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Diagnosis and management of chondral delamination injuries of the knee☆

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ABSTRACT

Background: Chondral delamination with intact articular surface is an under-recognised entity with no previous reports on how it should be managed. The purpose of this article is to increase awareness of this entity and make recommendations for its management.

Methods: We present a small case series of three patients who presented with knee pain and subsequent MRI scans revealed chondral delamination with intact articular surface as the only explanation of symptoms.

Results: Two of the lesions were located in the patella and one on the lateral aspect of the medial femoral condyle. All three were treated with bioabsorbable pin fixation. The delaminated area was easily recognised at arthroscopy by its bogginess on probing. All three patients made an excellent recovery and the lesions healed on MRI.

Conclusion: Chondral delamination with intact articular surface is best managed with bioabsorbable pin fixation so that it can be salvaged in order to optimise patient outcomes and avoid deterioration to a full thickness chondral lesion once the articular surface has separated.

1. Introduction

Chondral delamination (Figure 1) is defined as the separation of articular cartilage from the underlying subchondral bone. It occurs at the level of the tidemark (Figure 2) due to shearing forces that are concentrated at the junction of non-calcified and calcified cartilage [1–3] as a result of the discrepancy in Young's Modulus of the two layers. Delamination occurs parallel to the joint surface with the overlying articular cartilage remaining intact initially. The natural history of these lesions is unknown. Perhaps some settle and heal with time but undoubtedly some propagate in the undersurface, eventually breaching the articular surface with separation of the delaminated segment of articular cartilage resulting in chondral flaps or full-thickness defects and loose bodies. However, delamination injuries can be picked up before the articular surface is breached on MRI scans. The question then is "what are the treatment options?" The purpose of this article is to increase awareness of this condition, to encourage early diagnosis and surgical fixation, and to help avoid further propagation and formation of loose articular cartilage flaps. To our knowledge this is the first report on how to manage chondral delamination injuries with the articular surface intact. We report a case series of three patients treated in our unit for cartilage delamination with intact articular surface in chronological order of patient presentation.

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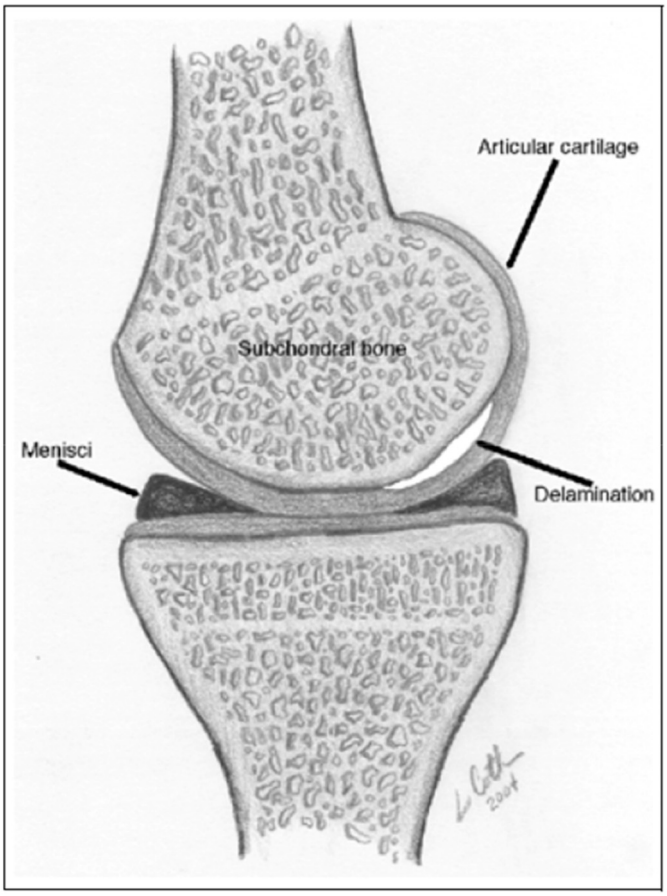

Figure 1. Illustration of the macroscopic structure of chondral delamination showing separation of the articular cartilage from subchondral bone at the femoral condyle posteriorly.
(Reprinted with permission from AJR Am J Roentgenol 2005;184:1486–14,899 [4].)

