Section: Radiodiagnosis

Original Research Article

RADIOLOGICAL IMAGING IN PATIENTS PRESENTING WITH HIP PAIN IN PEDIATRIC AGE GROUP – A PROSPECTIVE STUDY

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ABSTRACT

Background: Hip pain in children is a common but diagnostically challenging presentation. The causes vary widely from transient inflammatory conditions to life-threatening infections and malignancies. Imaging plays a pivotal role in accurately diagnosing the underlying cause and guiding prompt treatment. **Aim:** To assess the spectrum of radiological findings in pediatric patients presenting with hip pain and to evaluate the role of different imaging modalities—X-ray, ultrasound, and MRI—in diagnosis and management.

Materials and Methods: This was a prospective study conducted in the Department of Radiology, Government General Hospital, Kakinada over a 10-month period (September 2024 to June 2025). A total of 15 pediatric patients (under 16 years of age) presenting with hip pain were evaluated using appropriate imaging modalities. Each case was assessed with X-ray and ultrasound, followed by MRI when needed, based on clinical suspicion.

Results: Out of 15 cases:

- 6 cases (40%) were diagnosed as inflammatory conditions, including transient synovitis and juvenile idiopathic arthritis.
- 5 cases (33.3%) were diagnosed with infective etiologies, including septic arthritis and osteomyelitis.
- 2 cases (13.3%) had developmental dysplasia of the hip (DDH).
- 1 case (6.7%) was diagnosed as osteosarcoma, and 1 case had Perthes disease.

MRI proved to be the most sensitive modality in identifying early marrow changes, joint effusions, synovial thickening, and soft tissue involvement, especially in differentiating inflammatory and infective causes.

Conclusion: Early and appropriate use of imaging, particularly MRI, is crucial in evaluating pediatric hip pain. It not only facilitates early diagnosis but also aids in distinguishing between benign self-limiting conditions and serious pathologies, thereby improving patient outcomes.

Keywords: Hip pain, pediatric, MRI, transient synovitis, septic arthritis, juvenile arthritis, DDH, osteosarcoma.

INTRODUCTION

Hip pain in children is a common clinical complaint that often presents as a diagnostic challenge due to the wide range of possible etiologies. It may be due to transient and self-limiting conditions such as transient synovitis or may represent serious underlying pathology such as septic arthritis, juvenile idiopathic arthritis, or even malignancy. The clinical presentation is often non-specific and overlapping, which necessitates a multimodal imaging approach to identify the exact cause and initiate appropriate management promptly.[1]

In pediatric patients, the spectrum of hip pain causes includes inflammatory conditions (transient synovitis, juvenile arthritis), infective causes (septic arthritis, osteomyelitis), developmental disorders (such as developmental dysplasia of the hip DDH), trauma, Perthes disease, and neoplastic conditions (such as osteosarcoma or Ewing sarcoma). Many of these conditions can present with similar symptoms such as limping, restricted joint movements, low-grade fever, or irritability in younger children, which makes clinical differentiation difficult in the early stages.[2]

Imaging plays a vital role in the evaluation of hip pain in children. The choice of imaging modality depends on the clinical context, age of the child, and suspected diagnosis. Plain radiographs are the most readily available initial investigation and help assess bony alignment, joint space, epiphyseal development, and detect obvious structural abnormalities. However, radiographs may be normal in early infective or inflammatory pathology and are relatively insensitive to soft tissue or marrow changes.[3]

Ultrasound is particularly valuable in detecting joint effusion, synovial thickening, and guiding aspiration when infection is suspected. It is a preferred modality in younger children as it avoids radiation and allows dynamic evaluation of joint movement and fluid collections.

MRI is increasingly recognized as the gold standard for early and detailed assessment of hip pathology in children. It provides excellent soft tissue contrast, can detect early marrow changes, joint effusion, synovitis, and can help distinguish between infectious, inflammatory, traumatic, or neoplastic causes. Moreover, MRI can be used without contrast in most situations, making it suitable even in the pediatric population with minimal risk. In conditions like transient synovitis or juvenile idiopathic arthritis, MRI helps in detecting subtle synovial inflammation or joint effusions, while in osteomyelitis or septic arthritis, it aids in early identification of marrow edema and soft tissue involvement.[4]

Delay in identifying and treating conditions such as septic arthritis or osteomyelitis can lead to rapid joint destruction and long-term morbidity. On the other hand, over-investigation or overtreatment of self-limiting conditions like transient synovitis should also be avoided. Hence, imaging serves as a critical decision-making tool.[5]

The present study was undertaken to evaluate the utility of radiographs, ultrasound, and MRI in a series of pediatric patients presenting with hip pain and to analyze the imaging spectrum of different etiologies encountered in this population over a prospective 10-month period. This study aims to highlight how strategic and timely imaging helps in narrowing down differential diagnoses, facilitates accurate classification of cases, and ensures early intervention and better clinical outcomes in pediatric hip pathologies.

