Adolescent Femoral Chondral Fragment Fixation With Poly-L-Lactic Acid Chondral Darts

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Abstract

Large chondral injuries without attached bone are uncommon. This report describes a 14-year-old boy who had a unique stress reaction between the bone and the overlying cartilage, predominantly of the anterior lateral femoral condyle, during a week-long basketball camp, resulting in complete displacement of a 2.5 × 2.5-cm full-thickness articular cartilage lesion. There was a 6-day interval from the time of the injury to the first office appointment. Scheduling of magnetic resonance imaging and insurance approval took another week, and then surgery scheduling, including insurance approval and arranging for surgical supplies, took another week. Three weeks after the initial injury, the patient underwent diagnostic arthroscopy and open arthrotomy, and the cartilage-free fragment was returned to the donor site and fixed with poly-L-lactic acid chondral darts. Considerable delamination of the shoulders of the defect was noted on preoperative magnetic resonance imaging and at the time of surgery, suggesting an unusual prodromal stress reaction. Although there was no underlying subchondral bone on the free cartilage fragment, the injury healed. The patient had return of full knee range of motion and strength. Magnetic resonance imaging performed 3 months postoperatively showed healed cartilage. At 1 year of clinical follow-up, the patient had no clinical sequelae from the initial injury and had returned to competitive basketball. Prompt recognition of this injury pattern and subsequent surgical repair are necessary because the window of opportunity closes as fibrous healing occurs and the cartilage fragment deforms. The poly-L-lactic acid chondral dart system was instrumental to the success of this case. [Orthopedics. 2016; 39(2):e362-e366.]

osteochondral lesions of the knee are much more common than purely cartilaginous lesions.1-3 When bone is attached, options for fixation are more straightforward, including multiple-screw fixation with countersinking of the screw heads. Without bone attached, a purely cartilaginous lesion is thinner and presents more of a technical challenge for adequate fixation.4,5 In addition, bone-to-bone healing is much more reliable than healing of cartilage to underlying bone. Few reports have described fixation of full-thickness articular cartilage lesions involving the articular femoral condyles.4-7 To the authors’ knowledge, this is the first report of successful use of the poly-L-lactic acid chondral dart system (Arthrex, Naples, Florida) in the treatment of a large, full-thickness articular cartilage lesion without attached bone in an adolescent basketball player.

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Case Report

A 14-year-old boy who was an avid basketball player attended a 5-day summer basketball camp that ran from 9:00 AM to 4:00 PM daily. On the morning of day 2, he noted bilateral knee soreness, but was able to participate fully. On day 3, the patient noted swelling in the left knee but was able to continue. On day 4, the knee was painful and stiff but he again participated. On day 5, the knee felt unstable and then “popped” during running activities and gave out. He was seen in the office 6 days later. Physical examination showed range of motion of 20° to 75°, with moderate effusion, negative findings on patellar apprehension test, no localizing tenderness at the joint lines, a stable knee, and normal muscle tone bilaterally. Plain film radiographs showed open growth plates and mild lateral subluxation of the patella. The patient underwent magnetic resonance imaging (MRI) 1 week later. Subsequent MRI scans showed a very large, full-thickness cartilage defect involving the anterolateral trochlea and lateral femoral condyle, with a full-thickness cartilaginous loose body 2.5 cm in diameter in the lateral recess (Figure 1). The patient underwent surgery 1 week later, 3 weeks from the original injury and within 1 week of the definitive MRI.

