

**A study on plain radiograph and MR evaluation of painful HIP joint****Thakur Rajani<sup>1</sup>, Aluka Sundeep Kund Reddy<sup>2\*</sup>**<sup>1</sup>Assistant Professor, Department of Radiodiagnosis and Imageology, NIZAM'S Institute of Medical Sciences, Hyderabad, Telangana, India<sup>2</sup>Assistant Professor, Department of Orthopaedics, NIZAM'S Institute of Medical Sciences, Hyderabad, Telangana, India

Received: 04-09-2020 / Revised: 16-10-2020 / Accepted: 04-11-2020

**Abstract**

**Background and Objectives:** Hip joint pain is a common complaint in the present day practice and could be due to various reasons, as the investigations are invariably used to come to a diagnosis of the cause of pain. Plain radiographs are used as primary investigation followed by MRI which is a valuable tool in the evaluation of hip disorders. MR imaging is the modality of choice when clinical examination is suspect for hip disease and plain radiographs are normal or equivocal. Early diagnosis and treatment is important in many of the disorders. **Materials and Methods:** A prospective cross sectional study is done on a total of 50 patients including both the sexes and of all age groups who presented with hip joint pain and subsequently underwent plain radiographs followed by MRI of the hip joint. The data is analysed and the findings on plain radiographs correlated with that of MRI. **Results:** Of the 50 cases the males (70%) are commonly affected than females (30%). Majority of the patients fall under the age group of 31-40 years (28%). In our study we find the commonest pathology for the hip joint pain is AVN of femoral head 16 cases (32%), followed by joint effusion 12 cases (24%), Osteoarthritis 10 cases (20%), TB hip 6 cases (12%), Perthes 2 cases (4%), DDH 2 cases (4%) and metastatic disease 2 cases (4%). Out of 16 cases of AVN only 4 (25%) cases are detected on plain radiograph where as all the 16 cases (100%) are diagnosed on MRI. Similarly out of 12 cases diagnosed as joint effusion only 4 cases (33%) are detected on plain radiograph, but all the 12 cases (100%) are detected on MRI. Rest of the pathologies are detected 100% both on X-ray and MRI however, MRI helps in better delineation of articular cartilage, epiphyses and extra articular soft tissue abnormalities. **Conclusion:** The hip is a stable, major weight-bearing joint with significant mobility. Plain radiography is a widely established, economical investigation readily available in all kinds of health setups for imaging the hip joint. Plain film radiography is used in the initial evaluation of any cause of hip pain. MRI of the hips should be performed early in patients with persistent pain and negative radiography findings. MR imaging is a valuable tool in the evaluation of hip disorders because it enables assessment of articular cartilage, epiphyses, joint fluid, bone marrow and extra-articular soft tissues structures that can be affected by hip disease.

**Key words:** Plain radiograph, MRI, Hip joint, Tuberculosis of hip, Bone marrow edema, Arthritis, Perthes disease, DDH, Avascular necrosis of hip.

This is an Open Access article that uses a fund-ing model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.

**Introduction**

Imaging of the hip was among the earliest reported

*\*Correspondence*

**Dr. Aluka Sundeep Kund Reddy**

Assistant Professor, Department of Orthopaedics,  
NIZAM'S Institute of Medical Sciences,  
Hyderabad, Telangana, India

E-mail: [surenderjakkam@gmail.com](mailto:surenderjakkam@gmail.com)

applications of musculoskeletal magnetic resonance (MR) imaging. MR imaging is a valuable tool in the evaluation of hip disorders because it enables assessment of articular structures, extra-articular soft tissues, and the osseous structures that can be affected by hip disease [1]. In the setting of chronic hip pain, a normal-appearing radiograph, a nonspecific history and clinical findings can be a difficult diagnostic dilemma. Trauma, infection, arthritis, avascular necrosis, tumor,