Aims and Objectives

Aim of the Study

To evaluate the role of radiological imaging—specifically radiographs, ultrasound, and magnetic resonance imaging (MRI) in the diagnosis of various causes of hip pain in the pediatric age group.

Objectives

1. To assess the spectrum of imaging findings in pediatric patients presenting with hip pain.
2. To categorize the causes of hip pain based on imaging into inflammatory, infective, developmental, neoplastic, and other categories.
3. To analyze and compare the diagnostic value of radiograph, ultrasound, and MRI in these conditions.
4. To identify the most effective imaging modality for early and accurate diagnosis to guide clinical management.

MATERIALS AND METHODS

Study Design and Duration

This was a prospective observational study conducted over a period of 10 months, from September 2024 to June 2025.

Study Setting

Department of Radiology, Government General Hospital, Kakinada

Study Population

A total of 15 pediatric patients (aged below 16 years) presenting with hip pain were included in the study. All patients were referred for radiological evaluation based on clinical suspicion.

Inclusion Criteria

- Pediatric patients (under 16 years) presenting with hip pain.
- Patients referred for imaging with a clinical suspicion of infective, inflammatory, developmental, or other etiologies.
- Patients whose imaging data could be assessed using at least one or more modalities (X-ray, ultrasound, MRI).

Exclusion Criteria

- Patients with a history of recent trauma/fracture to the hip or pelvis.
- Known cases of hemato-oncological disorders.
- Patients with incomplete imaging studies or unavailable clinical records.

Methodology

1. **Initial Evaluation:**
   - Each patient underwent clinical examination and baseline laboratory work-up.
   - The first-line imaging modality was plain radiograph (anteroposterior and frog-leg lateral view) of the pelvis and hips.
2. **Ultrasound Examination:**
   - Conducted to detect joint effusion, synovial thickening, and periarticular soft tissue changes.
   - High-frequency linear transducers were used with real-time dynamic assessment.
3. **Magnetic Resonance Imaging (MRI):**
   - Performed where required, based on clinical suspicion or inconclusive initial imaging.

- MRI sequences included: T1-weighted, T2-weighted, STIR, and contrast-enhanced sequences in select cases.
- MRI was used to evaluate marrow edema, joint effusion, synovial enhancement, soft tissue involvement, and growth plate abnormalities.

Data Collection and Categorization:

- Imaging findings were categorized under five main etiological groups:

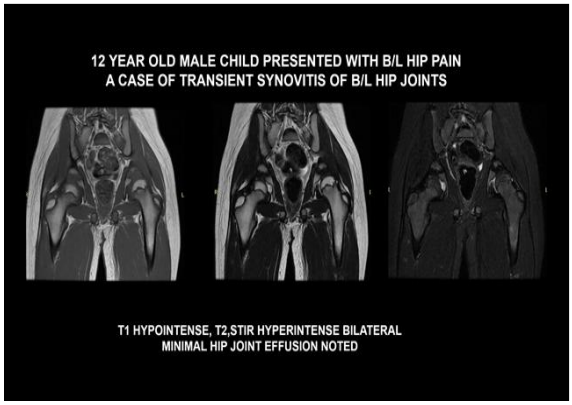
1. Inflammatory (e.g., transient synovitis, juvenile idiopathic arthritis)
2. Infective (e.g., septic arthritis, osteomyelitis)
3. Developmental (e.g., developmental dysplasia of the hip)
4. Neoplastic (e.g., osteosarcoma)
5. Other (e.g., Perthes disease)

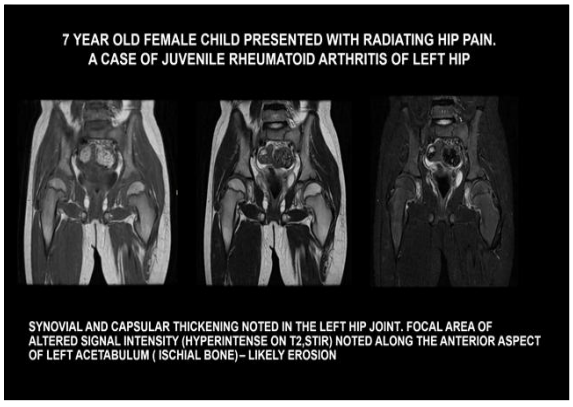
- Imaging findings were correlated with clinical presentation and laboratory results to arrive at the final diagnosis.

