



Review Article

ISSN : 2277-3657  
CODEN(USA) : IJPRPM

## *An Overview of the Diagnosis and Management of Avascular Necrosis: Literature Review*

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### ABSTRACT

Hip joint necrosis is the most commonly affected joint with avascular necrosis. Other common ischemic necrosis includes carpal bones, talus, metatarsal bones, mandible bone, and humeral head. It is important for the orthopedic surgeon to understand the underlying mechanisms and extent of severity to determine the best approach to management. PubMed database was used for article selection, papers on were obtained and reviewed. PubMed database was used for article selection, and the following keys terms: avascular necrosis, femoral head necrosis, ischemic necrosis management. Patients with avascular necrosis present with joint pain of varying degrees. This pain is often associated with an underlying bone framework collapse. Peri-operative classification systems such as Ficat-Arlet criteria are used for staging femoral head necrosis, and proves useful in imaging and operative approach to treatment. The orthopedic surgeon should rely on his/her clinical judgment on per case basis, combining this with high-resolution imaging of radiographs and magnetic resonance. Staging is helpful in determining the best approaches to management.

**Key words:** Avascular necrosis, Femoral head, Osteonecrosis, Aseptic necrosis

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### INTRODUCTION

Necrosis is cellular death, avascular necrosis of bone is cellular death of bony tissue after inadequate or complete loss of blood supply [1, 2]. Death of tissue combined with the external force of bone leads to the collapse of the bone framework [3]. When this latter event occurs, the patient would present to the emergency department complaining of sudden sharp pain, some would present with complete inability to move their joints [4]. Ischemic necrosis occurs at the epiphysis of long bones, an example of this event commonly occurs in the femoral head.

Hip osteonecrosis is the most common of all avascular necrosis, this is because of the disruption of vascular supply to the femoral head [5, 6]. Other common ischemic necrosis includes carpal bones, talus, metatarsal bones, mandible bone, and humeral head.

## MATERIALS AND METHODS

PubMed database was used for article selection, papers on were obtained and reviewed. PubMed database was used for article selection, and the following keys terms: avascular necrosis, femoral head necrosis, ischemic necrosis management.

### *Pathophysiology and risk factors*

Multiple factors combine to eventually cause ischemia to the bone. These factors include anatomical factors, such as having singular vascular supply with no or little to collateral vessels. This is especially true for the femoral head, the humeral head and the scaphoid bone. The pathophysiological process of avascular necrosis is not well understood but evidence points towards a combination of vessel interruption, increased lipid metabolism, coagulopathy, and inflammation [7]. Avascular necrosis pathology is reversible in children, as the epiphysis has re-growth capabilities. Unfortunately, osteonecrosis is not reversible in adults and bone collapse is permanent and requires surgical intervention [7]. There are various conditions that may increase the risk of developing avascular necrosis. For instance, the risk of AVN increases in post-organ transplant patients and others on corticosteroids. Certain medications may cause avascular necrosis, particularly of the jaw, as an adverse effect of their use, these include bisphosphonates and denosumab [8, 9].

### *Diagnosis*

Avascular necrosis can be suspected by clinical judgment, but imaging is necessary to establish the diagnosis. The surgeon should initially request radiographic imaging of the affected area, however, in many cases the necrosis would not be apparent. In such cases, further imaging is needed by magnetic resonance imaging. Nevertheless, most patients present late in the pathological process of avascular necrosis where collapse is established and necrosis has spread. Classification criteria exists on a clinical and radiological basis, an example of this criteria is Ficat-Arlet classification for femoral head avascular necrosis (**Table 1**) [10]. Some patients may present to the orthopedic surgeon after months of the initial episode, where the underlying tissue is completely destroyed. In cases of joint destruction, the orthopedic surgeon should advise joint replacement.

