Osteoid Osteoma of the Joint Capsule: A Case Report Highlighting Diagnostic Challenges and the Role of Advanced Imaging

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Nadeer M. Gharaibeh: Data collection, manuscript writing, figure preparation
Hissein M. Fadoul: Assisted in imaging interpretation and differential diagnosis drafting
Areej H. Al-Sarairah: Provided critical revisions and formatted figures and tables
Gang Wu: Supervised radiological analysis, manuscript review
Xiaoming Li: Conceptualized the case report, finalized the manuscript, corresponding author duties

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CONSENT

No

HUMAN AND ANIMAL RIGHTS

All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1975 Helsinki Declaration and its later amendments.

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ABSTRACT

BACKGROUND: Osteoid osteoma is a benign osteogenic tumor typically affecting cortical bone and often mimicking musculoskeletal conditions. This report describes a rare intra-articular osteoid osteoma within the hip joint capsule, highlighting diagnostic challenges and the role of multimodal imaging.

A 13-year-old male presented with a one-year history of persistent proximal left femoral pain, most severe at night, disrupting sleep. Initial computed tomography revealed a lesion extending from the proximal femoral cortex into the medullary cavity and quadratus femoris muscle, while contrast-enhanced magnetic resonance imaging confirmed an intra-capsular nidus. Surgical resection identified woven bone, confirming the diagnosis. This case demonstrates that computed tomography and contrast-enhanced magnetic resonance imaging are essential for visualizing the nidus and reducing misdiagnosis in atypical cases.

CASE REPORT

CASE REPORT

Imaging Findings

A 13-year-old male presented to Tongji Hospital with a one-year history of persistent left thigh pain, worsening over the past week. The pain was continuous, most severe at night, and disrupted sleep. There was no history of trauma, fever, or systemic symptoms. On physical exam, tenderness was noted over the proximal left femur, with no swelling or joint limitation. Laboratory tests, including complete blood count and inflammatory markers, were within normal limits.

A prior CT scan identified a benign lesion at the proximal left femur, extending from the cortex into the medullary cavity and involving the quadratus femoris muscle. At Tongji Hospital, plain radiographs showed focal cortical thickening (Figure 2A). Coronal CT reconstruction revealed a spindle-shaped nidus with surrounding sclerosis (Figure 2B), while axial CT demonstrated an oval, low-density nidus measuring approximately 1.5 × 1.2 × 0.8 cm, surrounded by a sclerotic rim and cortical thickening (Figure 2C). Contrast-enhanced MRI showed patchy high-density enhancement in the lesion extending into the bone marrow and joint capsule with well-defined margins (Figure 3D–3F).

Management

Surgical exploration was performed via incision of the hip joint capsule. A bone lesion was identified beneath the femoral neck with small perforations. The lesion was completely resected, followed by wound irrigation and artificial bone implantation.

Follow-Up

Histopathological examination of the excised specimen revealed woven bone tissue consistent with osteoid osteoma (Figure 1).

Immunohistochemistry Findings

- **SATB-2**: Positive
- **P53**: Diffuse positive (no mutation)
- **H3.3G34W, H3K36M, MDM2, P63, CDK4, P40, PCK**: Negative
- **Ki-67**: Labeling index approximately 10%

DISCUSSION

Etiology & Demographics

Osteoid osteoma (OO), first described in 1935 [1]. Accounts for approximately 13.5% of benign bone tumors, predominantly affecting individuals aged 5–25 years, it exhibits a male-to-female ratio of 1.6–4.0:1 [2]. The tumor typically invades the cortical diaphysis of long bones, with lower limbs most commonly affected, followed by upper limbs and spine [3]. Approximately 90% of patients experience localized, intense pain, worsening at night and relieved by non-steroidal anti-inflammatory drugs (NSAIDs) [4]. Radiologically, OO is characterized by a central nidus with marked surrounding sclerosis [5]. While typically cortical, OO within the joint capsule is rare [6]. And poses diagnostic challenges due to its atypical presentation.

Clinical & Imaging Findings

Intra-articular OO, as observed in this case within the hip joint capsule, is rare, with joint capsule involvement reported in 13% of OO cases [6], often affecting the medial femoral neck base [18]. Presenting with nonspecific symptoms like joint pain and stiffness mimicking femoroacetabular impingement or synovitis, its small nidus and complex anatomy pose significant diagnostic challenges [19,20]. Plain X-rays frequently miss the nidus, though reactive sclerosis may suggest osteomyelitis, while MRI's limited spatial resolution struggles to detect it amid bone marrow edema, joint effusion, and synovial hyperplasia [21,22]. Contrast-enhanced MRI (CE-MRI), leveraging the nidus's hypervascular enhancement, improved detection in this case, though synovitis and effusion can obscure findings [23,24]. CT, the gold standard, excels at nidus visualization with surrounding sclerosis [25].

