Technical Note

Fresh Precut Osteochondral Allograft Core Transplantation for the Treatment of Capitellum Osteochondritis Dissecans

Sagar Chawla, M.D., M.P.H., and Michael G. Saper, D.O., A.T.C., C.S.C.S.

Abstract: Osteochondritis dissecans (OCD) of the elbow is a disease of unclear etiology that affects young children and adolescents, particularly overhead athletes and gymnasts. Common surgical options include fixation, debridement, loose body removal, and marrow stimulation (microfracture/drilling). For large, deep, and/or uncontained defects, osteochondral autograft transplantation (OAT) has been advocated. However, there are some drawbacks to OAT, particularly related to donor-site morbidity. Fresh osteochondral allograft (OCA) transplantation avoids the donor-site morbidity associated with OAT and has been shown to be effective for treating capitellar OCD. This Technical Note details a surgical technique of OCA transplantation of the capitellum in an adolescent patient using a fresh precut OCA core. This procedure addresses the cartilage defect and loss of subchondral bone associated with OCD without the drawbacks associated with harvesting an autograft. Furthermore, as the graft is readily available, it avoids delays related to the donor—recipient matching process.

Osteochondritis dissecans (OCD) is a disorder in which a segment of articular cartilage loses the support of the underlying subchondral bone.[1] In the elbow, OCD most commonly involves the capitellum, and while unclear, its underlying cause is likely multifactorial, including ischemia, repetitive trauma secondary to valgus and axial loading, and altered biomechanics.[2] As such, it primarily affects young overhead athletes, with the greatest incidence in adolescent baseball players and gymnasts.[3-5]

Current management of symptomatic capitellar OCD is primarily based on lesion stability, size, and location.[6] Common surgical options include fixation, debridement, loose body removal, marrow stimulation (microfracture/drilling), and osteochondral autograft transplantation (OAT).[2,7] For large, deep, uncontained defects, restorative techniques such as OAT have been advocated. OAT harvests a cylindrical segment of non—weight-bearing articular cartilage and bone, typically from the superolateral lateral femoral condyle or costal cartilage.[8-11] The primary advantage of the procedure is that it uses native hyaline cartilage and re-establishes the subchondral bone stock.[12] Single-plug OAT has been shown to be an effective treatment option for adolescents with unstable OCD lesions of the capitellum.[8]

However, there are some drawbacks to OAT, particularly related to the donor site and postoperative rehabilitation. In a systematic review and meta-analysis, Bexkens et al.[13] reported donor-site morbidity in 7.8% of patients with a femoral condyle harvest site. Fresh osteochondral allograft (OCA) transplantation avoids the donor-site morbidity associated with OAT and has been shown to be effective for treating capitellar OCD.[14] However, the use of fresh OCAs is limited by the availability for donor allograft.[15]

This Technical Note details our surgical approach for large and/or uncontained capitellar OCD lesions using a fresh precut OCA core (JRF Ortho, Centennial, CO). This single-stage procedure allows for restoration of the subchondral bone and hyaline cartilage using a single press-fit osteochondral plug. Further, it avoids the donor-site morbidity of OAT and, as the precut cores

From the Department of Orthopaedics and Sports Medicine, University of Washington (S.C., M.G.S.) and Department of Orthopedics and Sports Medicine, Seattle Children's (M.G.S.), Seattle, Washington, U.S.A.

The authors report the following potential conflicts of interest or sources of funding: M.G.S. receives research support from Arthrex Inc., outside the submitted work. Full ICMJE author disclosure forms are available for this article online, as supplementary material.

Received December 28, 2019; accepted February 13, 2020.

Address correspondence to Michael G. Saper, D.O., A.T.C., C.S.C.S., 4800 Sand Point Way NE, Seattle, WA 98105. E-mail: Michael.Saper@seattlechildrens.org

2212-6287/2012
https://doi.org/10.1016/j.eats.2020.02.012

Table 1. Advantages and Disadvantages

Advantages	
•	Can treat large defects ≥1 cm in diameter
•	Can treat uncontained defects
•	Can treat defects with significant loss of subchondral bone
•	Avoids donor-site morbidity and time associated with graft harvest
•	Avoiding costs and delays related to the donor−recipient matching process for fresh distal humerus allografts
•	Uses existing OAT instrumentation
•	Anconeus splitting approach avoids iatrogenic injury to the lateral collateral ligament complex, which can lead to posterolateral instability
Disadvantages	
•	Cost of fresh precut OCA core
•	Stored OCA cores have a limited shelf life
•	Defect−OCA size mismatch; fresh OCA cores come precut in
•	10-mm or 16-mm diameters

OAT, osteochondral autograft transplantation; OCA, osteochondral allograft.

are readily available, it avoids delays related to the donor-recipient matching process.