**Table 1.** Ficat-Arlet Classification of Femoral Head AVN

Stages	Clinical Features	Radiography	Magnetic Resonance Imaging
0	None	None	None
1	Localized pain	Minor osteopenia	Edema
2	Localized pain and joint stiffness	Osteopenia, osteosclerosis, subchondral cysts	Visible defect
3	Pain and joint stiffness radiating to nearby joints	Crescent sign, cortical collapse	
4	Visible limping	Degenerative change	

### *Supportive management*

When the diagnosis of osteonecrosis is confirmed, the management is predominantly surgical, as conservative management is seldom beneficial in most patients with moderate to severe disease. In patients with osteonecrosis of the jaw, it would be advisable to stop the causative medication. Patients who are not suitable for surgery, include the elderly or those with co-morbid conditions. In this group, medications for symptomatic treatment are given. Non-steroidal anti-inflammatory medications are usually given to post-surgical patients and patients contraindicated for surgery. Supportive care is also of benefit, as physiotherapy can be helpful to restore limb and joint motion and improve posture and balance. In addition, electrical stimulation and extracorporeal shockwaves of affected joints may prove beneficial in stimulating healing and restoring the bone framework.

### *Surgical management*

The stage of Avascular necrosis is determined based on clinical and radiological features (**Table 2**). Surgical intervention is applicable to all stages of avascular necrosis, but the choice of procedure depends on severity

(Table 2). In stages 1 and 2 without subchondral collapse, it is reasonable for the orthopedic surgeon to attempt core decompression to relieve the collapse. Decompression will assist in the revascularisation process, by relieving the collapsed femoral head pressure. In addition to decompression, cancellous-cortical grafting to promote healing [11]. The graft source is usually proximal from the iliac bone, alternatively, an allograft is used [11].

**Table 2.** Ficat-Arlet Staging and Surgical Options

Stages	Surgical Procedure
1	
2 without subchondral collapse	Core decompression, cancellous-cortical grafting
2 with subchondral collapse	Trapdoor + allografting + osteotomies
3	
4	Arthrodesis + arthroplasty

Decompressive approach has shown benefit in more severe forms of the disease, unfortunately, some patients may still need to perform a total hip replacement. The former approach is subsequently followed by bone allograft [12]. When radiographic imaging confirms subchondral collapse, then advanced procedures of modified trapdoor and allografting are used [13]. Trapdoor approach is also used in stage 3 avascular necrosis, as evidence has shown that decompressive approaches are occasionally unsuccessful [12, 13]. In this approach, the orthopedic surgeon performs necrosection by elevating the covering cartilage and supplementing the bone with grafting.

Osteotomies are often used in the treatment of subchondral collapse with avascular necrosis in femoral head lesions [14]. Modalities such as arthrodesis where the fusion of the hip bone is instituted, have the disadvantage of requiring no weight bearing for at least three months. In more severe stages where degenerative change has already settled in, the orthopedic team should attempt arthrodesis and arthroplasty [15, 16]. In cases where total hip replacement is unsuitable, an osteotomy is often performed. The latter procedure has its own risk of causing union delay [17]. Unlike total hip replacement where the patient can weight bear immediately in the postoperative period, the post-osteotomy joint requires protection from any weight-bearing for the first 4–6 weeks [18].

In young patients with avascular necrosis of the femoral head, alternatives to total hip replacement exist. For instance, femoral arthroplasty could be done to treat severe avascular necrosis of the femoral head [19]. In older patients, or if arthroplasty fails, the total hip replacement is suitable as it would allow near-normal weight-bearing in the post-operative period. In patients with sickle cell disease, it is a total hip replacement that carries significant postoperative benefit for these patients [20].

## CONCLUSION

Avascular necrosis is a surgical condition requiring clinical judgment combined with advanced imaging. Staging is useful for peri-operative planning and thereafter, operative management. The orthopedic surgeon should rely on their clinical judgment on per case basis, combining this with high-resolution imaging of radiographs and magnetic resonance. Staging is helpful in determining the best approaches to management. The orthopedic surgeon should tailor their approach to each patient's condition, combining clinical prowess with high-resolution imaging findings.

**ACKNOWLEDGMENTS :** None

**CONFLICT OF INTEREST :** None

**FINANCIAL SUPPORT :** None

**ETHICS STATEMENT :** None

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