

A Cross-Sectional Comparative Study of Plain Radiography and MRI for Evaluating Avascular Necrosis of the Femoral Head: Correlation with Clinical Parameters in a Tertiary Care Centre in Chengalpattu District

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Received: 28th Feb, 2026; Revised: 6th March 2026; Accepted: 7th April, 2026; Available Online: 20th April, 2026

ABSTRACT

Background: Avascular necrosis (AVN) of the femoral head is a progressive disorder caused by interruption of blood supply, leading to bone necrosis, femoral head collapse, and secondary osteoarthritis. Early diagnosis is essential to prevent irreversible joint damage. While plain radiography is commonly used for evaluation, magnetic resonance imaging (MRI) has superior sensitivity for early detection.

Objectives: To compare the diagnostic performance of plain radiography and MRI in patients with suspected AVN of the femoral head and to correlate imaging findings with clinical parameters.

Methods: This hospital-based analytical cross-sectional study was conducted over 18 months in a tertiary care teaching hospital. Sixty-five patients with clinically suspected AVN underwent plain radiography and MRI of the hip joint. Clinical assessment included pain and range of movement evaluation. Imaging findings were correlated with clinical severity using appropriate statistical analysis.

Results: The mean age was 38.75 ± 9.15 years with male predominance. Pain was present in all patients, while limping and restricted movements were common. Steroid use, alcohol consumption, and trauma were major risk factors. Bilateral involvement was observed in nearly half the patients. Most cases belonged to Stage II and III disease. MRI detected early marrow changes, bone marrow edema, and double-line sign more effectively than radiography. Imaging stage showed significant correlation with clinical severity and functional impairment.

Conclusion: MRI is more sensitive than plain radiography for early detection and staging of AVN of the femoral head. Although radiography remains useful as an initial screening tool, MRI is essential for accurate diagnosis and management planning.

Keywords: Avascular necrosis; Femoral head; Magnetic resonance imaging; Plain radiography; Harris Hip Score.

How to cite this article: Sahal BK A, Sai Shankar MG, Balaganesan H, Remya R. A Cross-Sectional Comparative Study of Plain Radiography and MRI for Evaluating Avascular Necrosis of the Femoral Head: Correlation with Clinical Parameters in a Tertiary Care Centre in Chengalpattu District. *Int J Drug Deliv Technol.* 2026;16(58s): 859-865. DOI: 10.25258/ijddt.16.58s.93

Source of support: Nil.

Conflict of interest: None

INTRODUCTION

Avascular necrosis (AVN) of the femoral head is a progressive condition caused by compromised blood supply to the femoral head, resulting in osteocyte death,

subchondral collapse, and secondary osteoarthritis. It commonly affects individuals between 30 and 60 years of age and contributes significantly to disability and total hip arthroplasty worldwide.

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Corticosteroid use, chronic alcohol consumption, trauma, and hematological disorders are important risk factors for AVN. Clinically, patients present with groin pain, limping, and restriction of hip movements, although early symptoms are often nonspecific, leading to delayed diagnosis.

Imaging plays a crucial role in diagnosis and staging. Plain radiography is widely available and inexpensive but has limited sensitivity in early disease. MRI is considered the gold standard due to its high sensitivity and specificity in detecting early marrow changes and characteristic findings such as the double-line sign.

Early diagnosis is essential because joint-preserving procedures are effective mainly in pre-collapse stages. Therefore, this study was undertaken to compare plain radiography and MRI in evaluating AVN of the femoral head and to correlate imaging findings with clinical parameters.

MATERIALS AND METHODS

This hospital-based analytical cross-sectional study was conducted in the Department of Radiodiagnosis at a tertiary care teaching hospital over 18 months from March 2024 to January 2026. A total of 65 patients aged above 18 years with clinically suspected or confirmed AVN of the femoral head were included.

Patients with risk factors such as corticosteroid use, trauma, alcoholism, pancreatitis, radiation exposure, sickle cell disease, and infiltrative disorders who underwent both plain radiography and MRI of the hip joint were included. Patients with contraindications to MRI, active hip infection, or hip neoplasms were excluded.

Sample size was calculated using:

- $n = 4pq/L^2$

The final sample size obtained was 65 after accounting for a 10% non-response rate.

Ethical clearance was obtained from the Institutional Ethics Committee, and informed consent was obtained from all participants. Plain radiographs were obtained in standard anteroposterior and lateral views. MRI was performed using a Philips 1.5 Tesla scanner with axial, sagittal, and coronal sequences. Data were analysed using IBM SPSS version 27, with $p < 0.05$ considered statistically significant.

RESULTS

A total of 65 patients with suspected AVN of the femoral head were included. The mean age was 38.75 ± 9.15 years, with most patients belonging to the 30–40 years age group. There was significant male predominance (81.5%). Pain was present in all patients, while limping and restriction of hip movements were common clinical findings.

