Case Report

Failure of osteochondral lesions using bioabsorbable fixation in the adolescent patient: a case report

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ABSTRACT

Injury to the chondral surface and subchondral bone can be due to osteochondritis dissecans or traumatic injury. These lesions can lead to pain, swelling, and mechanical symptoms causing functional impairments for patients. Treatment can include nonoperative management or surgical intervention including internal fixation. Internal fixation can be performed through multiple methods including the use of bioabsorbable screw fixation, though there is concern for potential early failure of this method. We present three cases of osteochondral lesions treated with internal fixation with bioabsorbable screws, which experienced early failure of the bioabsorbable screws, leading to failure of fixation and requiring revision surgery with advanced cartilage restoration procedures. All patients had resolution of their symptoms and improved function postoperatively. While the use of bioabsorbable screw fixation can potentially decrease cost and morbidity, their mechanical properties may increase the risk of failure before lesion healing. We advocate caution with the use of these screws for the treatment of unstable osteochondritis dissecans lesion and recommend careful patient selection and meticulous surgical technique to avoid failure of fixation of these lesions.

1. The case

- Three adolescent patients sustained osteochondral injuries and underwent fixation with bioabsorbable screws at an outside hospital
- All three patients sustained failure of the fixation due to failure of the bioabsorbable screws
- All three patients required revision surgery including advanced cartilage restoration procedures
- All three patients returned to full activity with symptoms resolution

2. Lessons Learnt

- Bioabsorbable screws may sustain failure due to early degradation or improper insertion, leading to mechanical failure
- Careful patient selection and meticulous technique is needed to avoid failure that can lead to increased morbidity

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1. Introduction

Osteochondral injury to the knee is a significant injury with potentially long-lasting effects. Osteochondral injuries typically occur either traumatically or secondary to osteochondritis dissecans (OCD). Traumatic osteochondral injuries can occur from a direct blow or, more commonly, patellar dislocation with up to 38% of first-time patellar dislocations having concomitant osteochondral injury [1]. 24-37% of these osteochondral injuries involve the lateral femoral condyle [1,2]. OCD is a disorder of the subchondral bone that may extend to the chondral surface. OCD lesions most frequently occur in the knee, particularly in the skeletally immature patients with an incidence up to 29 per 100,000 cases and are up to four times more common in males [3-5]. The pathogenesis of OCD lesions is still incompletely understood, but it may be due to numerous causes that lead to subchondral bony damage that puts the overlying cartilage at risk [3-6].

Osteochondral and OCD lesions may be classified as stable or unstable if there is detachment of the chondral and bony fragment from the underlying bone. The goal of treatment for these lesions is to maintain or restore the native cartilage surface if possible. Stable lesions, particularly in skeletally immature patients, are commonly treated nonoperatively. Unstable lesions typically require surgery for internal fixation. Internal fixation shows good healing rates in both skeletally immature and mature patients, though lateral femoral condyle lesions are at a higher risk of failure [7].

There are multiple options for fixation including metal screws or bioabsorbable implants. Metal screws are effective but often necessitate a second surgery for removal to prevent secondary damage and wear to the chondral surfaces. In order to eliminate the need for a second surgery, bioabsorbable screws and implants have been used with increasing frequency and good success [8-10]. Unfortunately, there are reports of bioabsorbable screw failure including bone cyst formation, screw back-out or migration, and breakage [11-14].

The purpose of this report is to present three cases with an early failure of bioabsorbable screws after primary fixation of unstable osteochondral lesions and describe potential factors leading to the early failure. No ethical committee approval was required for this study.

2. Cases

This case report was presented following the CARE (CARE REport) guidelines [15]. Patients were informed that data concerning their case would be submitted for publication and they agreed. Patient characteristics are summarised in Table 1.

2.1. Case 1

A 14-year-old male sustained a patellar dislocation while playing baseball, which resulted in an approximately 2 × 2 cm osteochondral lesion of his lateral trochlea and medial patellofemoral ligament (MPFL) rupture. He underwent operative fixation of the osteochondral lesion with two bioabsorbable screws and an MPFL repair. He did well until 7 months after the operation when he developed mechanical symptoms, effusion, and pain without traumatic injury. Magnetic resonance imaging (MRI) showed a detached osteochondral fragment with broken and loose hardware (Fig. 1A-B). He underwent repeat arthroscopy 8 months postoperatively which revealed a 1.7 × 1.8 cm full-thickness chondral defect of the lateral trochlea. The previous implants were broken and fragmented (Fig. 2A-B) resulting in subchondral bone deficiency. He underwent implant removal, bone grafting of the lesion, and cartilage biopsy. Two months later, he underwent second-stage matrix-induced autologous chondrocyte implantation. At last, after follow-up 2 years after operation, he had returned to sports without pain or recurrent swelling. He demonstrated full range of motion from 0 to 140° and displayed excellent quadriceps function.