Surgical Technique (With Video Illustration)

A demonstration of the technique in the left elbow of a 12-year-old girl is provided in Video 1. The advantages and disadvantages of the procedure are presented in Table 1. The indications, pearls, and pitfalls are summarized in Table 2.

Patient Positioning and Preparation

After general anesthesia is administered, the patient receives a single-shot supraclavicular nerve block using a low concentration of 0.2% ropivicaine to best achieve a motor-sparing effect. A single preoperative dose of antibiotic is given for infection prophylaxis. The patient is positioned supine and an examination under anesthesia is performed to assess elbow stability, range of motion (ROM) of the operative and nonoperative limbs, and identify any ulnar nerve subluxation. A swinging arm board is placed at the hip and can be swung intraoperatively to support the limb in hyperflexion once the arthroscopy is completed. A nonsterile tourniquet is placed high on the arm and set at 200 mm Hg. The operative extremity is prepped and draped in standard sterile fashion and then secured using the Trimano arm positioner (Arthrex, Naples, FL) (Fig 1).

Table 2. Indications, Pearls, and Pitfalls

Indications
1. Failed previous surgery (fixation, debridement, marrow stimulation, osteochondral autograft transplantation)
2. Unstable capitellum OCD lesions (uncontained defects, defects ≥1 cm in diameter, significant bone involvement)
Pearls
1. Elbow arthroscopy in the supine position facilitates ease of anesthesia and conversion to arthrotomy
2. Trimano arm positioner maintains elbow position while avoiding overhead traction suspension with weights
3. A swinging arm board placed at the hip can be swung intraoperatively to support the limb in hyperflexion once the arthroscopy is completed
Pitfalls
1. Be sure to place the alignment rod perpendicular to the defect prior to inserting the guide pin; failure to do so may lead to irregularity at the articular surface
2. Avoid aggressive manual impaction of the graft with a tamp, which can hinder chondrocyte viability
3. Prolonged postoperative immobilization and excessive loading of the graft prior to incorporation

OCD, osteochondritis dissecans.

Fig 1. Arthroscopy is performed with the patient supine and the operative extremity (left elbow) secured using the Trimano arm positioner.

Procedure

Anatomic structures and landmarks about the elbow including the ulnar nerve are marked with a sterile pen. An esmarch bandage is used to exsanguinate the extremity and the tourniquet is inflated. A spinal needle is placed in the olecranon fossa via the direct posterior portal and the elbow joint is insufflated with approximately 30 mL of normal saline. Another 18-guage needle is then placed into the joint via the anterolateral portal confirming intra-articular placement with the flow of saline out of the needle. A #15 blade is then used to incise the skin at the anterolateral portal, approximately 1 cm anterior and 2 cm proximal to the lateral epicondyle. Blunt direction is carried down to the capsule. Next a blunt trocar is introduced over the lateral condylar ridge of the humerus into the elbow joint. The anteromedial portal is established under direct vision with spinal needle localization anterior to the intermuscular septum, approximately 1 cm anterior

Fig 2. After arthroscopy, the operative extremity (left elbow; patient supine) is positioned in hyperflexion, and a 4- to 6-cm incision is marked from the lateral epicondyle (asterisk) to the ulnar border.