In this case, the nidus, located at the corticomedullary junction near the hip joint capsule, penetrated the capsule, consistent with intra-articular OO's tendency to induce milder sclerosis and no periosteal reaction due to the absence of intra-articular periosteum. Extensive bone marrow edema, a sensitive marker of OO [26], was prominent, likely reflecting early lesion progression. Though not explicitly documented, potential synovial thickening and effusion align with prostaglandin-mediated inflammation triggered by the nidus's proximity to the capsule. Surgical resection revealed woven bone, confirming the diagnosis and underscoring osteoid osteoma's capacity to alter bone morphology.

Treatment & Prognosis

Surgical resection remains the standard treatment for intra-articular OO and was curative in this case. The prognosis following complete removal is excellent, with low recurrence rates.

Differential diagnosis

Brodie's abscess

OO and Brodie's abscess (BA) are distinct bone pathologies that share overlapping clinical and radiological features, often complicating diagnosis. OO is a benign osteogenic tumor typically located in the cortical region of long bones, characterized by a small (<2 cm) nidus surrounded by sclerosis, presenting with intense, localized, nocturnal pain relieved by NSAIDs [7,8]. In contrast, BA, a rare subacute osteomyelitis, forms a localized pus-filled cavity, often in metaphysis, surrounded by sclerotic bone, and manifests as insidious pain with swelling, lacking systemic symptoms or NSAID relief [9,10]. Radiologically, OO shows a central lucency with a "target" appearance on MRI, while BA exhibits a lytic lesion with sclerotic margins and the "penumbra sign" on T2-weighted MRI, indicating a high-signal rim [11]. OO is non-infectious, treated with radiofrequency ablation or resection, whereas BA,

commonly caused by Staphylococcus aureus, requires surgical debridement and antibiotics [12]. These differences in location, pain profile, imaging, etiology, and treatment underscore the need for precise diagnostic approaches to distinguish these entities [13].

Osteoblastoma

OO and osteoblastoma are benign osteogenic tumors with shared histological features, such as osteoid formation within vascular fibrous stroma and perilesional sclerosis, yet they differ markedly in size, behavior, and clinical presentation [14,15]. OO, typically smaller than (<2 cm), occurs predominantly in the cortex of long bones (e.g., femur, tibia) and is characterized by intense nocturnal pain relieved by NSAIDs, following a benign, self-limited course [15]. In contrast, osteoblastoma, defined as larger than (>2 cm), often affects the spine and exhibits locally aggressive behavior with a higher recurrence rate, presenting with persistent, non-nocturnal pain less responsive to NSAIDs [14,16]. Radiologically, OO shows a small nidus with pronounced sclerosis, while osteoblastoma features cortical expansion and milder sclerosis, necessitating CT and MRI for spinal cases [15,16]. Treatment for OO includes NSAIDs or minimally invasive ablation, whereas osteoblastoma requires complete surgical excision or radiofrequency ablation, especially for complex spinal lesions, to prevent recurrence [14,17].

This case of intra-capsular osteoid osteoma in a 13-year-old male highlights the diagnostic challenges of atypical OO presentations. Multimodal imaging, particularly CT and contrast-enhanced MRI, is essential for accurate diagnosis and guiding surgical management, reducing misdiagnosis in such rare cases.

TEACHING POINT

Intra-capsular niduses are small and may mimic normal anatomical structures, and sclerosis seen on X-ray can lead to misdiagnosis such as osteomyelitis. Non-enhanced magnetic resonance imaging may fail to detect these lesions amid edema or effusion, making computed tomography and contrast-enhanced magnetic resonance imaging essential for accurate evaluation near the femoral neck and joint capsule.

QUESTIONS

Question 1: Which imaging findings were observed in this case of intra-articular osteoid osteoma?

1. Focal cortical thickening (applies)
2. Oval low-density nidus with a sclerotic rim (applies)
3. Extensive periosteal reaction
4. Patchy high-density enhancement on contrast-enhanced MRI (applies)
5. Lytic metaphyseal lesion

Explanation: Focal cortical thickening was seen on plain X-ray. CT showed an oval low-density nidus with a sclerotic rim, and CE-MRI showed patchy high-density areas with clear margins. No periosteal reaction or metaphyseal involvement was reported in this case [see Case Report].

Question 2: Which clinical features were noted in this patient's presentation?