2.2. Case 2

A 14-year-old female developed left knee pain and mechanical symptoms without any specific incident and was diagnosed with a posterior lateral femoral condyle OCD lesion. She underwent open reduction and internal fixation (ORIF) of the lesion with three bioabsorbable screws. She did well initially, but approximately 5 months after operation, she reported increased pain, effusion, and catching and locking during physical therapy. She was evaluated and follow-up MRI showed a 2.5 × 2.5 cm osteochondral defect with broken hardware at the site of the prior fixation (Fig. 3A-B). She underwent repeat arthroscopy 6 months after the index procedure for broken implant removal and bone grafting of the large defect (Fig. 4A-B). Additional meniscal abrasion was identified due to 3rd body wear from the broken implants (Fig. 5). She underwent second stage osteochondral allograft of the lateral femoral condyle with distal femoral osteotomy due to valgus malalignment. The patient was lost to follow-up after 3 months but denied any pain or swelling and demonstrated range of motion at 0–135° and displayed good quadriceps function at that time.

2.3. Case 3

A 15-year-old male with nail-patella syndrome injured his right knee while playing football, resulting in a displaced osteochondral lesion of the posterior lateral femoral condyle. He underwent open reduction internal fixation of the lesion with two bioabsorbable screws. He did well until 14 months after operation when his knee suddenly gave out while walking. He developed pain, swelling, and mechanical symptoms including locking. Evaluation including MRI demonstrated failure of the implants and a loose osteochondral fragment with a 3 × 2.5 cm defect (Fig. 6). He underwent repeat arthroscopy 19 months after the index surgery for implant removal, loose body removal, and abrasion arthroplasty (Fig. 7A-B). A second-stage osteochondral allograft was planned.

Table 1

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age</th>
<th>Sex</th>
<th>Lesion location</th>
<th>Lesion size</th>
<th>Number of implants</th>
<th>Time to failure (months)</th>
<th>Type of failure</th>
<th>Mode of failure</th>
<th>Findings</th>
<th>Additional surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>14</td>
<td>M</td>
<td>Lateral trochlea</td>
<td>2 × 2 cm</td>
<td>2</td>
<td>7</td>
<td>Atraumatic</td>
<td>Screw fragmentation</td>
<td>Full thickness osteochondral defect</td>
<td>MACI</td>
</tr>
<tr>
<td>2</td>
<td>14</td>
<td>F</td>
<td>Posterior lateral femoral condyle</td>
<td>2.5 × 2.5 cm</td>
<td>3</td>
<td>5</td>
<td>Atraumatic</td>
<td>Screw breakage</td>
<td>Full thickness osteochondral defect, 3rd body wear to lateral meniscus and lateral trochlea</td>
<td>Osteochondral allograft and distal femoral osteotomy</td>
</tr>
<tr>
<td>3</td>
<td>15</td>
<td>M</td>
<td>Posterior lateral femoral condyle</td>
<td>3 × 2.5 cm</td>
<td>2</td>
<td>14</td>
<td>Atraumatic</td>
<td>Screw breakage</td>
<td>Full thickness osteochondral defect</td>
<td>Abrasion arthroplasty</td>
</tr>
</tbody>
</table>

F: female; M: male; MACI: matrix-induced autologous chondrocyte implantation.
but had not been performed, and at last, after follow-up 2 years after operation, he had returned to sports without recurrent effusion or mechanical symptoms, but he did report occasional soreness with increased activity. He demonstrated range of motion from 0 to 130° and displayed good quadriceps function.

3. Discussion

Surgical management of unstable OCD lesions has classically relied on the use of metal screws to achieve fixation. Unfortunately, this often necessitates a second surgery for implant removal, adding to cost and morbidity for the patient. With the advent of bioabsorbable screws and implants, however, the use of metal screws is becoming more infrequent. Bioabsorbable screws eliminate the need for a second surgery after the initial OCD fixation and are associated with decreased artifact on MRI. In support of bioabsorbable implants, several studies have shown good healing of osteochondral lesions treated with bioabsorbable implants [8–10]. Despite these advantages, there have been several reports describing implant failure prior to healing of the lesion [11,12,14].

Two of the most commonly used substances in bioabsorbable screws are polyglycolic acid (PGA) and polylactic acid (PLA). Both substances have similar biomechanical properties to bone with similar strength [16]. Reported effusion and synovitis related to the use of PGA has led to more frequent use of PLA screws [17]. PLA possesses chirality, enabling it to exist in three different enantiomeric states: L-Lactide (PLLA), D-Lactide (PDLA), and meso-lactide [18]. The screws used in these cases were made

Fig. 1. Sagittal T2 Magnetic resonance imaging demonstrating (A) breakage of bioabsorbable screw in the osteochondral lesion and (B) loose screw fragment in the anterior compartment.

Fig. 2. Intraoperative images demonstrating (A) broken bioabsorbable screw in the osteochondral lesion and (B) broken bioabsorbable screws fragments and osteochondral fragment after removal.