and hip dysplasia can all manifest with extremely subtle radiographic abnormalities[1]. Normal hip anatomy can be routinely demonstrated on coronal and axial MR images. The femoral head and neck and the intertrochanteric region are best appreciated on coronal MR images. Axial MR images provide good visualization of the articular space, hip musculature, and supporting ligaments[2]. The diagnostic role of MR imaging in the evaluation of AVN is evolving. MR imaging is performed to detect AVN in its early stages, thus allowing early treatment and prevention of subsequent bone destruction. MR imaging has been shown to be the most sensitive modality for imaging AVN. Screening of asymptomatic, high-risk patients may enable early intervention. The principal role of MR imaging is in establishing the diagnosis of AVN in symptomatic patients before radiographic changes become apparently visible[3,4]. MR imaging can be useful in the evaluation of a variety of hip disorders. We believe that attention to the details of MR examination technique and imaging protocol is essential for maximizing the diagnostic potential of MR imaging in the work-up of hip disease. Specific protocols that incorporate surface coil imaging, oblique image acquisition, and alternative pulse sequences are the foundation for successful hip studies. The use of GRE sequences is essential in the evaluation of cartilaginous disorders, particularly in pediatric hip disease[2]. Currently, high-resolution direct MR imaging of the hip provides the best means for evaluating intra-articular pathology. However, radiography remains important for the diagnosis of subtle bony irregularities associated with femoro-acetabular impingement[5].

Therefore, a comprehensive imaging strategy requires conventional radiographs and MRI to evaluate intra- and extra-articular sources of pain.

#### Objectives of the study

To estimate the role of MRI in early evaluation of painful hip joints with subtle plain radiographic findings.

To establish a differential diagnosis of the various painful hip joint conditions on MRI.

To assess the severity and extent of the underlying lesion in various conditions of painful hip joint.

#### Results

#### Source of Data

The main source of data for the study is patients from the following teaching Hospital attached to NIZAM'S Institute of Medical Sciences. Appropriate MRI sequences and multiplanar imaging will be performed for every patient. All patients referred to the department of Radio diagnosis with clinical history of hip pain in a period of 2 years from October 2017 to October 2019 will be subjected for the study.

Sample size: 50

**Duration of study:** 2 years

**Data Analysis:** A cross sectional study is performed and the data is analysed by Proportions.

**Inclusion Criteria:** The study include patients presenting with acute or chronic hip pain. Patients of all age groups and both sexes.

**Exclusion Criteria:** The study will exclude

- Patients with history of acute trauma
  - Patient having history of claustrophobia.
  - Patient having history of metallic implants insertion, cardiac pacemakers and metallic foreign body in situ
- Technique: Imaging will be done with 1.5 Tesla Philips Achieva Machine using abdominal surface coils and spine coils. The following sequences will be selected as required.

a)TIW coronal - TE(18ms) TR(500-700ms) slice thickness (1-3mm)

b)T1W axial - TE(18ms) TR(500-700ms) slice thickness(1-3mm)

c)T2W coronal - TE(100ms) TR(1000-1500ms) slice thickness (1-3mm)

d)T2W axial-TE(100ms)TR(1000-1500ms)slice thickness (1-3mm)

e)STIR coronal - TE(30ms) TR(2700-6000ms) slice thickness (3-5mm)

f)PD sagittal-TE(30ms)TR(2300-6500ms) slice thickness (3-5mm)

g)mFFE axial -TE(9.21ms) TR(500ms) slice thickness(1-3mm)

The study is mainly based on investigations as Radiology itself is a tool of Investigation. The study involves only humans. Informed consent would be taken after explaining about and before any procedure. Ethical clearance has been obtained from the Research and Dissertation Committee/ Ethical Committee of the institution for this study.

**Table 1 : Sex distribution**

Gender	Number of patients	%
Male	35	70%
Female	15	30%
<b>Total</b>	<b>50</b>	<b>100%</b>

**Table 2:Age wise distribution**

Age	Number of patients	%
0-10	4	8%
11-20	6	12%
21-30	11	22%
31-40	14	28%
41-50	8	16%
51-60	5	10%
61-70	2	4%
<b>Total</b>	<b>50</b>	<b>100%</b>

**Table 3 : Pathology**

Sl. No	Pathology	Number of patients	%
1.	AVN	16	32%
2.	Joint Effusion	12	24%
3.	OA	10	20%
4.	TB	6	12%
5.	Perthe's	2	04%
6.	DDH	2	04%
7.	Metastasis	2	04%
	Total	50	100%