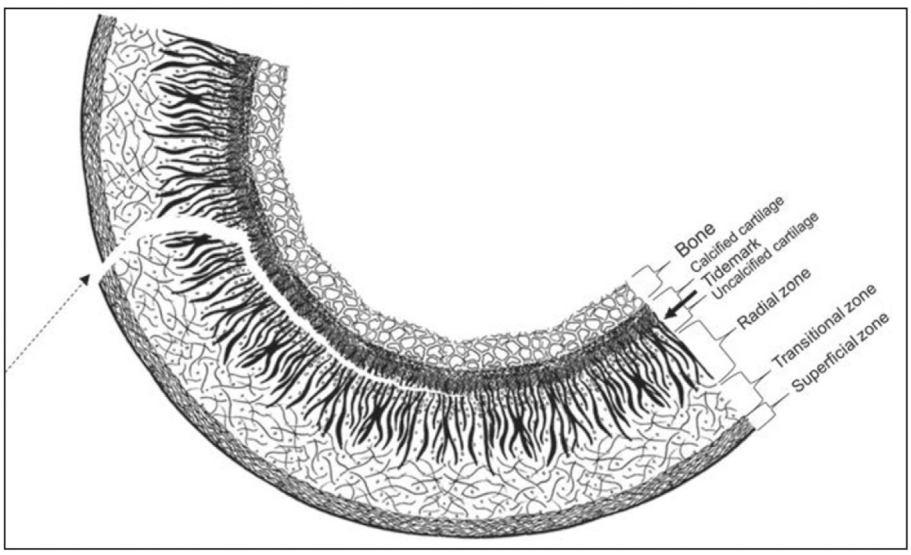

Figure 2. Illustration of the microcscopic structure of chondral delamination extending from the tidemark (solid arrow) and through radial, transitional and superficial cartilage layers into the articular surface (dashed arrow) thus forming a cartilage flap.
(Reprinted with permission from AJR Am J Roentgenol 2017;209:317–321 [5].)

2. Patients

2.1. Patient 1

A 12-year-old boy presented with intermittent pain in his left knee, which had been deteriorating over several months. There was no history of trauma, locking, giving way nor swelling but the pain was enough for him to be unable to participate in sporting activities. On examination he was found to have marked wasting of the affected lower limb. There was loss of hyperextension compared to the other side, symmetrical flexion, no effusion but tenderness on palpation of the medial femoral condyle at 90° of flexion. Ligaments were intact and the patellofemoral joint was unremarkable. MRI scan revealed chondral delamination with intact articular surface on the lateral aspect of the medial femoral condyle (Figure 3A, B), an area that is typical for osteochondritis dissecans. Non-surgical treatment failed. At arthroscopy, the articular surface of the medial femoral condyle was found to be intact but unstable to probing over its lateral aspect. Two 1.5 × 14 mm SmartNails (ConMed, Utica, NY) were inserted arthroscopically into the central region of the affected area. Five additional passages were made using the 1.5 mm drill evenly spaced around the lesion to stimulate bleeding and healing.

The patient was mobilised non-weight bearing for six weeks, with static isometric quadriceps exercises undertaken from the outset and loaded flexion allowed from 12 weeks. At three months, the patient had made a good recovery although he experienced mild aching medially on prolonged walks. An MRI scan at this stage showed that the articular cartilage had healed onto the subchondral bone with no evidence of high signal between the two (Figure 3C, D). Five years have passed since the operation and patient remains asymptomatic and is back to high level sporting activities.

