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Fountain morphology of an osteochondral defect in a paediatric patient: A case report

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ABSTRACT

Introduction: This case report describes a 13-year-old male patient, with unusual magnetic resonance imaging findings of subchondral cysts associated with an osteochondral defect of the right knee.

Case Report: The patient presented with a six-week history of right knee pain, swelling and locking. Clinical examination revealed a loose body in the suprapatellar pouch, a small effusion, and a fixed flexion deformity. Imaging features revealed an unusual fountain-like morphology of the subchondral cysts, deep to the defect. The patient underwent surgical repair.

Conclusion: This radiographical finding may suggest an interplay between biomechanical stress and subchondral bone remodeling, warranting further investigation into the pathogenesis of such morphology.

Keywords: Fountain morphology, Orthopedics, Osteochondral defect, Pediatric, Spray morphology, Subchondral cyst

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INTRODUCTION

Subchondral cysts (SCs) are fluid-filled osseous lesions that can result from biomechanical stress, cartilage degeneration, or additional pathology affecting the joint. They are frequently associated with osteoarthritis (OA) and osteochondral defects (OCDs). In pediatric populations, the interplay between SC formation and OCD requires further investigation and exploration. Advanced imaging techniques, particularly magnetic resonance imaging (MRI), have been pivotal in identifying SC morphology and distribution, with different patterns hypothesized to reflect localized biomechanical influences [1, 2].

Distinct morphological patterns could provide insight into the pathogenesis of OCD-related SCs, especially in younger patients where cartilage and subchondral bone dynamics differ significantly from adults. Jaramillo et al. (2016) detailed novel subchondral changes in pediatric OCDs, highlighting the potential mechanism of biomechanical forces and dynamic bone remodeling resulting in the formation of cystic lesions [3]. Magnetic resonance imaging (MRI) results in similar cases have been further associated with histologic evidence of microscopic subchondral changes, synovial fluid infiltration, and localized bone marrow necrosis, lending support to a biomechanical origin for these cysts [4, 5].

We present a case where MRI demonstrated a unique fountain-like arrangement of SCs in the subchondral bone of a paediatric patient. This case emphasizes the value of advanced imaging in characterizing atypical SC morphologies and developing an understanding of their clinical relevance.

CASE REPORT

This 43-kilogram, 13-year-old male, presented with a 6-week history of knee pain, locking, and swelling while

playing Gaelic football. There was no preceding history of knee symptoms and no significant past medical problems. This patient was able to demonstrate a loose body in the suprapatellar pouch at the initial consultation. Hip examination was normal and non-tender. The lower limb alignment was normal but there was a fixed flexion deformity of the right knee of approximately 15–20 degrees. Clinically this patient also demonstrated a small right knee effusion.

Plain radiographs revealed an osteochondral defect in the medial femoral condyle and a loose body in the suprapatellar pouch (Figures 1 and 2). An MRI performed showed a medial femoral condyle OCD (Figures 3–6). The MRI revealed multiple subchondral cystic lesions distributed in a distinctive fountain-like pattern. These lesions were located in the distal femoral subchondral bone. The multiple fluid filled lesions followed a distinct spray, or fountain-like appearance, which appear to be consistent with cyst accumulation within the cancellous bone.

This patient underwent a right knee arthroscopic examination under anesthesia with open reduction and internal fixation (ORIF) of the medial femoral condyle OCD, synovial and bone biopsy, and osteochondral autologous transfer surgery (OATS) (Figure 7). Microscopy from a bone biopsy of the osteochondral defect was normal with no evidence of bone necrosis or new bone formation.

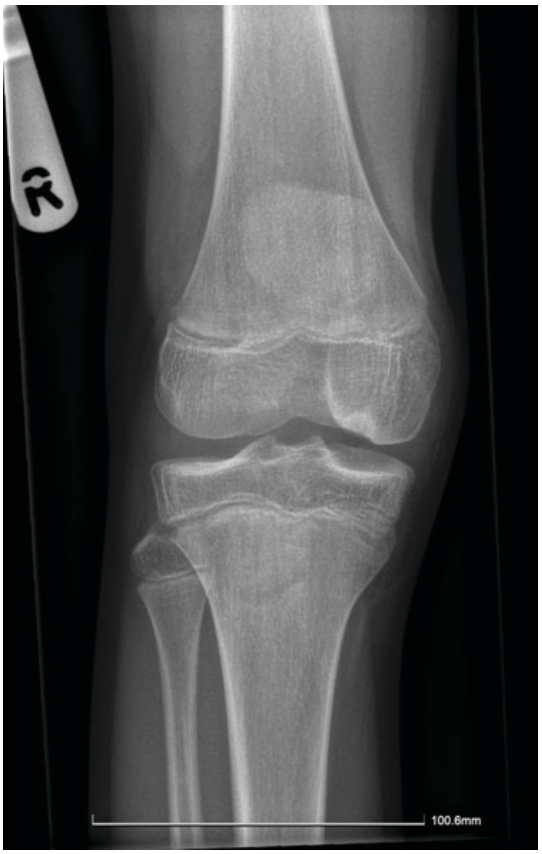

Figure 1: Plain radiograph of the right knee, revealing the medial femoral condyle OCD.

Figure 2: Lateral plain radiograph of the right knee, revealing the loose body in the suprapatellar pouch.

Figure 3: MRI (STIR sequence, coronal) of the right knee, showing the fountain-like morphology of the femoral condyle deep to the osteochondral defect in the medial femoral condyle.

Figure 4: MRI (STIR sequence, sagittal) of the right knee, displaying the fountain-like morphology of the femoral condyle deep to the osteochondral defect in the medial femoral condyle.

Figure 5: Coronal MRI sequence, demonstrating a loose body from the osteochondral defect.