1. Constant dull pain during physical activity
2. Severe night pain disrupting sleep (applies)
3. Swelling and joint limitation
4. Pain relief with NSAIDs (applies)
5. Systemic symptoms including fever

Explanation: The patient had severe proximal femoral pain that worsened at night, disturbing sleep. There was no swelling or systemic symptoms. Pain relief with NSAIDs is a hallmark of OO [see Case Report, Etiology & Demographics].

Question 3: Which imaging modalities played a key role in diagnosing the lesion in this case?

1. Ultrasound
2. CT scan (applies)
3. Contrast-enhanced MRI (applies)
4. Bone scintigraphy
5. Non-contrast MRI

Explanation: CT clearly showed the nidus and surrounding sclerosis, while CE-MRI demonstrated intra-capsular extension and enhancement of the lesion. These modalities were essential in confirming the diagnosis and planning treatment [see Clinical & Imaging Findings].

Question 4: What were the key differential diagnoses discussed in this case?

1. Giant cell tumor
2. Osteomyelitis
3. Brodie's abscess (applies)
4. Osteoblastoma (applies)
5. Aneurysmal bone cyst

Explanation: Brodie's abscess and osteoblastoma were specifically discussed due to overlapping radiologic and clinical features. The case emphasized differences in nidus size, location, pain patterns, and response to NSAIDs [see Differential Diagnosis].

Question 5: What treatment and histopathological findings confirmed the diagnosis in this patient?

1. Conservative NSAID management
2. Percutaneous biopsy
3. Surgical resection of the lesion (applies)
4. Presence of woven bone on pathology (applies)
5. Bone marrow aspiration

Explanation: The lesion was surgically resected, and histology confirmed osteoid osteoma with the presence of woven bone tissue. This was consistent with typical pathology findings in OO [see Surgical Findings, Case Report].

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FIGURES

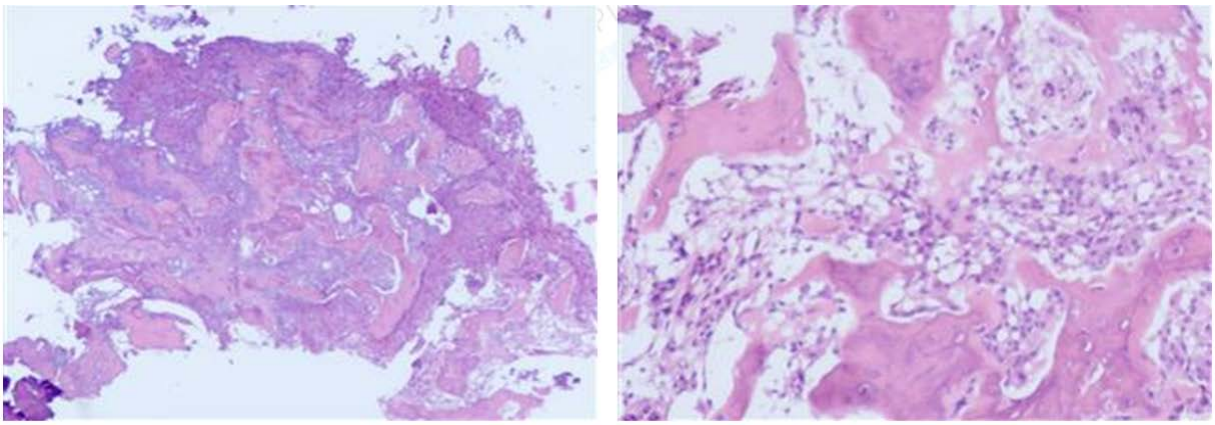

Figure 1: Histopathology showing woven bone tissue from the proximal femur lesion, confirming osteoid osteoma in the joint capsule.

