

Painful Chondral Delamination in Early-stage Osteonecrosis of the Femoral Head Precipitating Total Hip Arthroplasty

Sanjay Agarwala¹, Aditya Menon¹

Learning Point of the Article:

In early-stage osteonecrosis of the femoral head unresponsive to bisphosphonate therapy, clinically significant chondral delamination — not evident on standard imaging — may be the true driver of persistent pain, justifying total hip arthroplasty even in the absence of radiological progression.

Abstract

Introduction: Aim and Background: Osteonecrosis of the femoral head (ONFH)/avascular necrosis of the femoral head (FH) is a debilitating clinical entity. Bisphosphonates (BPS) are beneficial for conservative/medical management, especially in the early stages. There is, however, a subset of patients with early ONFH who do not respond to BPS and continue to worsen clinically despite no radiological progression. This retrospective cross-sectional study offers a possible explanation for the inexplicable cause of the severe pain in patients with early ONFH from the gross pathological changes of the retrieved FH.

Materials and Methods: A retrospective cross-sectional analysis was conducted on all patients who underwent THA for Early Ficat Arlet Stage Two by the senior surgeon following inadequate relief with BPS between August 2014 and February 2025. Gross intraoperative cartilage findings were graded as per Outerbridge Classification.

Results: 116 patients (mean age 38.1 years) met the inclusion criteria. Cartilage changes observed were: softening in 37, partial thickness fissure in 30, full-thickness fissure in 17 and exposed subchondral bone in 32 FHs.

Conclusion: Delamination of FH cartilage observed in retrieved FHs could explain the persistent pain in some patients with early ONFH unresponsive to medical therapy.

Keywords: Osteonecrosis, total hip arthroplasty, chondral lesion, delamination, avascular necrosis of femoral head, cartilage loss, femoral head sparing procedure, femoral head replacement procedure.

Level of Evidence: Level III – retrospective cross-sectional study.

Aim and Background

Osteonecrosis of the femoral head (ONFH)/avascular necrosis (AVN) of the femoral head (FH) is a debilitating pathology predominantly affecting younger adults [1]. Treatment options for ONFH include medications to manage pain and

inflammation, physical therapy to improve joint mobility and strength, and in severe cases, surgical intervention to replace the damaged bone or joint [2].

Various treatment options exist for Early ONFH before FH flattening/change in shape. These options include, but are not

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Dr. Sanjay Agarwala



Dr. Aditya Menon

¹Department of Orthopedics, P D Hinduja Hospital and Medical Research Centre, Mumbai, Maharashtra, India.

Address of Correspondence:

Dr. Sanjay Agarwala,
Department of Orthopedics, P D Hinduja Hospital and Medical Research Centre, Mumbai, Maharashtra, India.
E-mail: drsa2011@gmail.com

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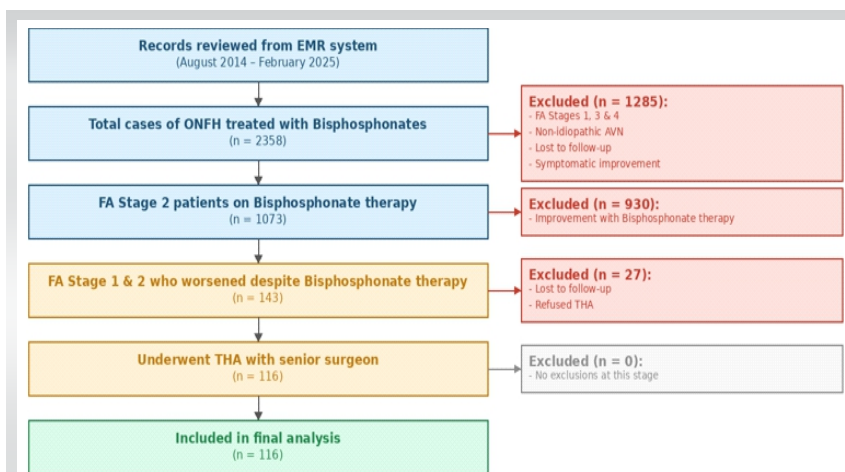