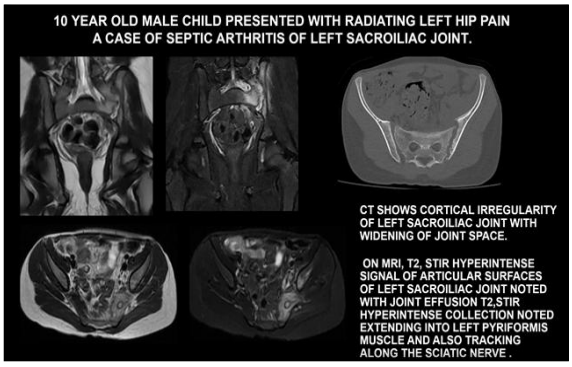
Data Analysis:

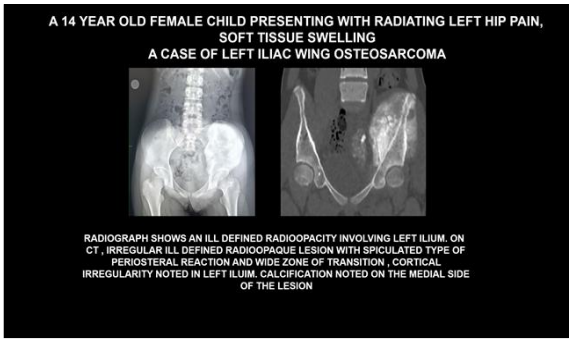
- Imaging modality performance was evaluated qualitatively for diagnostic contribution.
- Cases were analyzed based on their final diagnosis and the specific role each imaging modality played.

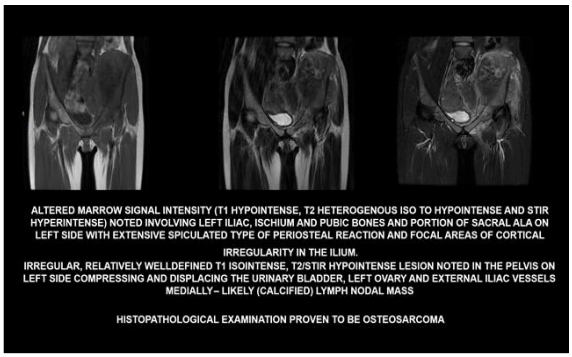
Descriptive statistics were used for frequency analysis; no statistical software was required due to the small sample size (n = 15).











RESULTS

This study evaluated 15 pediatric patients under 16 years of age who presented with hip pain. All patients underwent radiographic and ultrasound imaging, with MRI performed in cases requiring further evaluation. The imaging findings were grouped into five major categories based on etiology: inflammatory, infective, developmental, neoplastic, and other conditions.

Table 1: Distribution of Cases by Etiology (n = 15)

Etiology	Number of Cases	Percentage (%)
Inflammatory	6	40.0%
Infective	5	33.3%
Developmental	2	13.3%
Neoplastic	1	6.7%
Other (Perthes)	1	6.7%
Total	**15**	**100%**

Table 2: Imaging Modality and Findings in Each Case

Case No.	Modality Used	Findings Summary	Final Diagnosis
1	X-ray, USG, MRI	Bilateral effusion, marrow edema	Juvenile idiopathic arthritis
2	X-ray, USG, MRI	Left joint effusion, minimal synovitis	Transient synovitis
3	X-ray, USG	Effusion with echo debris	Septic arthritis
4	X-ray, MRI	Joint space narrowing, hyperintense marrow	JIA
5	X-ray, USG	Left hip subluxation, shallow acetabulum	DDH
6	X-ray, USG, MRI	Effusion, synovial thickening	Transient synovitis
7	X-ray, USG	Right-sided effusion	Septic arthritis
8	X-ray, MRI	Epiphyseal signal changes	Perthes disease
9	X-ray, MRI	Lytic lesion, periosteal reaction	Osteosarcoma
10	X-ray, USG	Joint effusion	Septic arthritis
11	X-ray, MRI	Bilateral joint space narrowing	JIA
12	X-ray, USG, MRI	Mild effusion, normal marrow signal	Transient synovitis
13	X-ray, USG	Irregular femoral head	Septic arthritis
14	X-ray, USG	Dislocated femoral head	DDH
15	X-ray, MRI	Synovial thickening, marrow edema	JIA