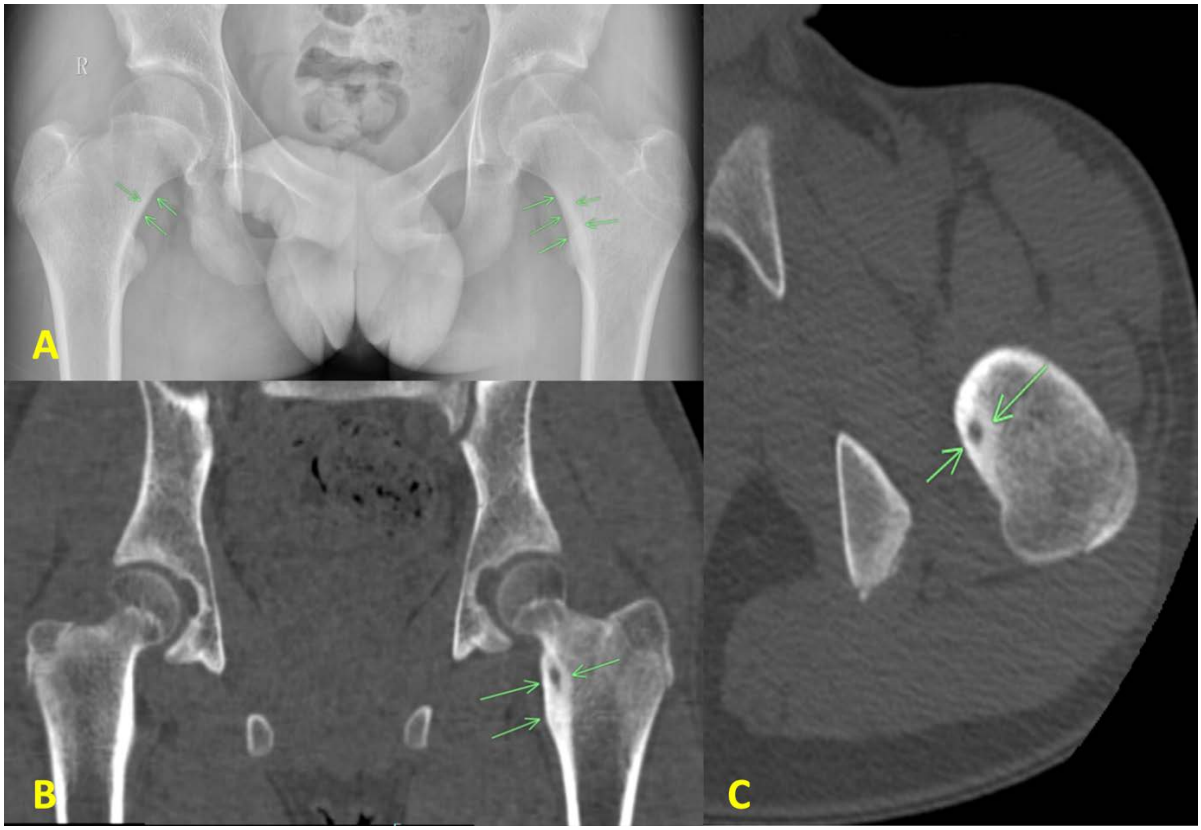

Figure 2: 13-year-old male with intra-articular osteoid osteoma of the proximal left femur.
Findings:
(A) Plain anteroposterior X-ray of the pelvis shows unilateral focal cortical thickening of the proximal left femur (indicated by arrows); the nidus is not clearly visualized.
(B) Coronal CT reconstruction demonstrates a spindle-shaped radiolucent nidus with surrounding sclerosis and prominent cortical thickening inferiorly (indicated by arrows).
(C) Axial CT image shows an oval, low-density nidus measuring less than 2 cm, surrounded by a ring-like sclerotic rim and cortical thickening (indicated by arrows).
Technique:
X-ray: AP pelvis view.
CT: Multidetector CT scan, coronal and axial planes, 0.625 mm slice thickness.