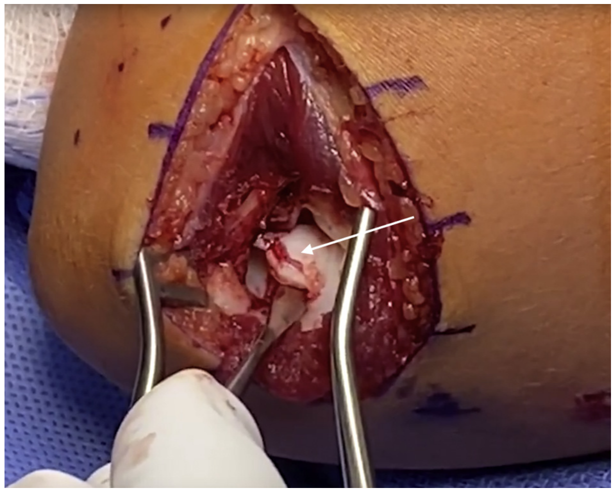

Fig 4. Synovium in the posterior compartment is resected sharply and the osteochondral defect (arrow) is encountered (left elbow; patient supine).

and 2 cm proximal to the medial epicondyle. A complete diagnostic arthroscopy of the anterior compartment is performed and intra-articular findings are addressed. Any loose bodies are removed, and a mechanical shaver may be used to perform a partial anterior synovectomy to eliminate possible impingement between the radial head and capitellum. Due to the planned arthrotomy through the anconeus, arthroscopy of the posterior compartment is not routinely performed.

After completion of the arthroscopic portion of the procedure, the patient's arm is removed from the Trimano. The elbow is positioned in hyperflexion. Depending on patient size, a 4- to 6-cm incision is marked from the lateral epicondyle to the ulnar border (Fig 2). Sharp dissection is carried down through skin to subcutaneous tissue. Bleeding is controlled with electrocautery. The fascia overlying the anconeus is identified and incised in line with the incision (Fig 3A). The anconeus is bluntly dissected to expose the capsule overlying the capitellum (Fig 3B). Blunt retractors are placed deeply, and the capsule is then incised in line with the incision. Synovium in the posterior compartment is resected sharply and the OCD lesion is encountered (Fig 4).

The loose osteochondral flap over the defect is removed with sharp dissection and the defect is measured to determine the size of graft needed. Most often, a fresh precut 10-mm OCA core is chosen. Next, the cannulated alignment rod (Arthrex) is placed perpendicular to the defect and a 2.4-mm guide pin is placed through the alignment rod into the capitellum (Fig 5A). A low-profile 10-mm reamer (Arthrex) is then passed over the guide pin to a depth of approximately 7-10 mm (Fig 5B). The pin is removed, and debris is removed. The 12 o-clock position of the socket is marked with a sterile pen. The depth of the socket is sized at the 3-, 6-, and 9-, and 12-o'clock positions. These marks are recorded for preparation of the graft. The 12 o-clock position of the graft is marked with a sterile pen to correspond to its recipient socket. It is then measured and sized to the appropriate lengths at the 3-, 6-, 9-, and 12-o'clock positions (Fig 6). The graft

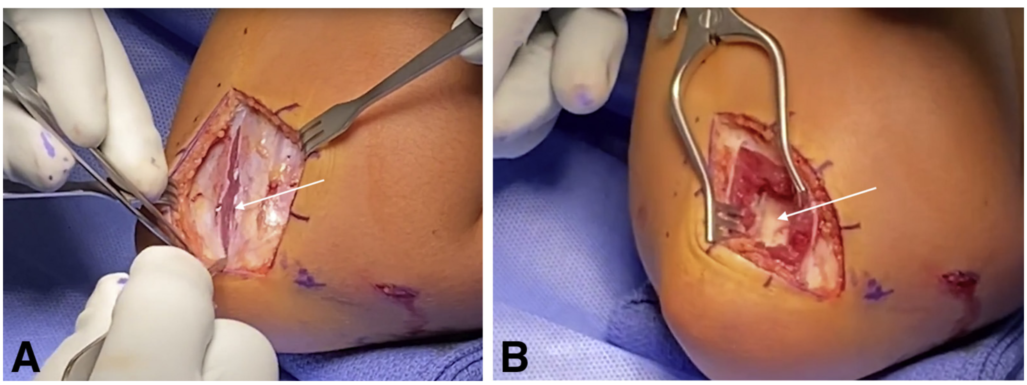

Fig 3. (A-B) Surgical approach in a left elbow with the patient supine. (A) The fascia overlying the anconeus (arrow) is identified and incised in line with the incision. (B) The anconeus is bluntly dissected to expose the capsule (arrow) overlying the capitellum.