Table 3: Role of Each Imaging Modality Across All Cases

Modality	Number of Cases Used (n = 15)	Key Diagnostic Contributions
X-ray	15	Baseline skeletal structure, DDH, osteosarcoma
Ultrasound	10	Joint effusion, echoic content, synovial thickening
MRI	9	Marrow edema, synovial inflammation, soft tissue masses

Table 4: Comparative Imaging Findings by Etiological Category

Etiology	X-ray Findings	Ultrasound Findings	MRI Findings
Inflammatory	Normal / Joint space narrowing	Effusion / thickened synovium	Marrow edema, synovitis
Infective	Irregular margins / joint changes	Complex effusion / septations	Marrow signal change, soft tissue edema
Developmental	Dislocation / shallow acetabulum	Dislocated femoral head	Not routinely done
Neoplastic	Lytic lesion, periosteal reaction	Not contributory	Mass lesion with marrow & soft tissue
Perthes disease	Early normal, later epiphyseal change	Not contributory	Epiphyseal signal change

Table 5: Age Distribution of Patients by Diagnosis

Age Group (Years)	Common Diagnoses	No. of Patients
<1	Developmental Dysplasia of the Hip (DDH)	2
1–5	Transient Synovitis, Septic Arthritis	5
6–10	Juvenile Idiopathic Arthritis, Perthes	4
11–15	Osteosarcoma, JIA	4

Key Findings by Etiology:

1. **Inflammatory (6 cases):**
   - Most common cause (40%).
   - MRI findings: marrow edema, synovial thickening, joint effusion.
   - Diagnosis included juvenile idiopathic arthritis and transient synovitis.
2. **Infective (5 cases):**
   - USG: joint effusion, echoic fluid.
   - MRI: marrow signal changes, synovial enhancement.
   - Diagnosis: septic arthritis and osteomyelitis.
3. **Developmental (2 cases):**
   - X-ray: dislocation/subluxation, shallow acetabulum.
   - Ultrasound confirmed femoral head displacement in infants.
   - Diagnosis: DDH.
4. **Neoplastic (1 case):**
   - MRI showed lytic lesion with periosteal reaction and soft tissue component.
   - Diagnosis: osteosarcoma.
5. **Other (1 case – Perthes):**
   - MRI revealed epiphyseal signal alteration without joint effusion.

DISCUSSION

Hip pain in pediatric patients is a frequent clinical presentation but often poses diagnostic challenges due to its broad spectrum of possible etiologies and the non-specific nature of symptoms in children. The current prospective study involved 15 pediatric patients under 16 years of age who presented with hip pain and underwent imaging evaluation through radiographs, ultrasound, and MRI. The study aimed to identify the role of radiological modalities in diagnosing the underlying causes, which included inflammatory, infective, developmental, neoplastic, and other disorders.[6]

Among the 15 cases, inflammatory causes such as transient synovitis and juvenile idiopathic arthritis constituted the largest group (40%). These patients commonly presented with joint effusion and pain but lacked systemic signs like fever. X-rays were often non-contributory or showed only mild joint space narrowing. Ultrasound provided initial confirmation of joint effusion and synovial thickening, but MRI was the most useful modality for these cases. It showed findings such as bone marrow edema, synovial enhancement, and joint fluid, allowing differentiation between transient synovitis and more aggressive inflammatory arthritis. In cases diagnosed as juvenile idiopathic arthritis, MRI also revealed chronic changes including synovial thickening and persistent marrow involvement.[7]

Infective causes were the second most common, comprising five cases (33.3%). These cases often presented with acute symptoms such as pain, fever, and refusal to bear weight. Ultrasound detected complex effusions with internal echoes, which helped in suggesting a diagnosis of septic arthritis. In a few cases, ultrasound was used to guide aspiration for microbiological confirmation. MRI provided critical additional information, including early marrow edema and soft tissue involvement, which could not be visualized on X-ray or ultrasound. MRI also enabled differentiation between septic arthritis and osteomyelitis, both of which demand prompt and specific management.[8]

Developmental dysplasia of the hip (DDH) was diagnosed in two infants. In both cases, radiographs showed a shallow acetabulum and lateral displacement of the femoral head. Ultrasound was especially valuable here due to the non-ossified femoral heads in infants, allowing real-time visualization of joint instability and confirming the diagnosis. MRI was not required for these cases as ultrasound and clinical findings were sufficient.

