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Introductory Chapter: Unusual Aspects of Osteonecrosis of the Human Skeleton

Alessandro Rozim Zorzi and
João Batista de Miranda

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1. Introduction

Osteonecrosis, also called avascular necrosis or aseptic necrosis, is the name given to a set of diseases that affect mainly young adults and that often evolve to deformities and osteoarthritis, generating serious functional incapacity. The most affected site in the human skeleton is the head of the femur, but it can occur in many other places.

Despite advances in the understanding of this condition, the pathogenesis, risk factors, and diagnosis are not yet fully understood. In addition, the available treatments are still controversial and may range from physiotherapy and medications to surgical procedures such as decompression and arthroplasties [1].

Some authors report that osteonecrosis is responsible for at least 10% of the hip arthroplasties practiced in the United States [2].

2. Etiology

The term osteonecrosis means, “bone necrosis.” Necrosis is a histopathological event that can occur after four types of injury:

1. Physical
2. Thermal
3. Toxic
4. Circulatory.

When we refer to osteonecrosis in orthopedics, we are actually using the term for circulatory lesions that affect the bone, which would be better called “infarction.” Necrosis caused by circulatory injury may be due to

- 1. arterial diseases
- 2. embolism
- 3. venous obstruction.

In 1915, Phemister described and differentiated histological changes from necrosis caused by infection (septic necrosis) of those caused by circulatory changes (aseptic necrosis).

Regardless of the predisposing factor, the cause of osteonecrosis is always the inadequate blood perfusion of the bone [3]. Bone is a rigid and nondistensible tissue. Besides that, subchondral limited collateral circulation on the convex side of articular surfaces and decreased perfusion pressure of all epiphyses, which helps to explain the higher incidence of osteonecrosis in some regions of the skeleton.

3. Risk factors

Risk factors for osteonecrosis can be divided into three major groups, summarized in **Table 1**. When no risk factor is identified, osteonecrosis is called “primary.”

Physical injury	Fractures Dislocations Surgeries Ionizing radiation Electric injuries Freezing
Lipid metabolism	Hypercortisolism Alcoholism Medication
Intraosseous hypertension	Dysbarism Gaucher’s disease Sickle cell disease Autoimmune diseases

Table 1. Risk factors for “secondary” aseptic osteonecrosis [3].

4. Pathological anatomy

The following four stages of disease progression were identified [4]:

- Stage I: necrosis of bone and bone marrow without evidence of repair

- Stage II: repair at the periphery of the lesion
- Stage III: joint surface collapse
- Stage IV: secondary osteoarthritis.

5. Diagnosis

The diagnosis of osteonecrosis is made through clinical presentation and imaging tests.

The clinical history suggestive of osteonecrosis is the acute onset of severe pain in a patient who had no previous symptoms or who had mild chronic pain. Most of the time, there is no history of trauma associated with the onset of pain.

On physical examination, the affected area shows tenderness and edema. In deep joints, such as the shoulder and the hip, this can be difficult to observe. In addition, both active and passive movements of the affected joint are painful.

Among the imaging exams, the most commonly used are simple radiographies (X-ray), radionuclide scintigraphy (bone scan), and magnetic resonance imaging (MRI). Although bone scan can detect changes well before X-ray, these two methods can only detect reparative processes. Therefore, they can only diagnose from stage II of the disease. The advantage of MRI is that it can detect early bone marrow changes, still in stage I of the disease [3, 5].

6. Clinical presentations

6.1. Hip

Femoral head osteonecrosis is the most common site affected by osteonecrosis and perhaps the best studied. About 20% of the cases are idiopathic. The rest are linked to alcoholism, corticosteroid therapy, and other factors already described in **Table 1**. Surgical treatment varies. In mild or moderate cases, there is the possibility of preserving the joint with techniques such as decompression, osteotomies, bone grafting, and new stem cell therapies. Severe cases should be treated with arthroplasties, which can vary in partial or total arthroplasties and resurfacing [6].

An important aspect related to osteonecrosis of the hip is the vascularization of the head of the femur and the changes that this vascularization presents throughout life. In this sense, Ismet Gavrankapetanović and co-authors present us, in this book, a very interesting chapter on this topic, addressing an unexplored topic, which is the relationship between hip development disorder and osteonecrosis.

6.2. Knee

In addition to the traditional osteonecrosis itself, two other entities must be recognized: spontaneous osteonecrosis of the knee (SPONK) described by Ahlback in 1968 and postoperative osteonecrosis (ONPK) described by Brahme in 1991.