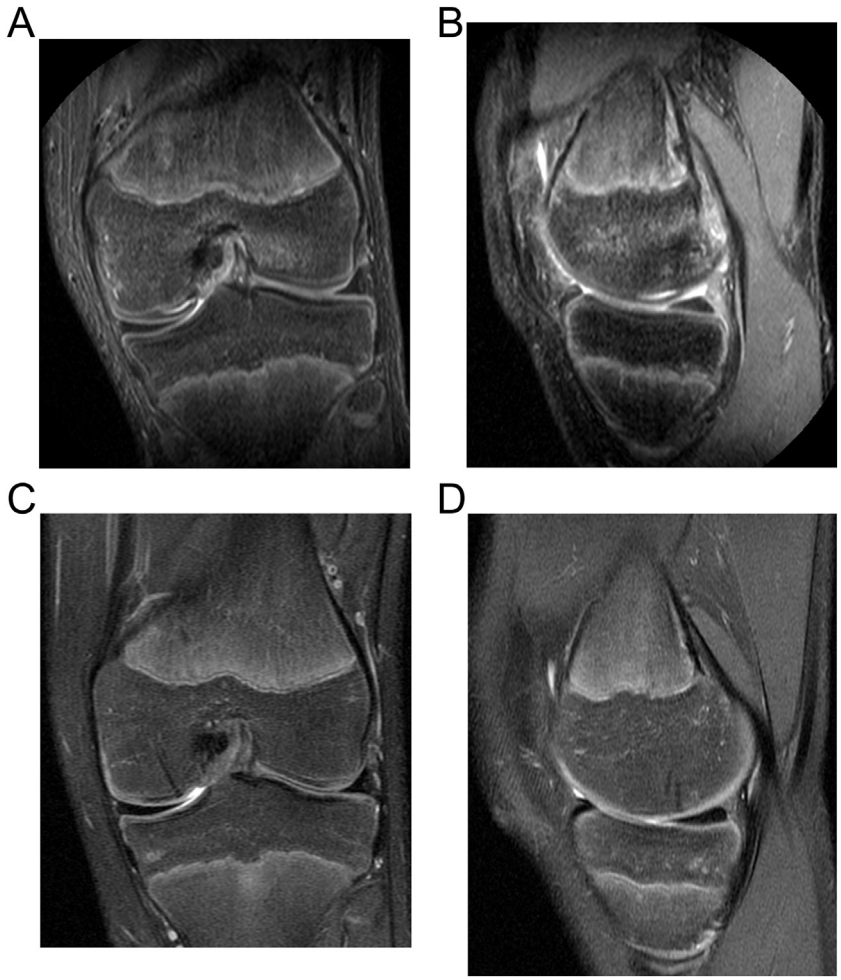

Figure 3. Pre and postoperative MRI images of first patient. A) Preoperative STIR Coronal image showing delamination of cartilage but with an intact articular surface at the lateral half of the weight bearing portion of the medial femoral condyle. B) Preoperative STIR sagittal image of the delaminated area of the medical femoral condyle. C) Postoperative coronal image showing cartilage fixation with two bioabsorbable fixation pins. Note that the head of the medial pin is buried under the cartilage surface and the proximal tip of the lateral adjacent pin is showing. D) Postoperative sagittal image of the medial femoral condyle showing elimination of delaminated layer and two bioabsorbable fixation pins in situ.

2.2. Patient 2

A 32-year-old male presented with a history of chronic bilateral patellar instability with numerous dislocations, more so on the left. Despite many years of physiotherapy, his symptoms of pain and instability persisted. He had previously had a left knee arthroscopy 10 years prior, to remove a small bony fragment following a patellar dislocation. At presentation, he described bilateral anterior knee pain and instability, particularly on stairs and rising to stand, which prevented him from participating in sport. The left knee had a full range of movement with increased lateral patellar glide and negative apprehension. He was tender over the inferior pole and medial facet of the left patella. He had normal coronal alignment in an otherwise stable knee. An MRI scan revealed subchondral delamination in the lateral patellar facet with adjacent focal subchondral cystic and sclerotic changes. The overlying articular surface was intact although there was a small focus of subchondral bone marrow oedema related to the lesion (Figure 4). The patellofemoral joint was dysplastic but the tibial tubercle trochlear groove distance and patella height were in the normal range.