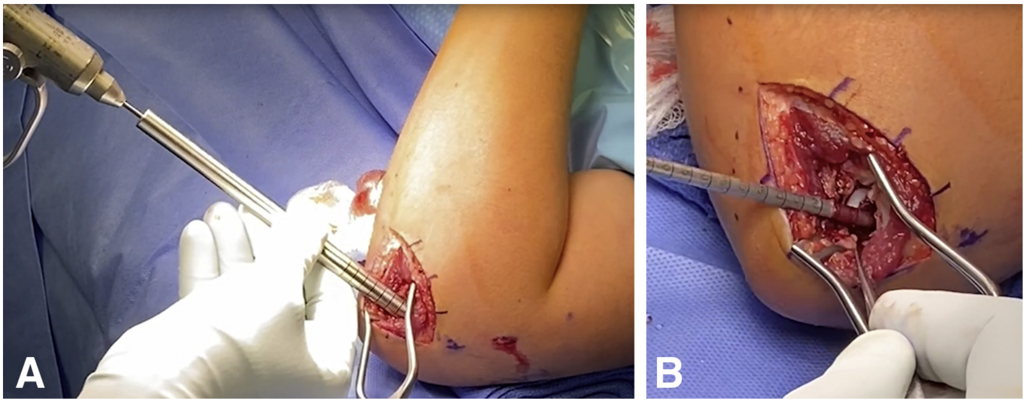

Fig 5. (A-B) Preparation of a 10-mm osteochondral defect (left elbow; patient supine). (A) The cannulated alignment rod is placed perpendicular to the defect and a 2.4-mm guide pin is placed through the alignment rod into the capitellum. (B) A low-profile 10-mm reamer is then passed over the guide pin to a depth of approximately 7 to 10 mm.

is then prepared by cleansing it of any remaining marrow elements using pulsed lavage. The graft is then placed into the socket using a press-fit technique. Gentle taps with a tamp can be performed to ensure the articular cartilage is flush with the surrounding cartilage (Fig 7). The elbow is then brought through a full ROM to ensure there is no impingement and the graft is flush.

Wounds are irrigated copiously, and the elbow is cleared of any loose debris. The capsule, fascial layer overlaying the anconeus, subcutaneous layer, and skin are all closed in standard fashion. A sterile dressing is applied and the arm is placed in a well-padded long arm plaster splint with the elbow flexed to approximately 80°.

Postoperative Protocol

Postoperative rehabilitation is carried out in a phased manner, progressing over a 4- to 9-month period depending on the sport and position. During the first phase (weeks 0-2 postoperatively), the patient remains immobilized in a splint at 80° for 7 to 10 days, allowing for initial healing and recovery from the soft tissue dissection. At this time, the patient is non-weight bearing to the operative extremity with a sling provided for comfort. During the second phase (weeks 2-6), the patient is transitioned to a hinged, unlocked brace and the patient initiates formal postoperative rehabilitation with a primary focus on regaining ROM. During the third phase (weeks 7-12 postoperatively), the brace is discontinued and light strengthening exercises are initiated. Phase 4 of rehabilitation (weeks 13-16 postoperatively) focuses on advanced strengthening and gradually loading the graft. The last phase (weeks 17 and beyond postoperatively) marks the initiation of push-ups, interval sport programs, and gradual return to competition.

Discussion

OCA offers a number of advantages that make it ideal for large, uncontained defects. A single graft can be

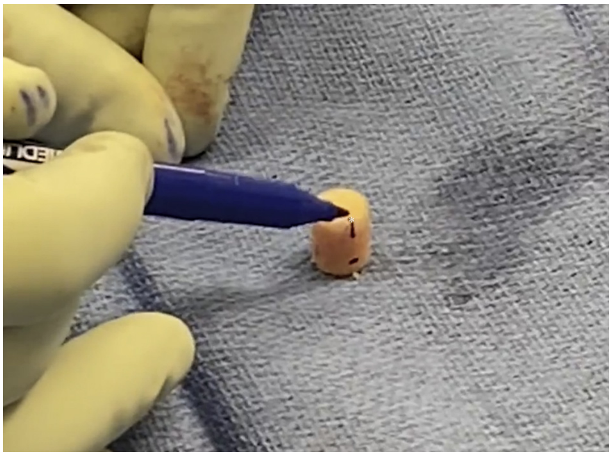

Fig 6. The fresh precut OCA core is measured and sized to the appropriate lengths at the 3-, 6-, 9-, and 12-o'clock (asterisk) positions. (OCA, osteochondral allograft.)