One case in the study was diagnosed as osteosarcoma. Radiographs revealed a lytic lesion with a periosteal reaction, and MRI was used for detailed evaluation. The MRI showed soft tissue extension, marrow infiltration, and helped in assessing local staging. This underscores MRI's utility not just in benign conditions but also in evaluating the extent of malignant pathology.[9]

A single case of Perthes disease was diagnosed in a child aged 7. The X-ray was initially inconclusive, but MRI revealed early epiphyseal changes and reduced signal intensity within the femoral head, confirming the diagnosis. This illustrates the importance of MRI in detecting early ischemic changes before they appear on radiographs.

Overall, this study reaffirmed the role of radiographs as a basic, widely available, and cost-effective initial tool in evaluating pediatric hip pain. However, its limitations in early disease stages were apparent. Ultrasound proved to be particularly valuable in the assessment of effusions, especially in infants and younger children. It also played a role in procedural guidance. MRI emerged as the most sensitive and comprehensive imaging modality, capable of detecting subtle and early pathological changes in both bone and soft tissues. It was instrumental in accurately classifying cases, especially in differentiating inflammatory from infective processes and in staging neoplastic conditions.[10]

The age distribution of diagnoses in this study also reflected typical patterns: DDH occurred in infants, transient synovitis and septic arthritis in preschool children, juvenile idiopathic arthritis in school-age children, and osteosarcoma in adolescents. Such patterns guide the selection of probable diagnoses even before imaging, and radiology helps in refining or confirming these suspicions.

While the sample size was limited to 15 patients, the study successfully highlighted the diagnostic value of a multimodality imaging approach in pediatric hip pain. Each imaging technique provided unique contributions, and the combined interpretation enhanced diagnostic accuracy and clinical decision-making.

CONCLUSION

Hip pain in children is a multifactorial symptom with a wide range of underlying causes—ranging from benign, self-limiting conditions like transient synovitis to urgent, potentially life-threatening disorders such as septic arthritis or malignant bone tumors. This study demonstrated the vital role of radiological imaging in differentiating these conditions, thereby enabling early diagnosis and appropriate management.

Radiographs served as an essential first-line tool to assess bony structures, joint space abnormalities, and developmental issues such as DDH. However, in several cases, particularly in early inflammatory or infective conditions, radiographs were either normal or non-specific. Ultrasound offered a quick and effective means of detecting joint effusion and guiding diagnostic aspirations, particularly in younger children. Its real-time capability and radiation-free nature make it highly suitable for initial screening and procedural support.

MRI, however, proved to be the most sensitive modality overall. It allowed visualization of early

marrow changes, synovial pathology, and soft tissue involvement. MRI was especially helpful in distinguishing between overlapping clinical entities, such as transient synovitis and early septic arthritis, or juvenile arthritis and osteomyelitis. It was also instrumental in identifying neoplastic lesions, staging their extent, and aiding in treatment planning.

Thus, a tiered approach to imaging starting with X-rays, followed by ultrasound and MRI when indicated can significantly enhance diagnostic precision in pediatric hip pathologies. This ensures timely intervention, prevents complications, and avoids unnecessary treatments.

Recommendations

1. **Adopt a multimodal imaging approach** in all pediatric patients with unexplained hip pain, starting with radiography, and escalating to ultrasound and MRI as clinically indicated.
2. **Use ultrasound** liberally in younger children to assess joint effusion and guide aspiration in suspected infective or inflammatory conditions.
3. **Perform MRI early** in cases where the diagnosis is uncertain, particularly when clinical signs suggest deep-seated infection, persistent inflammation, or marrow involvement.
4. **For suspected developmental anomalies** in infants (e.g., DDH), prioritize ultrasound as the first-line imaging modality, especially in the first 6 months of life when ossification is incomplete.
5. **Include MRI in diagnostic work-up** of suspected bone tumors or Perthes disease, where early changes are not always radiographically visible.
6. **Encourage close interdisciplinary coordination** between pediatricians, radiologists, and orthopedic specialists to ensure imaging findings are integrated into patient management plans.
7. **Future studies with larger sample sizes** are recommended to statistically validate imaging accuracy and compare outcomes with clinical and surgical findings.

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