Non-operative treatment failed. At the time of arthroscopy the patella articular cartilage was found to be intact but was mobile relative to the underlying patella on probing. A 'mini' medial parapatellar approach was performed and the delaminated cartilage was fixed with three SmartNails (1.5×16 mm) to the underlying bone. An MPFL reconstruction was performed concomitantly using an ipsilateral gracilis autograft. At five-month follow-up, the patient had no pain and no symptoms of patella instability. Examination revealed no effusion with pain free movement.

2.3. Third Patient

A 36-year-old woman presented with a one-year history of intermittent retropatellar knee pain with an acute exacerbation caused by landing after jumping a stream which caused immediate sharp retropatellar pain followed by a sensation of locking that settled after shaking her knee. She subsequently experienced similar episodes regularly which culminated in her being unable to run. She had undergone a right hamstring ACL reconstruction six years previously with excellent outcome. Examination revealed wasting of ipsilateral thigh, no effusion, and full range of motion. There was no tenderness and ligamentous examination was normal. Whilst the patella tracked normally, there was marked retropatellar crepitus with apprehension on lateral displacement. MRI revealed an intact ACL graft, and menisci. There was a 12×9 mm area of chondral delamination at the patellar apex with an intact articular surface and subchondral oedema (Figure 5A, B). Non-surgical treatment failed.

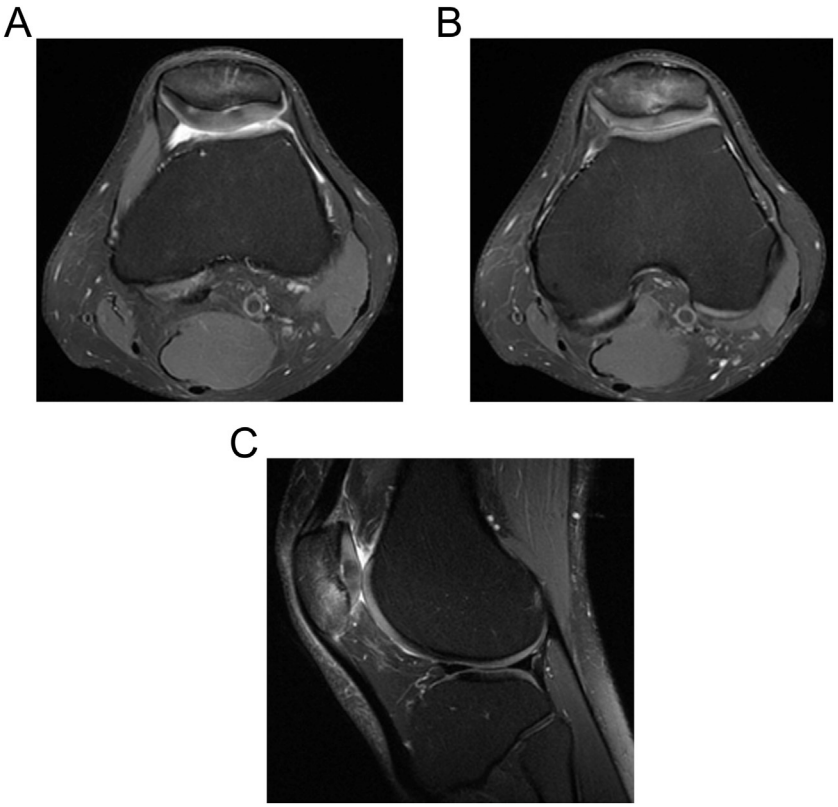

Figure 4. Preoperative MRI images of second patient. A) Proton density axial scan through patellofemoral joint. Note the area cartilage delamination just lateral to the apex with adjacent subchondral sclerosis and the area of high signal in the cartilage on the medial facet. B) Sequential Proton density axial scan showing more marked subchondral sclerosis. C) Proton density sagittal image showing chondral delamination in middle of patella.

