared to other techniques, despite the need for an invasive procedure.[18-21]

Authors' Preferred Surgical Technique

Preoperatively, elbow radiographs and MRI images should be carefully reviewed to characterize the OCD lesion and to identify the presence and location of any loose bodies. Knee radiographs are not routinely obtained, as the donor plug is harvested under direct visualization distal to the femoral physis and superior to the weight-bearing surface of the condyle; generally, more distal graft harvest is preferred in skeletally immature patients to avoid iatrogenic injury to the distal femoral physis.

The procedure is performed with the patient in the supine position to facilitate exposure of both the affected elbow and the ipsilateral knee (Figure 3). Standard small joint arthroscopy equipment and commercially available systems for cylindrical osteochondral graft harvest and recipient site preparation are utilized. Intra-operative fluoroscopy is not required. Diagnostic arthroscopy is performed in the standard fashion, allowing for direct assessment of the capitellum and removal of any loose bodies. Grafting may also be performed arthroscopically, but the authors' preference is to perform it via open arthrotomy.[8,22,23]

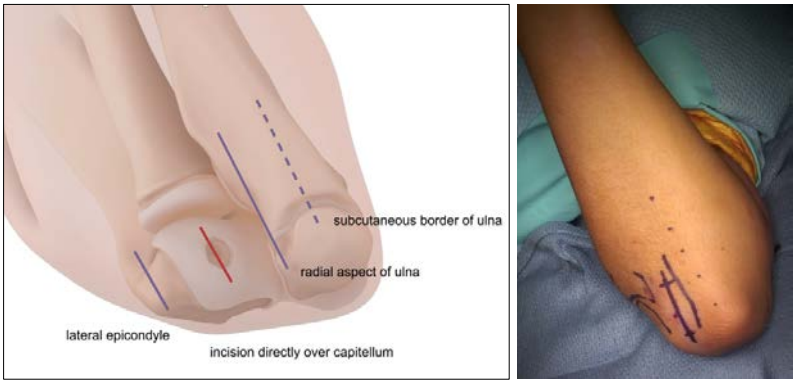

Figure 4. *Incision over the capitellum*

Following arthroscopic survey and loose body removal, the affected upper limb is taken out of overhead traction, and the elbow is placed in hyperflexion. Under tourniquet control, a longitudinal or oblique incision is created directly over the capitellum (Figure 4). In line with the skin incision, the anconeus fascia is incised, and the anconeus muscle fibers are spread bluntly and retracted. The joint capsule is then carefully incised

Figure 3. *Patient positioning and operating room setup allowing for access to the affected elbow and ipsilateral knee. A mobile arm board allows for easy conversion from arthroscopy to arthrotomy.*

under direct inspection, providing direct exposure of the affected capitellar articular surface (Figure 5).

Under direct visualization and with reference to preoperative imaging, the OCD lesion is inspected and sized. In cases in which loose body removal is performed, the dimensions of the osteochondral defect are more easily identified. With in-situ lesions, careful probing is necessary to identify the transition from injured to healthy tissue. Once the extent of the OCD lesion is characterized, a cylindrical core of unhealthy cartilage and subchondral bone is removed using an appropriately sized cylindrical chisel (Recipient Harvester, OATS Single Use Kit, Arthrex Inc., Naples, FL). This core typically measures 10mm in diameter and 10mm to 12mm in depth. Care is taken to avoid lateral or posterior cortical breakout, while also preparing the recipient site with enough depth to remove all diseased subchondral bone. This can be challenging, particularly when the OCD lesion is located on the lateral capitellum.[24] To minimize risk of lateral wall breakout, the recipient site may be created in an oblique orientation from distal and lateral to medial and proximal within the capitellum.[25] Although OATS has been performed using a mosaicplasty technique, the authors' preference is to use a single large osteochondral graft. Prior studies have demonstrated adequate anatomic restoration with a single plug.[26] While theoretically appealing, creating a

stable and smooth articular surface using multiple smaller grafts may be technically challenging.

Following recipient site preparation, attention is turned to the donor site on the ipsilateral knee. Under tourniquet control, the osteochondral graft can be quickly and easily obtained from the lateral femoral condyle via a small lateral parapatellar arthrotomy. Given the location of the distal femoral physis in skeletally immature patients, care is taken to harvest the plug distally while also remaining superior to the sulcus terminalis and the

Figure 5. *Exposure of the capitellum via elbow arthrotomy*

weight-bearing portion of the lateral condyle (Figure 6). A size appropriate chisel is oriented on the articular surface to match the contour of the recipient site, and an osteochondral plug is obtained (Donor Harvester, OATS Single Use Kit, Arthrex, Inc., Naples, FL). If an obliquely oriented donor site was created, the plug should be obtained at an angle to match that of the capitellar recipient site.[25] After a successful plug harvest, the knee wound is closed in layers, the tourniquet is deflated, and a sterile bandage is applied.

The donor osteochondral graft is then brought to the elbow within the harvester and gently press fit into the previously prepared recipient site. Care is taken to preserve alignment with the cylindrical recipient site to restore a congruent articular surface. Direct visualization and palpation can confirm that the donor plug is flush with the surrounding articular surface (Figure 7). The elbow is then ranged to confirm full flexion-extension and forearm rotation can be achieved without graft instability or joint crepitus. Following wound closure, a sterile bandage and long-arm bivalved cast are applied.