**Avascular Necrosis of Femoral Head**

Out of 50 cases 16 (32%) cases are diagnosed as AVN of femoral head. In 16 cases of AVN only 4(25%) cases are detected on X-Ray but, all 16 (100%) cases are detected on MRI. 12 (75%) cases which are normal {stage 1 & stage 2 of FICATS CLASSIFICATION} on X-Ray proved to

have AVN on MRI. Out of 4(25%) cases which are detected both on X-Ray and MRI 2 (12.25%) cases which are detected as stage 2 on X-Ray { FICATS } shows stage 3 or more on MRI {MITCHELL'S} 2 (12.25%) cases which are detected as stage 3 on X-Ray { FICATS } shows stage 4 on MRI {MITCHELL'S}

**Table 4 : AVN**

AVN	On X-Ray	On MRI
Total 16	4 (25%)	16 (100%)

**Table 5 : X-ray findings**

X-Ray findings	Number of patients	Percentage % (n=4)
Osteoporosis	4	100
Sclerosis	2	50%
Subchondral cysts	2	50%
Crescent sign/subchondral lucency	2	50%
Altered morphology	2	50%

**Table 6 : MRI Findings**

MRI Findings	Number of patients	Percentage % (n=16)
Bone marrow edema	13	81
Double line sign	11	68
Subchondral cysts	12	75
Femoral head altered contour	2	12.5
Femoral head fragmentation with collapse	2	12.5

**Joint effusion:** Out of 50 cases 12 (24%) cases show joint effusion. Out of 12 cases of joint effusion 4 (33%) cases detected on X-Ray. And all the 12 (100%) cases are positive for joint effusion on MRI.

**Findings on X-Ray:** widened tear drop distance

**Findings on MRI:** T2W and STIR hyperintensity within the joint space which is graded as mild, moderate and severe.

**Table 7 : Joint effusion**

Joint effusion	Positive on X-Ray	Positive on MRI
Total 12 cases	4 cases (33%)	12 (100%)

**Table 8 : On MRI joint effusion**

On MRI joint effusion	Number of patients	Percentage % (n=12)
Mild	6	50
Moderate	5	41.6
severe	1	8.3

**Osteoarthritis**

Out of 50 cases 10 (20%) cases show Osteoarthritis. All the 10 cases are detected both on plain radiography and MRI. But, out of 10 cases 3 (30%) cases showing stage 1 on X-Ray shows stage 2 or 3 on MRI. Out of

10 cases 3 (30%) cases showing stage 2 on X-Ray shows stage 3 on MRI. Out of 10 cases detected on X-Ray stage 1 (4 cases) stage 2 (4 cases) stage 3 (2 cases). On MRI stage 1 (1 case) stage 2 (4 cases) stage (3 cases) stage (2 cases).

**Table 9 : X-ray findings**

X-Ray findings	Number of patients	Percentage % (n=10)
Possible osteophytes	4	40
Definite osteophytes	4	40
Joint space narrowing	8	80
Sclerosis	6	60
Cyst formation	2	20
Deformation of femoral head	2	20

**Table 10 : MRI findings**

MRI Findings	Number of patients	Percentage % (n=10)
Articular cartilage T2W high signal	5	50
Indistinct trabeculae/ signal loss in femoral head & neck on T1W	9	90
Indistinct zone between femoral head and acetabulum	3	30
Subchondral signal loss	3	30
Femoral head deformity	2	20

**TB of hip joint**

Out of 50 cases 6 cases (12%) shows TB HIP. Out of 6 Cases of TB HIP 5(83%) cases detected on X-Ray , where as 6(100%) cases detected on MRI. Out of 5 cas detected on X-Ray stage 1 (1

case), stage 2(1case), stage3 (2cases) , stage 4 ( 0 ) & stage 5 (1 case). Out of 6 cases detected on MRI shows stage 1( 1case), stage2(1 case), stage 3(1 case), stage 4(2 cases) & stage5(1 case).

**Table 11 : TB hip joint**

TB hip joint	On X-RAY	On MRI
Total 6	5 (83%)	6 (100%)

**Table 12 : X-ray findings**

X-Ray findings	Number of patients	Percentage % (n=5)
Osteopenia	4	80
Joint effusion	1	20
Soft tissue swelling	1	20
Joint erosions and reduction of joint space	3	60
Subchondral cysts	2	40
Joint destruction & bony ankylosis	1	20

**Table 13 : MRI findings**

MRI Findings	Number of patients	Percentage % (n=6)
Synovial hyperintensity on T2W	1	16.66
Joint effusion	2	33.33
Bone marrow edema	3	50
Subarticular cysts	1	16.66
Joint space reduction	3	50
Joint destruction & bony ankylosis	1	16.66
Soft tissue hyperintensity on T2W	3	50