Figure 1: Flowchart illustrating the retrospective process of patient selection. THA: Total hip arthroplasty, FA: Ficat arlet, ONFH: Osteonecrosis of femoral head.

limited to, restricted weight bearing, use of various pharmacologic agents such as lipid-lowering drugs, anticoagulants, and vasodilators [3]. The early stages (Ficat and Arlet [FA] Stages One and Two) have also been successfully managed with oral and/or intravenous Bisphosphonates (BPS) [2,4,5,6,7,8,9]. Numerous FH sparing procedures (FHSP) (core decompression with or without osteoinductive substances, bone morphogenic proteins, mesenchymal stem cells implantation, growth factor-based treatment strategies, bone grafting, non-vascularized cortical grafts, free vascularized fibular grafting and osteotomies) have also been described in literature, though with highly variable outcomes [3,10,11,12,13,14,15,16,17]. FH replacement procedures, such as total hip arthroplasty (THA) or resurfacing total hip replacement, are generally reserved for late FA stage Three and Four [18].

There is, however, a subset of patients with early ONFH who continue to have persistent pain despite no radiological progression. The reasons for continued symptoms are poorly understood. Some of these patients chose to undergo THA at this early stage for pain relief and improvement in quality of life. The clinical, radiological and intraoperative correlation is yet not well-defined in the literature.

This retrospective cross-sectional study explains the inexplicable cause for the severe pain in patients with early ONFH from the gross pathological changes of the retrieved FH, thereby possibly explaining the reasons for discordance between the radiological findings and clinical severity.

Materials and Methods

Study design and participants

This was a retrospective cross-sectional study conducted at a tertiary reference center, after Internal Review Board Approval

(IRB/1476/AL, Feb, 2025). Medical records were reviewed for all patients with Early FA Stage 2 idiopathic ONFH who had undergone THA with the senior surgeon following inadequate pain relief despite receiving BPS, between August 2014 and February 2025. All other etiologies, such as post-traumatic ONFH, were excluded.

After systematically reviewing the electronic medical records (EMR), a total of 116 cases were identified and included for analysis (Fig. 1).

Management algorithm

All patients with ONFH had been prescribed BPS for 3 years as per the established protocol of oral alendronate along with intravenous Zoledronic acid. In addition, patients received daily supplements of calcium 500 mg and Vitamin D 400 IU. Analgesics were administered as and when required. Partial weight bearing using axillary or elbow crutches was advised for the first 3 months after the initiation of bisphosphonate therapy, and weight bearing was allowed as tolerated thereafter.

Patients were followed up at 3 months after initiation of therapy and then annually. Clinical and radiological progression were noted at each visit. Radiological assessment was performed with plain radiographs of both hips in anteroposterior and lateral views at every visit.

FHSP, as well as THA, with their associated advantages and disadvantages, were explained to those who had persistent or worsened pain despite adequate conservative management. Patients who chose FHSP were excluded from this study. The excised heads of all patients undergoing THA were photographed and classified according to Outerbridge classification [19].

Data collection

Data were extracted retrospectively from the EMR system and entered into a predesigned spreadsheet. Patient demography, symptoms, radiological findings, and operative details were systematically recorded. Those patients with incomplete records were excluded from analysis.

The gross findings of FH cartilage were classified as per the Outerbridge classification [19]:

- Grade 0: Normal articular cartilage
- Grade 1: Softening, blistering, or swelling of the cartilage
- Grade 2: Partial thickness fissure and clefts <1 cm in diameter
- Grade 3: Full-thickness fissures, to the subchondral bone >1 cm in diameter

Table 1: Patient demography

Parameter	Value
Total number of patients	116
Males	88
Females	28
Mean age (years)	38.1
Side (right/left)	51 / 65
Ficat Arlet stage 1	0
Ficat Arlet stage 2	116

- Grade 4: Exposed subchondral bone.

Outcome measures

The gross intraoperative findings were matched with the radiological findings, providing a possible rationale for the persisting pain and failure of BPS therapy in this retrospective cohort.

Results

Patient demographics (Table 1)

The retrospective review included a total of 116 patients with a mean age of 38.1 years. The cohort was predominantly male, consisting of 88 men and 28 women. Regarding the side of the procedure, 51 cases involved the right side, while 65 involved the left. Notably, all 116 patients were classified as being in FA Stage 2, with no patients in Stage 1.