The cast is removed 2 weeks postoperatively, and a gentle elbow range of motion is initiated. Protected range of motion is advanced gradually until 6 weeks postoperatively, at which point physical therapy is initiated for continued range of motion advancement and light isometric arm strengthening. Additional therapy is directed toward optimizing all elements of the kinetic chain via posterior capsular stretching as well as periscapular and cuff stretching of the throwing shoulder. Knee issues are uncommon; supervised therapy may be initiated if issues arise.[18, 27] As current literature suggests that complete healing of the implanted plug does not occur for up to 6 months postoperatively, it is the authors' preference to initiate an interval throwing program and a gradual return to sport at this 6-month milestone.[28] New research has shown that MRI-based quantitative evaluation tools appear to correlate with early clinical function and may be useful in guiding activity progression.[29]

Results

Reports of patient outcomes following operative treatment for capitellar OCD have demonstrated encouraging results after OATS. One recent meta-analysis compiled 24 studies on surgical treatment of elbow OCD.[20] This collection of 492 patients of mean age 14.3 years demonstrated that OATS had a significantly higher ($p<0.01$) rate of return to primary sport participation (94%) when compared to fixation (64%) and microfracture and debridement (71%). These measures are consistent with a second systematic review of OATS literature that also noted a 94% rate of return to primary sports, and also with the authors' own experience.[16,17,19,21,30] Longer-term results of various treatment options, including OATS, remain sparse;

further prospective longitudinal studies will help identify optimal surgical options for capitellar OCD.

Complications

Complications from OATS are rare, though early graft failure due to suboptimal plug placement is possible. Biomechanical studies have described increased contact pressures and strain when plugs are left as little as 0.5mm to 1mm proud.[31,32] Suboptimal graft placement may lead to pain, limitations in elbow range of motion, and early failure. Therefore, it is critical to ensure that the plug is press-fit flush to the adjacent cartilage.

During recipient site preparation, surgeons must also ensure that all abnormal bone is replaced. Failure to do so may result in persistent disease around the margin of the graft. Careful preoperative planning and radiographic evaluation, along with thorough intra-operative inspection, can minimize the risk of this outcome.

Long-term, one of the most dreaded sequelae of capitellar OCD is continued degenerative changes of the radiocapitellar joint. Persistent radiocapitellar incongruity can lead to radial head enlargement, joint instability, and arthrosis. Although osteochondral grafting theoretically restores subchondral bone and articular cartilage, longer-term data regarding graft longevity and durability, particularly in young growing athletes, remains sparse.

Figure 7*. Osteochondral graft press-fit flush with the surrounding articular surface of the capitellum*

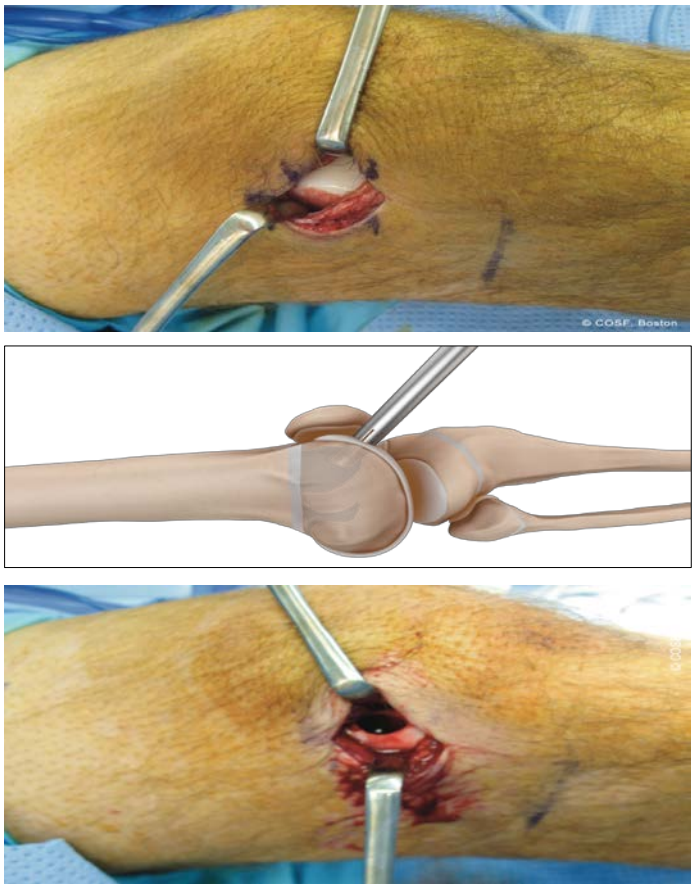

Figure 6. *Graft harvest from the lateral femoral condyle*

Conclusion

In conjunction with careful patient selection and meticulous surgical technique, OATS can provide superior healing and return to sports rates compared to other surgical techniques. Despite favorable short-term results, further investigation with longer-term follow-up and patient-reported outcomes is needed to better understand long term surgical results and functional measures. A multicenter prospective registry is currently underway to help address these and other unresolved questions. With the information collected through such studies, we will be able to gain a more comprehensive understanding of optimal treatment strategies for capitellar OCD.

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