Steroid use (52.3%), alcohol consumption (43.1%), and trauma (40%) were the major associated risk factors. Bilateral involvement was observed in 46.2% of cases. The mean Harris Hip Score was 68.92 ± 13.31 .

Most patients belonged to Stage II and Stage III disease on both radiography and MRI. MRI identified early pathological findings more effectively than plain radiography, including bone marrow edema (70.8%) and double-line sign (64.6%). Significant positive correlations were observed between imaging stage and clinical severity. Functional impairment progressively worsened with advancing disease stage.

Table 1: Demographic and Clinical Characteristics of the Study Population

Variable	Value
Mean age (years)	38.75 ± 9.15
Male sex	53 (81.5%)
Pain	65 (100%)
Limping	53 (81.5%)
Restriction of movements	44 (67.7%)
Steroid use	34 (52.3%)
Alcohol consumption	28 (43.1%)
Recent trauma	26 (40%)
Bilateral involvement	30 (46.2%)
Mean Harris Hip Score	68.92 ± 13.31
Mean pain score	5.66 ± 0.87

Table 2: Distribution of AVN Staging on Plain Radiography and MRI

Stage	X-ray n (%)	MRI n (%)
I	7 (10.8%)	7 (10.8%)
II	26 (40.0%)	29 (44.6%)
III	21 (32.3%)	26 (40.0%)
IV	11 (16.9%)	3 (4.6%)

Table 3: Comparison of Imaging Findings on Plain Radiography and MRI

Imaging finding	X-ray n (%)	MRI n (%)
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Sclerosis	38 (58.5%)	47 (72.3%)
Osteopenia	18 (27.7%)	26 (40.0%)
Subchondral cysts	27 (41.5%)	27 (41.5%)
Bone marrow edema	-	46 (70.8%)
Double-line sign	-	42 (64.6%)
Subchondral fracture	20 (30.8%)	24 (36.9%)
Joint effusion	-	32 (49.2%)
Joint space narrowing	23 (35.4%)	23 (35.4%)

Table 4: Correlation of Imaging Stage with Clinical Severity and Functional Outcome

Parameter	Imaging modality	Correlation/Statistic	p-value
Pain score vs stage	X-ray	Spearman rho = 0.667	<0.001
Pain score vs stage	MRI	Spearman rho = 0.665	<0.001
Movement restriction vs stage	X-ray	Spearman rho = 0.710	<0.001
Movement restriction vs stage	MRI	Spearman rho = 0.674	<0.001
HHS functional score vs stage	X-ray	F = 93.75	<0.001
HHS functional score vs stage	MRI	F = 40.19	<0.001

DISCUSSION

AVN of the femoral head predominantly affected young and middle-aged adults with marked male predominance, findings comparable with previous studies. Pain, limping, and restriction of movements were the major presenting complaints, reflecting significant functional impairment.

Most patients presented in Stage II and III disease, indicating delayed diagnosis. MRI demonstrated characteristic findings such as bone marrow edema and double-line sign more frequently than plain radiography, confirming its superior sensitivity in early disease detection.

Significant positive correlations were observed between imaging stage and clinical severity. Although radiographic staging correlated more strongly with functional disability, MRI was superior for early diagnosis and accurate staging. These findings emphasize the importance of early MRI evaluation in patients with persistent hip pain and associated risk factors.

CONCLUSION

Avascular necrosis of the femoral head predominantly affected young and middle-aged adults and showed a marked male predominance. MRI demonstrated superior sensitivity compared with plain radiography in detecting early pathological changes such as bone marrow edema and double-line sign. Although plain radiography remains useful as an initial screening modality, MRI is the imaging modality of choice for early diagnosis, accurate staging, and assessment of disease extent. Early MRI evaluation may facilitate timely joint-preserving interventions and improve functional outcomes.

LIMITATIONS

This study was conducted at a single tertiary care centre with a relatively small sample size, which may limit the generalizability of the findings. The cross-sectional design did not allow assessment of disease progression or long-term outcomes. Further multicentric longitudinal studies are recommended to validate the findings.

IMAGES FROM FEW CASES:



Figure 1: Frontal radiograph of hip showing Stage I AVN in left femoral head
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Figure 2: MRI-T2 coronal and STIR coronal section of bilateral hip showing Stage I AVN in left femur head with joint effusion.



Figure 3: Frontal radiograph of hip AP view- bilateral AVN femur heads - Stage III (right) and II (left)



Figure 4: MRI- T2 coronal section - bilateral AVN femur heads - Stage III (right) and II (left)



Figure 5: Frontal radiograph of hip AP view - bilateral AVN femur heads - Stage II (right) and III (left)



Figure 6: MRI T2 coronal section- bilateral AVN femur heads - Stage II (right) and III (left)



Figure 7: Frontal radiograph of hip AP- bilateral AVN femur heads - Stage III (right) and IV (left)



Figure 8: MRI - bilateral AVN femur heads - Stage III (right) and IV (left)

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