**Perthe’s disease:** Out of 50 cases 2cases( 4%) show Perthe’s disease. Both 2 cases are detected on X-Ray(100%) and MRI (100%)

**Table 14 : X-ray findings**

X-Ray findings	Number of patients	Percentage % (n=2)
Small epiphyses	1	50
Complete resorption of epiphyses	1	50

**Table 15 : MRI findings**

MRI Findings	Number of patients	Percentage % (n=2)
Epiphyseal hyperintensity on T2W	1	50
Bone marrow edema	2	100

**Discussion**

Plain radiography is a widely established, economical investigation readily available in all kinds of health setups for imaging the hip joint. Whereas MRI is an expensive, not readily available investigation at the level of primary health care centers[5].However, is the

non-invasive gold investigation in early diagnosis, evaluate the extent of pathological involvement more accurately and narrow down the differential diagnosis. Our study aims at the early detection of the disease before the appearance of signs on radiography or in patients having subtle findings on plain radiography by

using MRI that helps the clinician to treat the patient at the early stages to prevent the further progression of disease. It also aims at the accurate staging of the disease and assesses the extent of involvement of the pathology in cases which are already detected on X-Ray, using MRI to guide the clinician in appropriate treatment according to the stage of involvement of pathology. Our discussion also proves MRI as gold standard in evaluation of soft tissue and articular cartilage which are having limitations for the detection of pathology on plain radiography.

#### **Avascular necrosis of femoral head**

In our study, AVN of femoral head is the commonest pathology identified as the cause for painful hip joint. In 16 (32%, n=50) cases of AVN diagnosed on MRI only 4 (8%, n=50) cases are identified on plain radiography. Out of 4 (25%, n=16) cases diagnosed on plain X-Ray 2 (4%, n=16) cases are showing subchondral cysts, osteoporosis suggestive of stage 1 AVN (FICATS staging). Other 2 (4%, n=16) cases are showing crescent sign, altered head morphology and osteoporosis suggestive of stage 2 AVN (FICATS staging). Of 16 cases detected on MRI 13 (81.25%, n=16) cases show bone marrow edema, reveals it is the common feature seen and can be detected only on MRI where X-Ray have its limitation in diagnosing Bone marrow edema. On MRI 11 (68.75%, n=16) cases shows double line sign i.e., on T2W sequences inner bright line representing granulation tissue and outer dark line suggestive of sclerotic bone. 12 (75%, n=16) cases diagnosed as normal or stage 1 (FICATS) on plain X-Ray shows stage 1 or 2 changes on MRI. Of 4 (25%, n=16) cases detected on plain X-Ray. (12.5%, n=16) cases are staged as stage 1 (FICATS) which shows stage 3 (MITCHELLS) giving fluid signal intermediate signal on T1W and T2W shows bright signal. (12.5%, n=16) cases which are staged as stage 2 (FICATS) shows stage 4 on MRI (MITCHELLS) giving fibrosis signal, dark on both T1W and T2W sequences, reveals that MRI evaluates better than X-Ray in staging and assess the extent of the pathological involvement in already proven cases of AVN on plain radiography that helps in appropriate treatment plan by the clinician based on the stage of AVN.

Our study is compared to the study done by Robinson HJ Jr. et.al, 11 in which 23 of the 96 hips that were suspected of having early-stage necrosis of the femoral head but showed slight or no radiographic changes were studied by repeat radiographs. Of the 23 hips, 18 (78 per cent) had positive changes on magnetic resonance imaging; In our study out of 16 hips MRI detects 16 cases (100%), whereas radiography detects only 4 cases (25%).

#### **Osteoarthritis**

In our study, 10 (20%, n=50) cases are diagnosed as osteoarthritis. All 10 cases are detected both on plain X-Ray and MRI. Out of 10 cases on plain X-Ray, 4 (40%, n=10) cases shows stage 1 (Kellgren and Lawrence staging) that is possible narrowing of joint space and possible osteophytes. 4 (40%, n=10) cases showing stage 2 that is definite narrowing of joint space inferiorly, minimal sclerosis and osteophytes. 2 (20%, n=10) cases showing stage 3 that is marked narrowing of joint space, definite osteophytes, cyst formation, deformation of femoral head and acetabulum.