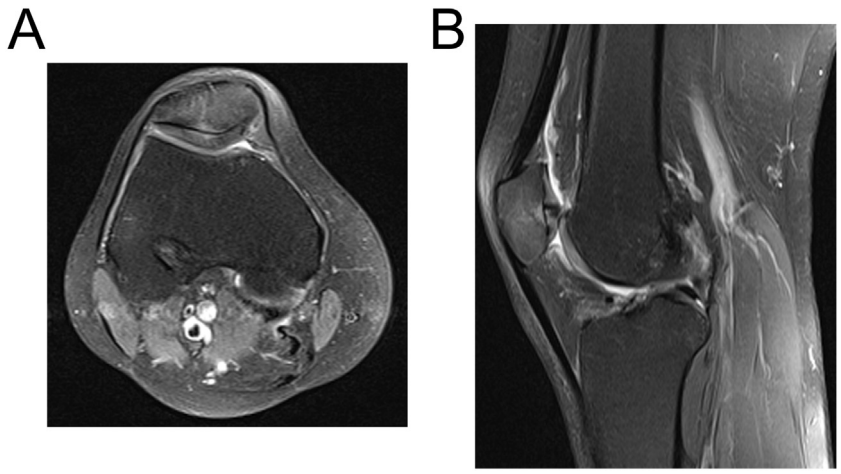

Figure 5. Images from third patient. A) Proton density MRI axial images showing chondral delamination just lateral to the apex of the patella. B) Proton density MRI sagittal image through patellofemoral joint.

An arthroscopy confirmed the patellar lesion. A 'mini' lateral parapatellar approach was then made and the area of delaminated cartilage was easily distinguishable by its instability on probing, and fibrillation/fissuring that had not been visible on MRI 10 weeks earlier. This was fixed with five 1.3 × 18 mm Chondral Darts™ (Arthrex, Naples, Florida) and two further 1.0 mm drill holes were made through the articular surface into subchondral bone to stimulate further healing. The patient was placed in a range of motion brace 0–30° and advised to mobilise weight bearing as tolerated the first six weeks. The brace was removed for unrestricted range of flexion whilst not under load. At the time of writing, she is five months following her operation and her symptoms of retropatellar catching and locking have fully resolved.

3. Discussion

Hyaline cartilage is avascular, aneural and alymphatic and, as such, has a limited capacity for healing. Consequently, its preservation is paramount for joint health and mobility. Structurally it is composed of chondrocytes and an extracellular matrix of water, type II collagen, and proteoglycans. The interplay between the solid and fluid components provide it with its biphasic and viscoelastic properties that are critical for its shock absorbing ability and provide an almost frictionless articulation. Once hyaline cartilage loses its structural integrity, it no longer functions optimally leading to deterioration of joint protection and function.

Articular cartilage is anchored to the underlying bone by vertically orientated collagen fibres that cross from the calcified layer to the non-calcified layers of cartilage. This transition is demarcated by the 'tidemark'. It is at this level where delamination occurs. Whilst the overlying articular cartilage may stay intact, it loses its anchorage, resulting in increased susceptibility to further damage either by increasing the area of delamination or a breach in the articular surface with subsequent formation of chondral flaps. The mainstay of treatment of chondral delamination where there has been a breach in the articular surface is debridement of the chondral flaps to a stable base and (depending on the size of the defect and level of symptoms) microfracture, or other chondral resurfacing techniques such as ACI or mosaicplasty. All of these techniques can improve symptoms but they are no substitute for patients' own stable and healthy articular cartilage. Prompt surgical fixation of chondral delamination, as described above, allows preservation of this precious body material before the only options are 'second-best'.

Whilst there have been reports in radiology journals of chondral delamination injuries with an intact articular surface, we were unable to find any articles in the surgical literature which describe how they should be managed. Kendell et al. [4] describe the MRI appearances of chondral delamination injuries in 5 patients of which only two had intact articular surfaces. Although, they state that all 5 patients' symptoms improved after surgical treatment, they do not provide details of the surgery performed.