Patients with SPONK have a different epidemiological profile, since they affect women over 50 in only one joint, with a single small lesion, without the traditional risk factors (use of corticosteroids, alcoholism, etc.).

Similarly, ONPK has an epidemiological profile similar to SPONK, only occurring after a surgical intervention, which is most often an arthroscopic meniscectomy indicated for meniscal degenerative lesions. Anterior Cruciate Ligament (ACL) surgery and cartilage procedures also could predispose to ONPK.

The current trend is to consider SPONK and ONPK as subchondral bone insufficiency fractures, unlike osteonecrosis, which is caused by a bone infarct [7].

6.3. Ankle

The site most affected by osteonecrosis in the foot and ankle segment is the talus. The most frequent etiology is trauma (75%). Osteonecrosis is a complication well known and feared in the treatment of talus fractures because of the precarious vascular supply of this bone.

One of the ways to treat and prevent osteonecrosis of the talus is through early and accurate anatomic reduction. Once osteonecrosis is established, the first measure is limited weight bearing. In the failure of this treatment, the surgery is indicated, being basically divided into two groups: the arthrodesis and the ankle arthroplasty [8].

6.4. Shoulder

Osteonecrosis of the humeral head (ONHH) is an uncommon condition, but after the hip, it is the second most common site of nontraumatic osteonecrosis. The four-part fracture is the most common cause of ONHH.

The most widely used classification is the Cruess classification system, which has five stages according to radiographic appearance as follows:

Stage I: normal X-ray with altered MRI;

Stage II: sclerotic bone without collapse;

Stage III: crescent sign;

Stage IV: collapse of the humeral head;

Stage V: osteoarthritis.

Treatment could be divided as nonoperative, arthroscopic debridement, core decompression, bone grafting, and shoulder arthroplasty [9].

6.5. Elbow

The elbow is rarely affected by osteonecrosis. According to Le et al. [10], the most affected sites are the capitellum and the lateral epicondyles, being, therefore, a rare differential diagnosis of tennis elbow syndrome.

6.6. Wrist

Osteonecrosis of the wrist most commonly involves the scaphoid, lunate, and capitate. Scaphoid is the most frequently injured bone in the carpus. It is second only to the femoral head in the incidence of posttraumatic osteonecrosis. In the absence of trauma, it is known as Preiser's disease [11].

Osteonecrosis of the lunate is known as Kienbock's disease. It is associated with trauma, overuse, and negative ulnar variance [11].

Osteonecrosis of the capitate is a rare condition and often associated with trauma.

6.7. Spine

Osteonecrosis of the vertebral body is also known as Kummel's disease (KD), usually related to osteoporotic vertebral fractures. It is a rare and under diagnosed disease. Elizabeth Pérez Hernández and co-authors gave us a rare chapter on this subject in this book.

6.8. Jaw

Unlike orthopedics, where the term osteonecrosis has been used for pathologies resulting from aseptic bone infarction, in dentistry, the term is used in its broadest sense, indicating the death of the bony tissue. Recently, the problem of osteonecrosis caused by the use of medicines, known by the abbreviation MRONJ, has gained much interest.

In this book, Kenji Yamagata and Mario Pérez-Sayáns García present chapters that address in depth of this relevant and current topic.

6.9. Multifocal osteonecrosis

When three or more separate articulations are involved, concurrently or consecutively, it is called a multifocal osteonecrosis (MFON).

The most common cause of MFON is the use of corticosteroids [5]. It is therefore important to have a high degree of suspicion in patients on chronic use of this medication that present more than one site of involvement in X-ray. Bone scintigraphy may be helpful in these cases, as some sites, such as the shoulders, may be little symptomatic at the beginning, when preservation strategies of the joint, such as decompression, have its indication.

7. Conclusion

Publications regarding osteonecrosis rarely provide an overview of the problem. In general, the subject is included as a chapter on books that address some specific joints, such as osteonecrosis of the hip and osteonecrosis of the knee.

Works dedicated to dealing with the subject also usually give greater prominence to the novelties related to the articulations of greater prevalence.

Although succinct, the aim of this book is to highlight some recent or little discussed topics of the subject, hardly present in other works. In this sense, the reader will find very interesting chapters, written by several specialists who deal in research and clinical practice with the set of problems called osteonecrosis.

Author details

Alessandro Rozim Zorzi* and João Batista de Miranda

*Address all correspondence to: alessandrozorzi@uol.com.br

Department of Orthopedic Surgery, State University of Campinas, Campinas, Brazil

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