Fig. 3. Sagittal T1 magnetic resonance image demonstrating failure of fixation of osteochondral lesion with multiple broken screws.
of PLLA, which is a semicrystalline polymer that is hard and brittle, but its properties can be improved through processing [19,20].

The absorption rate of PLLA screws is highly variable, taking from 6 months to 8 years to achieve complete degradation due to its hydrophobic nature [12,19–22]. PLLA typically degrades in vivo in over 2 to 5 years, though it starts to lose strength after approximately 6 months [21]. A study by Yoshitaka et al. found that PLLA implants were still intact after 3 years in two of four cases. At 8 years, full absorption had occurred leaving behind empty screw holes [22]. Friederichs et al. and Scioscia et al. report similar variability in their case studies and even suggest that absorption rates may not be equal throughout the implant itself.

Fig. 4. Intraoperative images demonstrating (A) broken bioabsorbable screw loose within the knee joint and (B) nonhealed osteochondral fragment with multiple broken bioabsorbable screws.

Fig. 5. Intraoperative images demonstrating additional damage to the lateral meniscus due to third-body abrasion.

Fig. 6. Sagittal T1 magnetic resonance image demonstrating loose osteochondral fragment with broken bioabsorbable screw.

Fig. 7. Intraoperative images of (A) broken bioabsorbable screw in the lateral femoral condyle osteochondral lesion defect and (B) broken bioabsorbable screw fragment removed from the knee.
Disproportionate rates of absorptions along the length of the implant may lead to failure of the implant and fixation [11,13]. While following a predictable pattern of degradation, the rate of screw absorption in each patient is unpredictable and is likely to be dependent upon multiple implant- and patient-specific variables. Implant-related factors include the crystallinity of the polymer, molecular weight, viscoelasticity, and composition and porosity of the implant [23]. Patient-specific factors such as pH, bone quality, local vascularity, location of the lesion, and stress and loading of the implant are more variable [16,23]. Nonuniform screw degradation may be of concern in the management of unstable OCD lesions. A screw that is absorbed too quickly, or at disproportionate rates along its length, could lead to failed fixation prior to the occurrence of adequate bony healing. Migration or back-out of the implant may also lead to damage of opposing cartilage or other tissue. Thus, presentation of pain and effusion during the postoperative treatment period should be investigated.

It is also necessary to consider the structural design of bioabsorbable screws. In some screw designs, the screw has two separate thread sections with different pitch and taper, with a central smooth section in order to compress the two fragments together to enhance healing. This central section between two consecutive thread segments is subjected to high torsion and stress loads during placement. PLLA screws do not have the hardness provided by metal screws, and this central section could be a weak point that fails early on during insertion. Poor technique such as under-drilling, graft–screw mismatch, improper size, or screw-tunnel divergence can lead to excess force applied to the screw and thus also contribute to this premature failure. For example, if the bone is under-drilled, this may lead to early engagement of the distal segment of the screw in the bone, leading to increased torsion during insertion, particularly to the central section of the screw, which may lead to breakage during insertion that may be unrecognised. In addition, damage to the instruments may lead to abnormal stresses being transmitted to the screw. Watson et al. reported a series of bioabsorbable screw breakage during insertion that was attributed to torsional plastic deformation of the screwscrew tip, leading to incomplete seating of the screwdriver and unequal torsional forces being transmitted to the screw and ultimately leading to screw failure during insertion [24].

Screw breakage in vivo may also be caused by a combination of factors such as mechanical damage during insertion below the threshold for breakage followed by early degradation causing ultimate failure of the weakened screw. In these three cases, two patients had failure within the first 7 months, suggesting failure due to damage at the time of insertion or degradation of the screws before biological healing of the lesion. The third case failed at approximately 14 months, with multiple potential causes. It is possible this failure was secondary to biological nonhealing of the osteochondral lesion, causing the failure of the implants due to continued motion. Conversely, the screws may have begun early degradation, impairing the healing of the osteochondral lesion, resulting in the ultimate failure of the screws and fixation of the lesion. While it is impossible to say the exact cause, the failure in multiple locations of each screw may imply early degradation and disproportionate resorption of the bioabsorbable screw along its length. These outcomes are consistent with the findings of Camahlias et al. In their study, 17% of sustained implant failure and late failure was attributed to differential screw decomposition [1,4].

In recent years, bioabsorbable screws have become a popular substitute for their metal counterparts. The potential problems related to their degradation, however, may limit their utility in the treatment of unstable osteochondral lesions. Eliminating the need for metal screw removal decreases cost and morbidity but comes with implant unpredictability and the potential for secondary surgeries. We advocate for caution when using these screws to ensure proper patient selection and technique is utilised to decrease the risk of early failure. Further studies are needed to better understand the potential modes of failure and absorption process of bioabsorbable screws and ensure appropriate utilisation of these implants in the future.

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Disclosures

None.

Declaration of interests

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References