Intra-operative findings (Table 2)

During the intraoperative assessment of the FHs using the Outerbridge grading system, no cases were identified as Grade 0 (normal). The most frequent finding was Grade 1 (softening or blistering), which was observed in 37 FHs. Grade 2 findings, characterized by partial thickness fissures or clefts, were present in 30 cases. Grade 3 findings, involving full-thickness fissures reaching the subchondral bone, were seen in 17 instances. Finally, 32 FHs demonstrated Grade 4 findings, indicating exposed subchondral bone.

Discussion

ONFH is a condition that predominantly affects young adults [18]. It results in a debilitating state with a varied response to conservative management. Clinical improvement with medical/conservative therapies is higher in early FA Stages

Table 2: Intraoperative findings

Outerbridge grade	Gross findings	No. of femoral heads
0	Normal	0
1	Softening/blistering	37
2	Partial thickness fissure/Cleft	30
3	Full thickness fissure to subchondral bone	17
4	Exposed subchondral bone	32

[4,7,9]. Conservative therapies aim to ensure a relatively pain-free quality of life and delay the onset of flattening of the FH and secondary osteoarthritis. However, none of them adequately address cartilage changes/delamination.

Some patients with early ONFH continue to have persistent pain and disability. There is scant literature on the reasons behind the failure of conservative therapy. It has been postulated that bone oedema is one of the main causes for pain in ONFH, especially in the pre-collapse stages [5,6,7]. BPS have proven to be beneficial by resolving this edema underlying the cartilage [20].

Browne and Branch have shown that subchondral edema must be considered as a flag for detailed evaluation of the overlying articular surface cartilage [19]. Although magnetic resonance imaging (MRI) is the gold standard in diagnosing ONFH, it has variable sensitivity and specificity in identifying cartilaginous lesions [21,22,23]. MRI remains the ideal non-invasive investigation, with arthroscopy being the ideal diagnostic and/or therapeutic intervention [24].

This retrospective cross-sectional study evaluated the morphological changes in FH cartilage from the retrieved heads of patients who had undergone THA for persistent pain in early ONFH. A variety of cartilaginous changes were found, ranging from softening to complete loss of cartilage with exposed subchondral bone, based on the Outerbridge classification (Fig. 2,3,4,5).

Similar gross cartilage changes were described by Babhulkar, describing severe cartilage loss with advanced stages [25]. Cartilage loss has been noted in Stage 2 in our series, which could be secondary to the underlying non-collapsed ischemic subchondral bone.

Lands et al., described a case report of THA following delamination in a case of ONFH [26]. The patient underwent THA after failure of conservative management. They

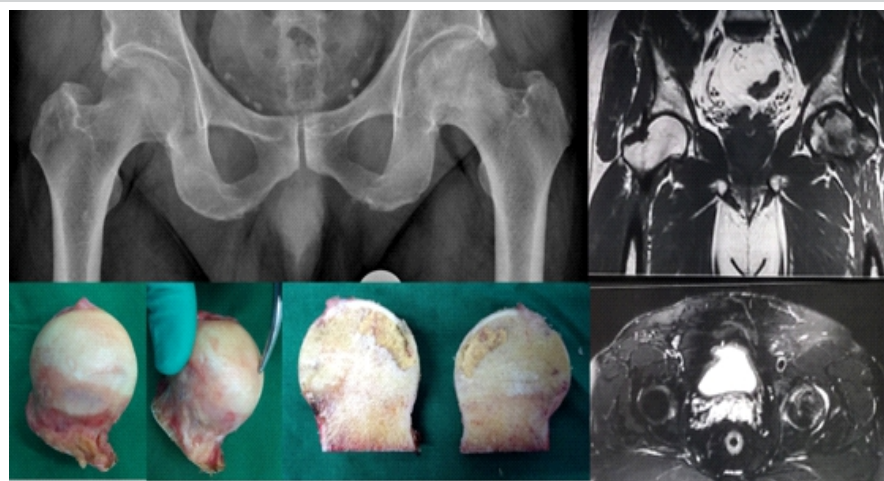


Figure 2: Softening of cartilage – left hip avascular necrosis (Outerbridge grade 1).