Surgical Technique

The patient underwent surgery 3 weeks after injury, and diagnostic arthroscopy confirmed the pathology. Arthroscopic intraoperative images showed the large free chondral fragment and the bare anterolateral donor site (Figure 2). The senior author (J.K.M.) had experience with a similar case involving a smaller lesion on the medial femoral condyle. In that case, it was technically too difficult to trim the swollen piece to fit into the donor site, maneuver it into place, and stabilize the piece for insertion of darts. Based on that experience, the authors performed an arthroscopic evaluation but did not attempt to fix the articular lesion arthroscopically. Open lateral arthrotomy allowed for retrieval of the large free cartilage fragment from the lateral recess. The donor site on the lateral femoral condyle was roughened with a curette to promote healing. The chondral dart system was then used to anatomically repair the free fragment back to the lateral...
femoral condyle (Figure 3). In addition to preparing the anterolateral donor site, the free chondral fragment was prepared before reattachment. The free cartilage piece had become engorged as it bathed in synovial fluid, and the inferior aspect was trimmed to fit the fragment into the donor site. An area of thin, undermined cartilage in the center of the trochlea was excised because it was too deficient to accept fixation. Local microfracture was performed to promote healing. A small region of the articular cartilage of the medial femoral condyle was undermined as well. This area was elevated to allow preparation of the underlying bone, and the overlying cartilage was subsequently repaired back to the bone with a chondral dart (Figure 4).

Postoperatively, the patient was placed into a hinged knee brace that was locked between 20° and 40° of knee motion. He was allowed toe-touch weight bearing. Quadriceps and hamstring isometric exercises were initiated in the immediate postoperative period. At postoperative week 6, knee range of motion was advanced and the patient fully flexed the knee from 0° to 140°. He had trace effusion, good quadriceps control, and mild patellofemoral crepitus. The hinged knee brace was discontinued, and the patient was allowed full weight bearing and released to activities of daily living. At postoperative month 3, repeat MRI scan showed healing of the chondral injury with no evidence of collapse or fluid at the bone-cartilage interface. The chondral darts were still visible, without a significant surrounding reaction (Figure 5). He was released to activities as tolerated and started a formal physical therapy program that included progressive stretching and strengthening. At 4.5 months postoperatively, the patient had full range of motion of the knee, with minimal swelling, mild patellofemoral crepitus, and mild thigh atrophy. He walked without a limp and resumed playing pickup basketball. At 1 year postoperatively, he had returned to competitive basketball without symptoms. The patient provided photographs showing knee range of motion 1.5 years postoperatively (Figure 6).
DISCUSSION

Osteochondral lesions in the pediatric and adolescent knee are common. Less common, and rarely described, is an isolated chondral lesion of the knee in this patient population. This report describes a case of the latter in which several days of prodromal symptoms with subsequent catastrophic failure suggested a stress reaction between the bone and the overlying articular cartilage that ultimately led to cleavage between cartilage and bone. Undermining of articular cartilage adjacent to the free cartilage lesion also suggested a stress reaction to shear force and ultimate failure. This mechanism of injury has been postulated to occur in this age group because the cartilage-bone interface is the weakest transitional region in the intra-articular knee. Isolated chondral lesions on the lateral femoral condyle are often associated with lateral patellar dislocations; however, there was no clinical or imaging evidence of dislocation in this patient.

To the authors’ knowledge, this is the first report of an isolated chondral lesion with prodromal symptoms indicative of a stress reaction and likely a fatigue failure rather than an isolated acute injury. The literature on chondral lesions in the knee describes acute causal events, such as patellar dislocation, blunt trauma, or a twisting injury with no antecedent pain or symptoms.\(^5\) Hopkinson et al\(^9\) described a group of 8 West Point cadets over a 4-year period who had pure chondral fractures. The mechanism of injury in each case was either blunt trauma or a twisting injury. None of the cadets had antecedent symptoms, but rather had an isolated acute causal event.

Few studies have reported treatment of isolated chondral lesions, regardless of whether the cause is acute trauma or a stress reaction. The Table summarizes fixation methods described in the literature for isolated chondral lesions. Fixation options for a large cartilage lesion with or without bone attached are limited and traditionally include bone pegs, small headless screws, and K-wires.\(^8,10-12\) More recently, synthetic absorbable screws or tacks have been made available for osteochondral and isolated chondral lesions. Although the number of cases reported is small, the use of bioabsorbable screws or tacks in the treatment of isolated chondral lesions has had promising results.\(^4,5,7\) Nakamura et al\(^4\) reported successful use of bioabsorbable pins to fix a large cartilaginous lateral femoral condyle fragment in an adolescent. The authors also presented detailed histologic evidence of the injured tissue and the subsequent healing process.\(^5\) Uchida et al\(^5\) reported 3 cases of pure chondral fragments of the knee in adolescents who were successfully treated with bioabsorbable pins.

