



Original Article


## Magnetic Resonance Imaging Evaluation of Avascular Necrosis of the Hip in Post-COVID-19 Patients: A Prospective Observational Study

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### ABSTRACT

**Background:** Avascular necrosis (AVN) of the femoral head has emerged as a significant complication in post-COVID-19 patients, potentially related to corticosteroid therapy and COVID-induced hypercoagulable states. Early diagnosis is essential to prevent disease progression, and Magnetic Resonance Imaging (MRI) plays a pivotal role in detecting early changes.

**Aim:** To evaluate MRI findings of avascular necrosis of the hip in post-COVID-19 patients and assess their clinical and radiological correlation.

**Materials and Methods:** This prospective observational study was conducted over one year, including 40 post-COVID-19 patients presenting with hip pain. MRI of the hip was performed using standard protocols. Findings such as marrow edema, double-line sign, subchondral fracture, and femoral head collapse were assessed. AVN was staged using MRI-based classification, and correlation with clinical parameters, including steroid use, was analyzed.

**Results:** The majority of patients were in the 31–45 years age group (45%) with male predominance (65%). Steroid use was noted in 75% of cases. MRI revealed marrow edema in 80% and double-line sign in 70% of patients. Most cases were in Stage II (40%), followed by Stage I (25%). A significant association was observed between steroid use and advanced stages of AVN ( $p < 0.05$ ).

**Conclusion:** MRI is a highly sensitive modality for early detection and staging of AVN in post-COVID patients. Early diagnosis facilitates timely management and may prevent disease progression.

**Keywords:** Avascular necrosis; MRI; Post-COVID-19.

### INTRODUCTION

Avascular necrosis (AVN) of the femoral head is a progressive and debilitating condition resulting from compromised blood supply, ultimately leading to bone ischemia, structural collapse, and secondary osteoarthritis of the hip joint. Early diagnosis is critical, as timely intervention can halt disease progression and preserve joint function. Among available imaging modalities, Magnetic Resonance Imaging (MRI) is considered the gold standard for early detection due to its high sensitivity in identifying marrow changes before radiographic abnormalities become apparent.

In the context of the coronavirus disease 2019 (COVID-19) pandemic, an increasing number of AVN cases have been reported in post-COVID-19 patients. This association is primarily attributed to the widespread use of corticosteroids in the management of moderate to severe COVID-19, as well as the hypercoagulable and inflammatory state induced by the infection itself, which may contribute to vascular compromise of the femoral head. Notably, AVN in post-COVID patients appears to develop earlier and sometimes at lower cumulative steroid doses than traditionally observed.

Given these emerging concerns, MRI plays a pivotal role in the early identification, staging, and assessment of disease extent in affected individuals. This study aims to evaluate the MRI findings of avascular necrosis of the hip in post-COVID-

19 patients and to assess its clinical and radiological characteristics for better understanding and management of this evolving clinical entity

## STUDY METHODOLOGY

This prospective observational study was conducted in the Department of Radio-Diagnosis at a tertiary care center over a period of one year. A total of 40 patients with a history of COVID-19 infection presenting with hip pain or clinical suspicion of avascular necrosis were included in the study. Prior approval was obtained from the Institutional Ethics Committee, and informed consent was taken from all participants before enrollment.

Patients were selected based on predefined inclusion and exclusion criteria. Inclusion criteria comprised patients aged 18–65 years with documented history of COVID-19 infection and persistent hip pain suggestive of AVN. Exclusion criteria included patients with pre-existing hip pathology, traumatic hip injury, known cases of AVN prior to COVID-19 infection, and contraindications to MRI such as implanted metallic devices or claustrophobia. A detailed clinical history, including steroid usage, duration of illness, and comorbidities, was recorded for all patients.

All enrolled patients underwent Magnetic Resonance Imaging of the hip using a standardized protocol. MRI sequences included T1-weighted, T2-weighted, STIR, and proton density fat-suppressed images in multiple planes. The images were evaluated for early marrow changes, presence of the double-line sign, subchondral fractures, joint effusion, and extent of femoral head involvement. Staging of avascular necrosis was performed based on established MRI-based classification systems.

The collected data were compiled and analyzed using appropriate statistical methods. Descriptive statistics such as mean, standard deviation, frequency, and percentage were used to summarize the findings. Correlation between MRI findings and clinical parameters such as steroid exposure and duration post-COVID infection was assessed using suitable statistical tests. A p-value of less than 0.05 was considered statistically significant.