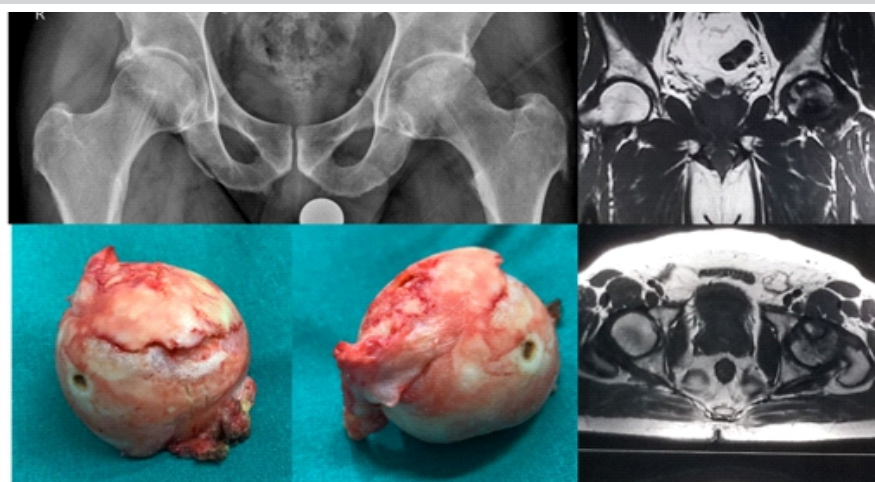


Figure 3: Partial fissure – left hip avascular necrosis (Outerbridge grade 2).

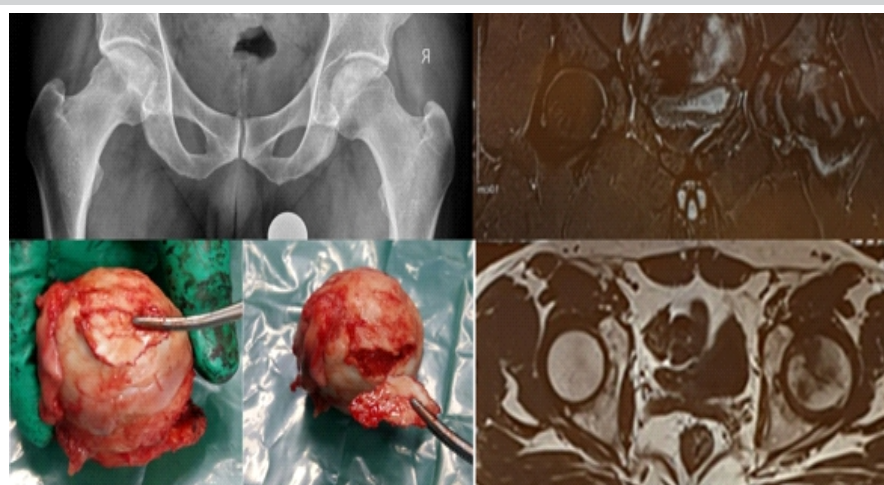


Figure 4: Complete fissure – left hip avascular necrosis (Outerbridge grade 3).

the articular cartilage could start to separate from the underlying bone, known as delamination. This could cause pain and stiffness in the hip joint and can eventually lead to joint collapse and the development of osteoarthritis [26].

Although there are numerous reports on conservative management for such chondral lesions, ranging from arthroscopic debridement to mosaicplasty to microfracture, THA still remains the gold standard for such lesions [18, 24, 27]. Difficult surgical technique, surgeon experience, and variable outcomes are some of the reasons behind secondary THA after conservative surgeries for chondral defects [26,27]. In addition, there are reports of ON following Chondral Resurfacing Procedures [28]. Moreover, many of the cartilaginous lesions in ONFH may be missed even on MRI, the diagnostic modality of choice [19].

Unrecognized and untreated chondral injuries can have a poor prognosis, with possible outcomes including worsening of cartilaginous injury due to AVN [29]. It can hasten progression from pre-collapse to end-stage degenerative changes [26].