Whilst these areas of delamination may be identifiable at arthroscopy, they can easily be missed as the chondral surfaces appear normal on visualisation, unless probed to check stability. The importance of an MRI scan in both the investigation of these patients and the subsequent surgical planning is clear. Articular cartilage lesions on MRI scans are best shown on fluid sensitive fat suppressed sequences such as intermediate weighted proton density (PD) weighted or T2 weighted fast spin-echo (FSE) and spoiled gradient-recalled echo (SPGR) imaging [5]. Proton density weighted images show good clarity for cartilaginous surface and intrasubstance defects. The use of intermediate-weighted sequences with longer TE (time to echo) can provide superior signal intensity in cartilage than standard T2-weighted sequences, as it combines the contrast advantage of proton density weighting with that of T2 weighting [6]. These will provide improved differentiation between cartilage and subchondral bone and are less prone to the 'magic angle effect' seen in proton density-weights imaging with a shorter TE [7].

Despite the small number of cases in this series, the pattern that has emerged is that patients present with a long-standing history of pain, which is relatively tolerable during everyday activities but not for heavier loading situations such as sport.

There is often muscle wasting and crepitus but examination is otherwise usually unremarkable. We strongly advocate the use of MRI scans to confirm the diagnosis and aid preoperative planning. An initial arthroscopy should be performed to confirm the diagnosis with visualisation and application of the probe to the articular surfaces, to exclude confounding pathology, and to perform a chondroplasty if appropriate. The affected delaminated area can be distinguished from the intact surrounding cartilage by probing for instability – the probe will 'ruck up' articular surface and sink into such lesions in a trampoline like manner. The area of delamination should then be fixed with bioabsorbable pins; this may be done arthroscopically or via a small arthrotomy depending on the location of the lesion. If lesion size allows, additional passage of a fine drill through the articular surface affected into the related subchondral bone may stimulate lesion healing.

In the first two cases (above), SmartNails (ConMed, Utica, NY) were used. SmartNails are bioabsorbable osteochondral fixation darts. They are inert, non-collagenous and composed of poly-L-lactic acid (PLLA) copolymer. The head is low profile and smooth and can be impacted to be countersunk under the chondral surface but above the subchondral layer. They are barbed distally so as to engage and prevent 'pull-out'. They allow for compression and fixation whilst minimising the risk of subchondral bone fracture. Tension is lost after about 50 weeks and the implant biodegrades between two and five years [8]. For the third case, Arthrex Chondral Darts™ (Naples, Florida) were used. Like SmartNails, they are also bioabsorbable and made of PLLA copolymer.

The third patient waited 10 weeks between MRI scan and operation and, even though the scan had shown intact articular cartilage, at the time of arthroscopy the cartilage surface had begun to break down to a degree that would have been visible on the scan. This emphasises the fact that prompt surgery should be considered in these cases as chondral deterioration can be rapid.

All three patients had a period of conservative management which included analgesia, rest, physiotherapy and activity modification. This period was variable and generally occurred before they were seen at our centre. Whilst we acknowledge that the patients did not receive just chondral fixation with bioabsorbable pins (two had microfracture and one had an MPFL reconstruction), and there was variability in the location of the lesion (two in patella and one in medial femoral condyle), we are of the opinion that the chondral fixation was directly and solely responsible for eliminating the fluid between the chondral and subchondral surfaces and thus promoting healing of the delaminated chondral area.

4. Conclusion

Chondral delamination with intact articular surface is a salvageable condition if dealt with promptly by fixation of the affected area with bioabsorbable pins. The purpose of this paper is to raise awareness of this condition and to describe the MRI findings, the fixation technique and surgical outcomes. Prompt surgical fixation is preferable to surgical options once a chondral surface has broken off as a flap or loose body as the former preserves host articular surface reliably before it is too late.

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