The current case showed a unique presentation of an isolated chondral injury that was successfully managed with poly-L-lactic acid chondral darts. The chondral darts worked well, allowing a large full-thickness piece of articular cartilage to be successfully repaired back to its origin. Important characteristics of this implant that led to successful healing include the ease of implantation, the flushness of the

<table>
<thead>
<tr>
<th>Study</th>
<th>Fixation Method</th>
<th>No. of Cases</th>
<th>Follow-up</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nakamura et al,(^4) 2004</td>
<td>Bioabsorbable pins</td>
<td>1</td>
<td>2 y, 9 mo</td>
<td>Successful repair</td>
</tr>
<tr>
<td>Uchida et al,(^5) 2012</td>
<td>Bioabsorbable pins</td>
<td>3</td>
<td>2 y</td>
<td>1 of 3 patients required later surgical removal of 2 pins because of protrusion from the articular surface</td>
</tr>
<tr>
<td>Maletius and Lundberg,(^6) 1994</td>
<td>Fibrin sealant and polydioxanone pins</td>
<td>2</td>
<td>Unknown</td>
<td>Only 1/3 to 1/2 of the defect healed</td>
</tr>
<tr>
<td>Chan et al,(^7) 2014</td>
<td>Bioabsorbable suture anchors, absorbable suture (polyglactin 910), polylactide bone fixation nails</td>
<td>1</td>
<td>11.5 mo</td>
<td>Successful repair</td>
</tr>
<tr>
<td>Nakayama and Yoshiya,(^8) 2014</td>
<td>Autograft bone pegs</td>
<td>1</td>
<td>26 mo</td>
<td>Successful repair</td>
</tr>
</tbody>
</table>

Figure 6: Patient’s knee range of motion 1.5 years after surgery. Lateral full flexion view of the patient’s operative knee (A). Lateral full extension view of the patient’s operative knee (B).
head to the articular surface, the security of the dart without implant backout, and the lack of biologic reactivity. Biologic reactivity to biodegradable implants, leaving the implant proud to the surface, and backing out of the implant head all have led to iatrogenic damage and poor outcomes with previous implants. The chondral dart does not require additional surgery for implant removal. There has been concern about the placement of biodegradable implants in skeletally immature patients because of their effect on the physis. Animal models have shown temporary growth retardation after placement of transphyseal bioabsorbable screws. In a rabbit model, growth was retarded for 6 weeks and then returned to normal. In a study of epiphysiodesis in a rabbit model, all histologic evidence of the bioabsorbable implants was gone by 24 weeks, with no signs of infection and no more disturbance in growth than a drill hole of equal bore. Similar studies of transphyseal biodegradable implants have not shown disturbance of the growth plate. In the current case, the implants were not placed across the physis. The physis is sufficiently distant from the articular surface that this is not a major concern.

**Conclusion**

There is a small but growing body of literature describing the recognition and treatment of isolated chondral injuries of the knee. This case report describes a unique cause of this injury with fatigue failure caused by a stress reaction at the cartilage-bone interface associated with prodromal symptoms. Prompt recognition of this injury pattern and subsequent surgical repair are necessary because the window of opportunity closes as fibrous healing occurs and the cartilage fragment deforms. In this case, there was a 6-day interval from the time of injury to the first office appointment. Scheduling of MRI and insurance approval took another week, and then surgery scheduling, including insurance approval and arranging for surgical supplies, took another week. The poly-L-lactic acid chondral dart system is an excellent option for surgical repair of isolated chondral injury and was instrumental to the success of this case.

**References**