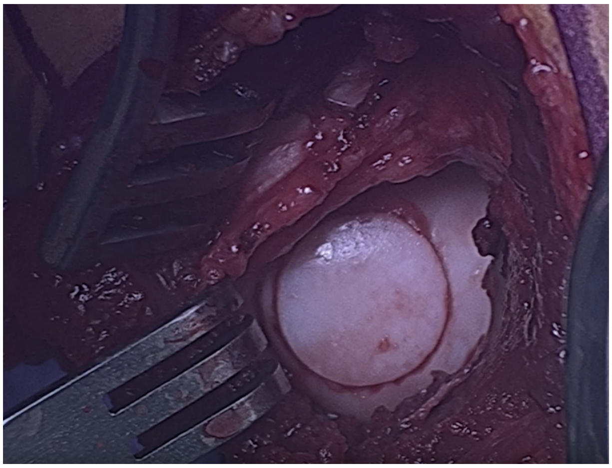

Fig 7. The graft is placed into the socket using a press-fit technique. The articular cartilage of the OCA is flush with the surrounding cartilage (left elbow; patient supine).

used to treated elongated defects, which have shown to be superior to multiple plugs.[16] As it contains subchondral bone, OCA also restores the bone loss, which may be present with large/deep osteochondral defects. In addition, the articular surface of hyaline cartilage can be restored in a single procedure.[15] Perhaps, the primary benefit of OCA as compared with autograft is the avoidance of donor-site morbidity required of OAT. In a systematic review and meta-analysis of OAT for capitellar OCD, harvesting from femoral condyle was associated with donor-site morbidity in 7.8% of patients, whereas harvesting from a rib was associated with donor-site morbidity in 1.6% of patients, including pneumothorax.[13]

Mirzayan and colleagues[14] previously described a technique for using fresh OCA for capitellar OCD lesions. Similarly, we include the use of arthroscopic confirmation of the OCD lesion and the use of press-fit fresh allograft. However, we access the OCD lesion via an anconeus splitting approach versus the Kocher interval, as the more posterior approach avoids iatrogenic injury to the lateral collateral ligament complex which can lead to posterolateral instability. Another major difference in our technique is the use of a fresh precut OCA core, thus avoiding costs and delays related to the donor-recipient matching process. At our institution, the cost of a precut 10-mm fresh OCA core is approximately $2500, roughly one third the cost of a fresh distal humerus allograft ($6800, JRF Ortho).[17] The grafts are readily available and can be stored in the surgery center operating room refrigerator for convenience. Furthermore, this technique enables single-step treatment without patient size matching, and utilizes existing OAT instrumentation.

Clinical results after single-plug OCA for capitellar OCD are limited. Mirzayan et al.[14] reported high rates of graft survival and encouraging patient outcomes in 9 male youth baseball players with capitellar OCD treated with OCA with 4-year follow-up. The authors observed a mean Mayo score improvement from 57.8 to 98.9, a decrease in visual analog scale pain from 7.8 to 0.5, and 100% return to throwing with active participation in sport for a minimum of 2 years. These results are similar to those of single-plug OAT for unstable capitellar OCD. In their review of 28 adolescent patients, Bae et al.[8] reported improvements in elbow motion and functional outcomes with 100% of patients returning to general sports participation (69% of patients returned to their primary sport).

This Technical Note details a surgical technique of OCA transplantation of the capitellum in an adolescent patient using a fresh precut OCA core. This is a treatment modality to address the cartilage defect and loss of subchondral bone associated with OCD without the drawbacks associated with harvesting an autograft. Furthermore, as the graft is readily available, it avoids delays related to the donor—recipient matching process. This technique can be performed safely in adolescent and adult patients with large, deep, and/or uncontained capitellar defects.

Acknowledgments

The authors acknowledge Arien Cherones, Director of Technology and Systems Management, (University of Washington, Department of Orthopaedics and Sports Medicine) for his assistance with the video production.