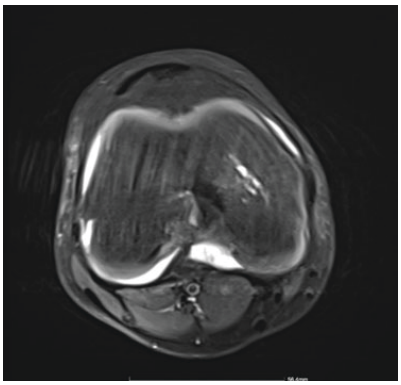

Figure 6: Axial MRI sequence, demonstrating the cystic lesions in the medial femoral condyle.

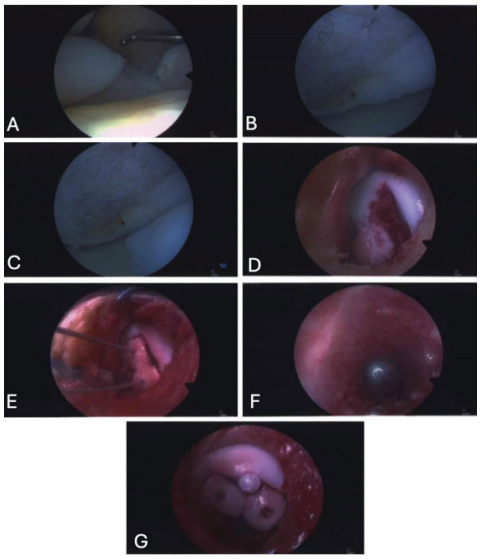

Figure 7: Intraoperative images, acquired with the arthroscopy camera. (A) Loose body demonstrated. (B and C) Osteochondral lesion in the medial femoral condyle. (D) Image taken of the whole extent of the osteochondral defect in the medial femoral condyle with a small open approach to the medial femoral condyle. (E) Pinning of the two loose bodies, before inserting headless compression screws to hold them in place. (F) Image taken from within the donor site of the osteochondral autograft transfer (OATS) to prove no physis was taken from the donor site (also confirmed with intraoperative radiography). (G) Final intraoperative image, demonstrating the two loose bodies, secured using headless compression screws, and the OATS.

DISCUSSION

The fountain-like morphology of SCs observed in this case is an unusual imaging feature. To our knowledge, no prior reports have described this radiological pattern. Subchondral cysts are traditionally described as rounded or ovoid lesions; however, atypical patterns like the one presented may suggest alternative mechanisms of formation. One hypothesis is that high joint pressures force synovial fluid through subchondral microcracks, creating interconnected cystic cavities under repetitive biomechanical loading [3]. This hypothesis aligns with studies describing fluid ingress through damaged cartilage and subchondral bone in response to repetitive stresses [3, 5].

Jaramillo et al. (2016) noted that the growing and developing subchondral bone in the paediatric population is more vulnerable to effects of localized stress and remodeling, which may help explain the development of unusual cyst patterns in younger patients [3]. A comparable pattern of cyst formation is described in post-traumatic cysts, with cyst formation ultimately resulting from fluid intrusion secondary to microfractures in subchondral bone [6, 7].

While SCs related to OA generally occur alongside degenerative changes, cartilage loss, and bone remodeling [8], the similarities in morphological features may prompt further research into shared biomechanical and biochemical mechanisms. The classification systems of MRI, including those put forward by Bohndorf, provide a frame of reference for differentiating cystic patterns and prognosticating their clinical relevance [9]. Additionally, researchers posit that subchondral cysts can be a marker of joint degeneration and may present clinically with localized pain, especially in cases with concurrent bone marrow edema [4, 10].

Beyond biomechanical factors, vascular compromise and impairment of chondrocyte-osteoblast crosstalk has been suggested as a key factor in the pathogenesis of osteochondral defects and related cystic remodeling. Localized hypoxia in subchondral bone may lead to necrosis, weakening of the bony matrix, and eventual cyst formation [11]. In addition, inflammation and oxidative stress have been implicated in SC development, particularly through the action of cytokines such as interleukin-1 and tumor necrosis factor-alpha, which may result in cartilage degradation and subchondral bone restructuring [12]. These processes may interact with mechanical stresses, accelerating cyst development and influencing morphology.

Future research should aim to characterize and classify SC morphologies, such as the fountain-like subchondral cysts observed in this patient. There is also a role for future exploration of their biomechanical or inflammatory mechanisms. Understanding their influence in joint degeneration and pain could aid in both prognostic value and therapeutic clinical interventions.

CONCLUSION

This case demonstrates the importance of detailed imaging in identifying different subchondral cyst morphologies, associated with osteochondral defects. The fountain-like subchondral cysts in this pediatric patient represent a potentially novel presentation. Recognition of such features could enhance our understanding of OCD pathogenesis.

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Author Contributions

Nadim Sayani – Conception of the work, Design of the work, Acquisition of data, Analysis of data, Interpretation of data, Drafting the work, Final approval of the version to be published, Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

Oliver Richard Boughton – Conception of the work, Design of the work, Acquisition of data, Analysis of data, Interpretation of data, Drafting the work, Revising the work critically for important intellectual content, Final approval of the version to be published, Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

Katherine Pirie – Conception of the work, Design of the work, Acquisition of data, Analysis of data, Interpretation of data, Drafting the work, Final approval of the version to be published, Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

Siobhan Hoare – Analysis of data, Interpretation of data, Revising the work critically for important intellectual content, Final approval of the version to be published, Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

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Guarantor of Submission

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Consent Statement

Written informed consent was obtained from the patient for publication of this article.

Conflict of Interest

Authors declare no conflict of interest.

Data Availability

All relevant data are within the paper and its Supporting Information files.