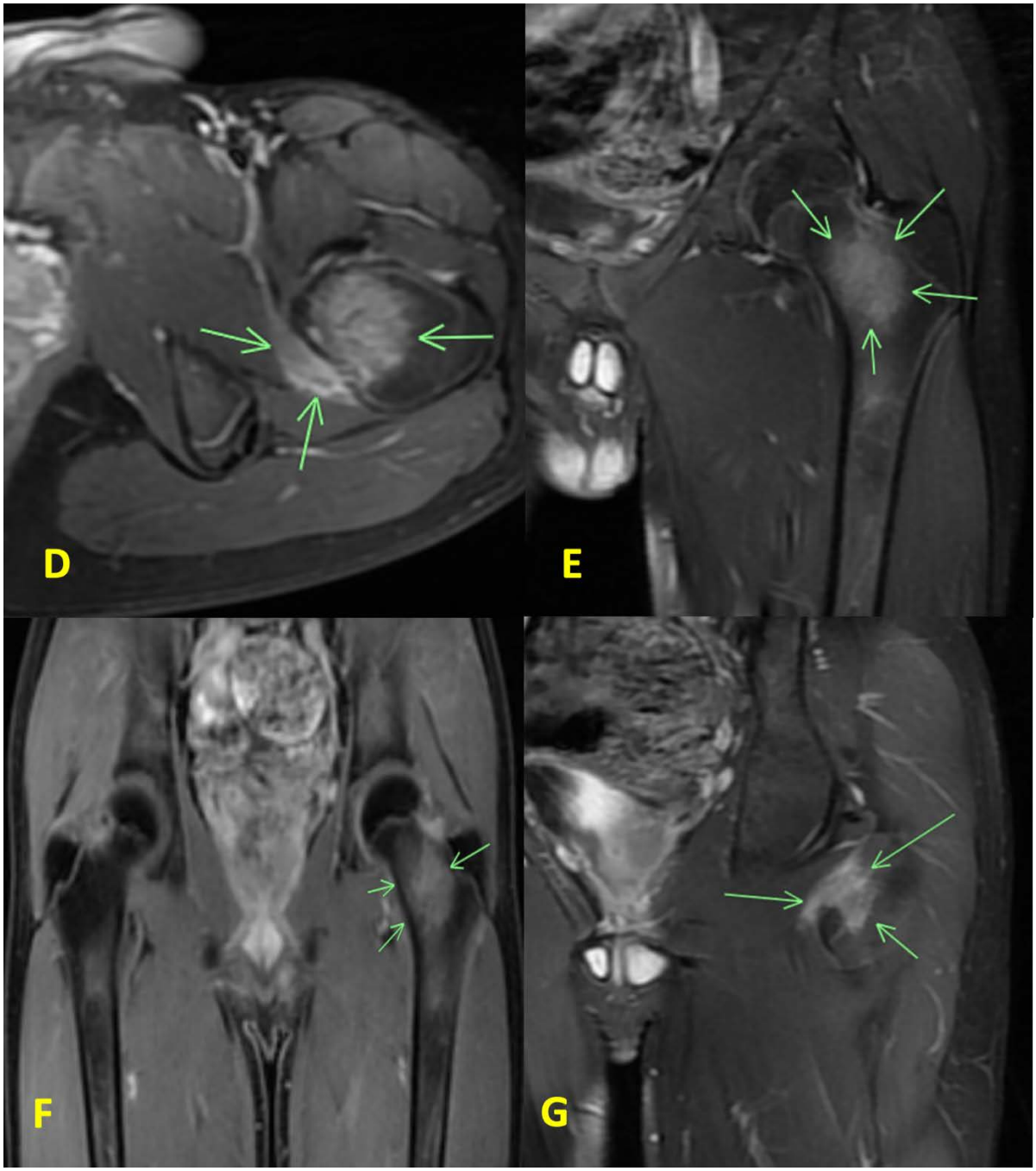

Figure 3: 13-year-old male with intra-articular osteoid osteoma in the left proximal femur.
Findings:
(D–F) Axial and coronal contrast-enhanced T1-weighted MRI images demonstrate a hyperintense lesion extending from the cortex into the bone marrow cavity of the proximal left femur (indicated by arrows), with patchy enhancement and surrounding edema. No abnormal signal is observed in the right femur.
(G) Coronal contrast-enhanced T1-weighted image shows marked enhancement in the soft tissues posterior to the lesion with well-defined margins (indicated by arrows).

Technique:
MRI was performed on a 1.5 Tesla system. Contrast-enhanced T1-weighted images acquired post-intravenous gadolinium administration (0.1 mmol/kg). Axial and coronal planes were used. Imaging sequences included T1-weighted spin echo (TR 550 ms, TE 15 ms) and STIR for edema assessment.

KEYWORDS

Osteoid osteoma; multimodal imaging; benign osteogenic tumor; cortical bone lesion; hip joint

ABBREVIATIONS

CT = COMPUTED TOMOGRAPHY
MRI = MAGNETIC RESONANCE IMAGING
CE-MRI = CONTRAST-ENHANCED MAGNETIC RESONANCE IMAGING
NSAIDS = NON-STEROIDAL ANTI-INFLAMMATORY DRUGS
OO = OSTEOID OSTEOMA
BA = BRODIE'S ABSCESS
TR = REPETITION TIME
TE = ECHO TIME
SATB-2 = SPECIAL AT-RICH SEQUENCE-BINDING PROTEIN 2
P53 = TUMOR SUPPRESSOR PROTEIN 53
H3.3G34W = HISTONE H3.3 GLYCINE34 TO TRYPTOPHAN MUTATION
H3K36M = HISTONE H3 LYSINE36 TO METHIONINE MUTATION
MDM2 = MOUSE DOUBLE MINUTE 2 HOMOLOG
P63 = TUMOR PROTEIN P63
P40 = TUMOR PROTEIN P40
PCK = PAN-CYTOKERATIN
CDK4 = CYCLIN-DEPENDENT KINASE 4
KI-67 = NUCLEAR PROTEIN ASSOCIATED WITH CELLULAR PROLIFERATION

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