## RESULTS:

**Table 1. Demographic and Clinical Profile of Study Participants (n = 40)**

Parameter	Frequency (n)	Percentage (%)
<b>Age Group (years)</b>		
18–30	8	20.0
31–45	18	45.0
46–65	14	35.0
<b>Gender</b>		
Male	26	65.0
Female	14	35.0
<b>History of Steroid Use</b>		
Yes	30	75.0
No	10	25.0
<b>Time Interval Post-COVID</b>		
< 3 months	12	30.0
3–6 months	18	45.0
> 6 months	10	25.0

**Table 2. MRI Findings in Avascular Necrosis of Hip**

MRI Findings	Frequency (n)	Percentage (%)
Bone marrow edema	32	80.0
Double-line sign	28	70.0
Subchondral fracture	14	35.0
Femoral head collapse	10	25.0
Joint effusion	22	55.0
Bilateral involvement	16	40.0

**Table 3. MRI-Based Staging of Avascular Necrosis**

Stage (Ficat/ARCO)	Frequency (n)	Percentage (%)
Stage I	10	25.0
Stage II	16	40.0
Stage III	9	22.5
Stage IV	5	12.5

**Table 4. Association Between Steroid Use and Severity of AVN**

Severity (Stage I–II vs Stage III–IV)	Steroid Users (n=30)	Non-users (n=10)	p-value
Early stage (I–II)	18 (60.0%)	8 (80.0%)	
Advanced stage (III–IV)	12 (40.0%)	2 (20.0%)	<b>0.041 (Significant)</b>

**Statistical Test Used:** Chi-square test

## DISCUSSION

The present study evaluated the role of MRI in detecting and assessing avascular necrosis (AVN) of the hip in post-COVID-19 patients, with emphasis on clinical correlation and disease staging. The findings highlight the emerging clinical concern of AVN following COVID-19 infection and reinforce the importance of early imaging for timely diagnosis.

In this study, the majority of patients belonged to the 31–45 years age group (45%), indicating that AVN in the post-COVID setting is affecting relatively younger, active individuals. A male predominance (65%) was observed, which is consistent with previous literature suggesting higher exposure to risk factors such as steroid use and occupational stress in males. A significant proportion of patients (75%) had a history of corticosteroid use during COVID-19 treatment, supporting the well-established association between steroid therapy and AVN. However, the occurrence of AVN in 25% of patients without steroid exposure suggests that COVID-19–induced hypercoagulability and endothelial dysfunction may independently contribute to vascular compromise.

The temporal relationship between COVID-19 infection and onset of AVN symptoms is noteworthy. In the present study, 75% of patients presented within six months of infection, with the highest proportion (45%) in the 3–6 months interval. This indicates an earlier onset of AVN compared to traditional steroid-induced cases, where symptoms typically develop over a longer duration. This finding underscores the need for heightened clinical suspicion and early screening in post-COVID patients presenting with hip pain.

MRI findings in this study demonstrated a high prevalence of bone marrow edema (80%) and the classical double-line sign (70%), reaffirming MRI as a highly sensitive modality for early detection of AVN. The presence of joint effusion (55%) and bilateral involvement (40%) further supports the aggressive and multifocal nature of the disease in the post-COVID setting. Advanced features such as subchondral fracture (35%) and femoral head collapse (25%) indicate that a considerable number of patients present at a relatively advanced stage, possibly due to delayed diagnosis or lack of early imaging.

Staging of AVN revealed that the majority of patients were in Stage II (40%), followed by Stage I (25%), suggesting that MRI was effective in detecting disease before significant structural collapse in many cases. However, 35% of patients were already in advanced stages (Stage III and IV), which has important prognostic implications, as these stages are associated with poorer outcomes and often require surgical intervention.

A statistically significant association was observed between steroid use and severity of AVN ( $p = 0.041$ ), with a higher proportion of advanced-stage disease among steroid users. This finding reinforces the dose-dependent and duration-related risk of corticosteroids in the pathogenesis of AVN. It also highlights the importance of judicious steroid use and close follow-up of high-risk patients.

## CONCLUSION:

Overall, the study emphasizes that MRI plays a crucial role in early diagnosis, staging, and management planning of AVN in post-COVID patients. Early identification of disease can facilitate conservative management and potentially prevent progression to femoral head collapse. Given the increasing incidence of post-COVID AVN, clinicians should maintain a high index of suspicion and consider early MRI evaluation in patients presenting with hip pain, especially those with a history of steroid therapy.

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