References

1. Edmonds EW, Polousky J. A review of knowledge in osteochondritis dissecans: 123 years of minimal evolution from König to the ROCK study group. *Clin Orthop Rel Res* 2013;471:1118-1126.
2. Logli AL, Bernard CD, O'Driscoll SW, et al. Osteochondritis dissecans lesions of the capitellum in overhead athletes: A review of current evidence and proposed treatment algorithm. *Curr Rev Musculoskelet Med* 2019;12:1-12.
3. Kajiyama S, Muroi S, Sugaya H, et al. Osteochondritis dissecans of the humeral capitellum in young athletes: Comparison between baseball players and gymnasts. *Orthop J Sport Med* 2017;5. 2325967117692513.
4. Matsuura T, Suzue N, Iwame T, Nishio S, Sairyo K. Prevalence of osteochondritis dissecans of the capitellum in young baseball players: Results based on ultrasonographic findings. *Orthop J Sport Med* 2014;2. 2325967114545298.
5. van Bergen CJ, van den Ende KI, ten Brinke B, Eygendaal D. Osteochondritis dissecans of the capitellum in adolescents. *World J Orthop* 2016;7:102.
6. Takahara M, Mura N, Sasaki J, Harada M, Ogino T. Classification, treatment, and outcome of osteochondritis dissecans of the humeral capitellum. *J Bone Joint Surg Am* 2007;89:1205-1214.
7. Logli AL, Leland DP, Bernard CD, et al. Capitellar osteochondritis dissecans lesions of the elbow: A systematic review of osteochondral graft reconstruction options [published online February 6, 2020]. *Arthroscopy*. doi: 10.1016/j.arthro.2020.01.037.
8. Bae DS, Ingall EM, Miller PE, Eisenberg K. Early results of single-plug autologous osteochondral grafting for osteochondritis dissecans of the capitellum in adolescents [published online January 8, 2018]. *J Pediatr Orthop*. doi: 10.1097/BPO.0000000000001114.
9. Kirsch JM, Thomas J, Bedi A, Lawton JN. Current concepts: Osteochondritis dissecans of the capitellum and the role of osteochondral autograft transplantation. *Hand* 2016;11:396-402.
10. Kirsch JM, Thomas JR, Khan M, Townsend WA, Lawton JN, Bedi A. Return to play after osteochondral autograft transplantation of the capitellum: A systematic review. *Arthroscopy* 2017;33:1412-1420.e1411.
11. Vezeridis AM, Bae DS. Evaluation of knee donor and elbow recipient sites for osteochondral autologous

transplantation surgery in capitellar osteochondritis dissecans. *Am J Sport Med* 2016;44:511-520.
12. Yamamoto Y, Ishibashi Y, Tsuda E, Sato H, Toh S. Osteochondral autograft transplantation for osteochondritis dissecans of the elbow in juvenile baseball players: Minimum 2-year follow-up. *Am J Sport Med* 2006;34:714-720.
13. Bexkens R, Ogink PT, Doornberg JN, et al. Donor-site morbidity after osteochondral autologous transplantation for osteochondritis dissecans of the capitellum: A systematic review and meta-analysis. *Knee Surg Sports Traumatol Arthrosc* 2017;25:2237-2246.
14. Mirzayan R, Lim MJ. Fresh osteochondral allograft transplantation for osteochondritis dissecans of the capitellum in baseball players. *J Shoulder Elbow Surg* 2016;25:1839-1847.
15. Jones KJ, Cash BM, Arshi A, Williams RJ III. Fresh osteochondral allograft transplantation for uncontained, elongated osteochondritis dissecans lesions of the medial femoral condyle. *Arthrosc Tech* 2019;8:e267-e273.
16. Cotter EJ, Hannon CP, Christian DR, et al. Clinical outcomes of multifocal osteochondral allograft transplantation of the knee: An analysis of overlapping grafts and multifocal lesions. *Am J Sport Med* 2018;46:2884-2893.
17. JRFOrtho JRF. Ortho osteochondral Allogract Products. Available at: https://jrfortho.org/products/2/osteochondral-allografts. Published 2019. Accessed December 14, 2019.