It is debatable whether a chondral resurfacing procedure would help in a progressive pathology like ONFH, where the changes are occurring in the underlying bone. In a recent review, Du et al. [30] described numerous surgical options for repairing cartilage defects in the FH, such as microfracture, cartilage replantation, ACI/MAC, and autograft/allograft transplantation. Most of these techniques were originally established for the management of the knee joint. Their application for FH pathologies is limited, which can be explained by the fact that the articular surface of the FH exhibits greater curvature, deeper location, and more complex blood supply, as compared to the knee joint. Clinical evidence available on these procedures for the hip is limited to single case reports or case series, and the clinical outcomes are not comparable to those in the knee.

postulated that articular cartilage delamination could be a cause of early-stage ONFH of the hip joint. In the early stages of AVN,

clinical outcomes are not comparable to those in the knee.

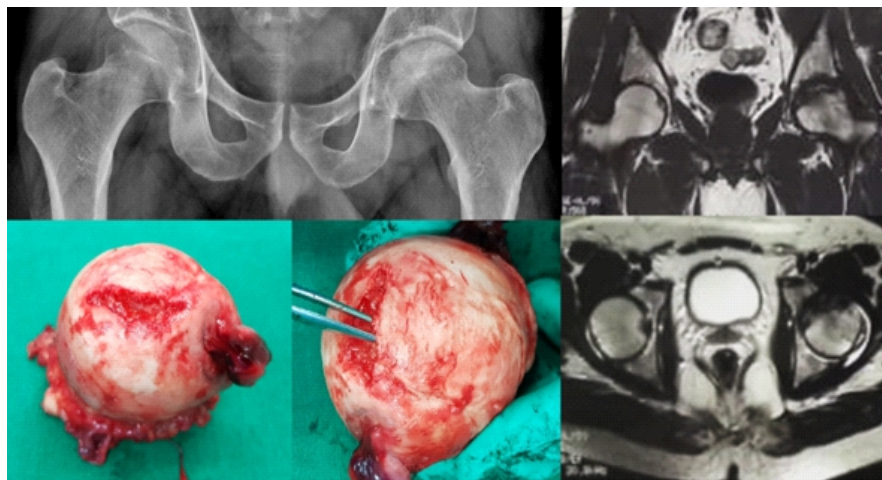


Figure 5: Exposed subchondral bone – left hip avascular necrosis (Outerbridge grade 4).

Larger clinical studies with additional efficient solutions or options are desirable to treat cartilage defects in the FH.

The limitations of this study include its retrospective design, relatively small number of cases, and the inherent possibility of selection bias. Excluding those lost to follow-up after failure of BPS therapy and including only those who eventually underwent THA means the conclusions may not apply to all patients with persistent pain despite adequate BPS therapy.

Future studies with detailed MRI cartilage mapping with intra-operative correlation could provide additional information and insight. A randomized controlled trial between chondral resurfacing procedures and THA for such cases would represent an ideal study design.

Ethical Statement and Consent

Informed consent was obtained from all the patients for participation and publication of this retrospective cross-

sectional study and accompanying images. All procedures were performed in accordance with the ethical standards of the institutional research committee and with the Helsinki Declaration and its later amendments. This study was approved by the Institutional Review Board (IRB/1476/AL, February 2025).

Conclusion

Medical therapy, such as BPS, continues to be an important treatment strategy for early ONFH before a change in the shape of the FH. There is, however, a subset of patients who have persistent pain with no obvious cause in view of the seemingly normal

radiology. This retrospective cross-sectional study highlights that cartilage softening/delamination in this complex ball-and-socket weight-bearing joint could possibly be the cause of the persistent incapacitating pain. THA, an established and proven surgical intervention, provides a viable option to overcome this cartilage damage.

Clinical Message

In patients with early-stage ONFH who do not experience pain relief from bisphosphonate therapy and show no radiological progression, persistent severe pain may be due to painful chondral delamination, including cartilage softening, fissures, or loss. These cartilage changes often remain undetected on standard imaging, explaining the clinical-radiological discordance. Recognition of this pathology supports THA as an effective treatment option to alleviate pain and improve quality of life in this patient subgroup.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

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