Out of 10 cases detected on MRI.

1 (10%, n=10) case shows stage 1 (Higgs and Aiesen staging) that is inhomogeneous high signal on T2W within the cartilage.

4 (40%, n=10) cases show stage 2 that is inhomogeneity of articular cartilage high signal on T2W sequences and indistinct trabeculae or signal intensity loss in femoral head & neck on T1w sequences.

3 (30%, n=10) cases show stage 3 that is having criteria of stage 1&2 as mentioned above and indistinct zone between femoral head & acetabulum, subchondral signal loss due to bone loss.

2 (20%, n=10) cases show stage 4 that is criteria of stage 1,2&3 and showing femoral head deformity.

2 (30%, n=10) cases showing stage 1 on X-Ray shows stage 2 on MRI 3 (30%, n=10) cases showing stage 2 on X-Ray shows stage 3 on MRI 2 (20%, n=10) cases showing stage 3 on X-Ray shows stage 4 on MRI

Thus, MRI reveals better delineation of cartilage destruction and reveals accurate pathological involvement and staging of osteoarthritis which helps in appropriate plan of treatment or intervention by the clinician.

#### **Joint effusion**

In our study 12 (24%, n=50) cases show joint effusion. All 12 cases are detected on MRI (100%) but only 4 (33.33%, n=12) cases are detected on plain X-Ray. 4 (33.33%, n=12) cases diagnosed on plain X-Ray shows widened tear drop distance. On MRI joint effusion is seen as high signal intensity within the joint space both in T2W and STIR sequences suggestive of fluid collection within the joint space. On MRI it helps better in evaluation of the quantification of the amount of fluid within the joint and can be graded as minimal, moderate and severe joint effusion. On MRI 6 (50%, n=12) cases show minimal joint effusion, 5 (41.67%, n=12) cases show moderate joint effusion and 1 (8.33%, n=12) case shows severe joint effusion.

8 (66.67%, n=12) cases diagnosed as normal on plain X-Ray shows positive for joint effusion on MRI.

Thus, by our study it reveals MRI is more sensitive in detection of joint effusion particularly in cases where plain radiography shows normal or subtle changes even in strong clinical suspicion. It also helps better quantification of joint fluid collection[ 6-7].

#### **Tuberculosis of hip joint**

In our study 6(12%, n=50) cases are diagnosed as TB hip. 5(83.33%, n=6) cases are diagnosed on plain X-Ray. All 6 cases are diagnosed on MRI (100%, n=6). Among which, 1 (16.66%, n=6) case shows only osteopenia, joint effusion and soft tissue swelling.

1(16.66%, n=6) case shows along with osteopenia, marginal joint erosions and diminution of joint space.

2(33.33%, n=6) cases show osteopenia, joint erosions, joint space reduction and subchondral cysts.

1(16.66%, n=6) case shows joint destruction and bony ankylosis. 6(100%, n=6) cases diagnosed on MRI.

Among which, 1 (16.66%, n=6) case shows only synovial T2W hyperintensity and joint effusion in the form of high signal intensity within the joint space in T2W and STIR sequences, that is diagnosed as normal on plain X-Ray. It reveals the importance of MRI in early detection of TB where plain X-Ray remains normal in spite of strong clinical suspicion.

1(16.66%, n=6) case shows synovial hyper intensity, joint effusion and bone marrow edema as high signal intensity within the marrow on STIR sequence.

1(16.66%, n=6) case shows sub articular T2 hyper intense cysts and joint space reduction.

2(33.33%, n=6) cases show joint deformity along with bone marrow edema, joint space reduction and para articular soft tissue hyperintense signal on T2W.

1(16.66%, n=6) case shows marked joint destruction and bony ankylosis seen as hypo intensity on both T1W and T2W and para articular soft tissue involvement also. Thus, MRI helps in better delineation of synovial involvement and detection of joint effusion in early stages of TB Hip where plain X-Ray has limitation in diagnosis. MRI also helps in detection of bone marrow edema in early stages of TB Hip[8]. In diagnosed cases on plain X-Ray, MRI helps in better evaluation of the extent of the articular cartilage destruction and also para articular soft tissue involvement.

#### **Perthes disease**

In our study 2(4%, n=50) cases are diagnosed as Perthes disease. The 2 cases are diagnosed both on X-Ray and MRI(100%,n=2).

#### **On plain X-Ray**

1(50%, n=2) case shows cessation of femoral epiphyseal growth in the form of small epiphyses.

1(50%, n=2) case shows complete resorption of femoral epiphyses in healed/residual stage. On MRI 1(50%,n=2) case showing only cessation of femoral epiphyses growth on plain X-Ray, shows epiphyseal abnormality in the form of T1 Hypointensity, T2W hyperintensity and bone marrow edema in the form of STIR hyperintensity and metaphyseal T2W hyperintensities.

Our study is compared to the study done by Toby EB, Koman LA, Bechtold RE9 in the assessment of pediatric hip disease by scanning the hips of 24 children (30 scans). Twelve patients with Legg-Calvé-Perthes disease (17 hips) showed characteristic areas of low-intensity signal representative of necrotic areas of the capital epiphysis.

In our study both the cases are showing small epiphyses which are hypointense on T1W and hyperintense on T2W. Thus, MRI helps in better evaluation of femoral epiphyses along with detection of bone marrow edema on STIR sequence.

#### **Conclusion**

MR imaging is performed to detect AVN in its early stages, thus allowing early treatment and prevention of subsequent bone destruction. MR imaging has been shown to be the most sensitive modality for imaging AVN. MR imaging is uniquely capable of depicting the soft-tissue abnormalities that occur in arthritis, including synovial inflammation, joint effusion, and articular cartilage destruction. Joint effusion and synovial proliferation can be identified better by MRI than by conventional radiography. In proven cases on plain radiography like Perthe's and metastatic disease of Hip MRI helps in better staging of the disease, extent of pathological involvement and soft tissue extension. MRI is extremely sensitive to alterations in the bone marrow that may represent pathology occult to plain radiography of the hips.

#### **Acknowledgment**

The authors Thankful to Department of Radio Diagnosis and Orthopaedics for providing all the facilities to carry out this work.

#### **References**

1. Manaster BJ. Adult Chronic Hip Pain: Radiographic Evaluation. Radio Graphics 2000; 20: S3-S25.

2. Gabriel H, Fitzgerald SW, Myers MT, Donaldson JS, Andrew K. Poznanski. MR Imaging of Hip Disorders. *Radio Graphics* 1994; 14:763- 781.
3. Shih TT, Su CT, Chiu LC, Erickson F, Hang YS, Huang KM. Evaluation of hip disorders by radiography, radionuclide scanning and magnetic resonance imaging. *J Formos Med Assoc* 1993; 92(8): 737.
4. Khanna AJ, Yoon TR, Mont MA, Hungerford DS. David A, Bluemke. Femoral Head Osteonecrosis: Detection and Grading by Using a Rapid MR Imaging Protocol *Radiology* 2000; 217: 188-19
5. Donald G. Rao MV, Dalinkal M, Charles E, Spritzer, Jester WB, Axel L. MRI of Joint Fluid in the Normal and Ischemic Hip *AJR* 1986; 146 :1215-1218.
6. Huang GS, Chan WP, Chang YC, Chang CY, Yu-Chen C, Joseph S. MR imaging of bone marrow edema and joint effusion in patients with osteonecrosis of the femoral head: relationship to pain. *AJR Am J Roentgenol* 2003 ; 181(2): 545-9.
7. Jaramillo D, Galen TA., Winalski CS., DiCanzio J. Legg-Calve-Perthes Disease: MR Imaging Evaluation during Manual Positioning of the Hip—Comparison with Conventional Arthrography *Radiology* 1999; 212: 519-525.
8. Toby EB, Koman LA, Bechtold RE. Magnetic resonance imaging of pediatric hip disease. *J PediatrOrthop.* 1985; 5(6): 665-71.
9. Paluello MGB, De Pellegrin M, Tacchini S, Portinaro N, Maschio DM, De Gaspari A et al. Persistent coxalgia in the child. The value of magnetic resonance *Radiol Med.* 1995; 89(4): 402-8.
10. Robinson HJ Jr, Hartleben PD, Lund G, Schreiman J. Evaluation of magnetic resonance imaging in the diagnosis of osteonecrosis of the femoral head. Accuracy compared with radiographs, core biopsy and intraosseous pressure measurements. *J Bone Joint Surg* 1989;71(5):850-63.

**Conflict of Interest: Nil**

**Source of support: Nil**