



## FREIBERG INFRACTION SCOPING REVIEW

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### SUMMARY

**Introduction:** Freiberg's infringement is an osteochondrosis of the metatarsal bone heads, primarily of the second or third metatarsal. It is usually a chronic and progressive process that gradually causes pain and loss of normal function of the metatarsophalangeal joint. Objective: to detail the current information related to Freiberg's disease, etiology, epidemiology, pathophysiology, clinical history, evaluation, differential diagnosis, treatment, prognosis, complications and postoperative period.

**Methodology:** a total of 32 articles were analyzed in this review, including review and original articles, as well as clinical cases, of which 26 bibliographies were used because the other articles were not relevant for this study. The sources of information were PubMed, Google Scholar and Cochrane; the terms used to search for information in Spanish, Portuguese and English were: Freiberg infraction, Freiberg disease, metatarsalgia, osteochondrosis.

**Results:** Freiberg's disease is the only osteochondrosis that is more frequent in women with a ratio of 5:1 in relation to men. Bilateral involvement is reported less than 10% of the time. The involvement primarily involves the second metatarsal in 68% of cases, the third metatarsal in 27% and the fourth metatarsal in 3% and the fifth is rarely affected.



**Conclusions:** Freiberg disease is an osteochondrosis of the metatarsal bone heads, commonly found in second or third metatarsals and common in women and athletes. Osteochondroses are a group of disorders resulting from a lesion of the epiphysis that modifies endochondral ossification and generates irregularity in the articular surface. The pathophysiology of Freiberg's disease is multifactorial. Affected individuals present with pain and swelling located in the affected metatarsal head area of the forefoot. Diagnosis can be confirmed by physical examination and radiographs. Conservative treatment should first be attempted to relieve symptoms and decrease epiphyseal deformity to restrict progression to arthritis regardless of the severity of the disease. There are a number of surgical techniques described for the treatment of Freiberg's disease if conservative treatment fails.

**Key words:** bone infraction, Freiberg's disease, metatarsalgia, osteochondrosis, metatarsals.

## INTRODUCTION

Freiberg's disease is caused by a bony infraction of the metatarsal head; the exact etiology is still uncertain. Freiberg's infringement is an osteochondrosis of the metatarsal bone heads, primarily of the second or third metatarsal. The pathology is more common in women and athletes. Since its description in 1914 by Freiberg, several classifications and methods of treatment of the pathology have been created. Although the head of the second metatarsal is the most frequently involved, Freiberg's disease can attack any of the five metatarsal heads. It is usually a chronic, progressive process that gradually leads to pain and loss of normal function of the metatarsophalangeal joint. Classifications are usually based on vascular influence and radiographs. The objectives of management are early identification to indicate and place the affected individual in conservative therapy to achieve healing and prevent progression to advanced arthritis(1-6).

The following are some important concepts.

Osteoarthritis (OA) is a degenerative disease of the articular cartilage, a chronic inflammatory arthropathy that affects articular elements such as subchondral bone, synovial membrane, hyaline cartilage and others. Osteochondritis is a variety of disorders of the epiphysis and apophysis, which have in common that they begin with an incomplete interruption of their blood circulation. Osteochondrosis is a degeneration or necrosis of an ossification center followed by its regeneration, especially in children. Osteonecrosis are lesions generated by a complete and definitive interruption of the blood supply, an example could be avascular necrosis of the lunate bone, also known as lunatomalacia. Ischemia or bone infarction is the arrest of arterial circulation(7-9).

The etiology, epidemiology, pathophysiology, clinical history, evaluation, differential diagnosis, treatment, prognosis, complications and postoperative course of Freiberg's disease are described below.

## METHODOLOGY

A total of 32 articles were analyzed in this review, including review and original articles, as well as cases and clinical trials, of which 26 bibliographies were used because the information collected was not sufficiently important to be included in this study. The sources of information were Cochrane, PubMed and Google Scholar; the terms used to search for information in

Spanish, Portuguese and English were: Freiberg infraction, Freiberg disease, metatarsalgia, osteochondrosis.

The choice of bibliography exposes elements related to Freiberg's disease, etiology, epidemiology, pathophysiology, clinical history, evaluation, differential diagnosis, treatment, prognosis, complications and postoperative period.

## DEVELOPMENT

### Etiology

Freiberg's disease is an osteochondrosis involving the metatarsal heads. Osteochondroses are a group of disorders resulting from an epiphyseal lesion that modifies endochondral ossification and generates irregularity in the articular surface. There are multiple potential explanations for Freiberg's disease, however, the most widely accepted are microtrauma, vascular involvement and systemic disorders. Some systemic conditions linked to the development of Freiberg's disease are systemic lupus erythematosus, hypercoagulability and diabetes mellitus. In addition, a genetic component is thought to be involved, as the condition has been reported in identical twins.

There are now studies describing Freiberg's infraction as the first clinical sign of Sneddon's syndrome, which is an unusual vasculopathy associated with livedo racemosa and various ischemic strokes(10-12).

### Epidemiology

Freiberg's disease is the only osteochondrosis that is more frequent in women with a 5:1 ratio in relation to men. Bilateral involvement is reported less than 10% of the time. The involvement primarily involves the second metatarsal in 68% of cases, the third metatarsal in 27% and the fourth metatarsal in 3% and the fifth metatarsal is rarely affected. The dominant foot is affected 36% of the time. The age of presentation is between 11 and 17 years, however it can be seen in women in the seventh decade(5,10,13,14).

### Pathophysiology

The pathophysiology is multifactorial and can be caused by trauma, alteration of the biomechanics of the foot, systemic disorders and arterial insufficiency. The pathologic origin of articular osteochondrosis originates in 3 steps, as described by Omer:

Intra-articular and periarticular soft tissues become swollen and congested.

There is irregularity of the epiphyseal contour.

Replacement of necrotic tissue(3,4,15).

### Clinical History

Patients present with pain and swelling located in the area of the affected metatarsal head of the forefoot. They report a sensation of walking on something hard, such as a stone. The onset of symptoms is usually gradual, with no specific acute episode. Sufferers describe that their symptoms are worse when walking, particularly when barefoot or wearing shoes with high heels. A short course of steroids following foot trauma may be associated with an atypical presentation of acute Freiberg's disease(14).

The involved toe may be swollen on physical examination, usually being more evident near the metatarsophalangeal joint. Elevation (dorsiflexion) of the toe may be appreciated. In more chronic or advanced stages, sagittal or coronal plane malalignment may form, such as hammertoes or cruciate deformities. Range of motion at the metatarsophalangeal joint is decreased and crepitus may be palpable. A callus may develop under the head of the involved metatarsal on the plantar fat pad. The Lachman digital test can be performed, which assesses joint instability and is divided according to the amount of dorsal translation of the proximal phalanx in relation to the metatarsal head and in comparison to the contralateral foot. The test is abnormal when the joint is dorsally subluxed, which will usually reproduce the pain of the affected individual(16-18).

**Figure 1. Anteroposterior and oblique views of the metatarsophalangeal joint, radiograph of the right foot showed a flattened and sclerotic head of the second metatarsal, as well as an irregularity of the articular surface.**



Source: Inokuchi R, Iwashita K, Jujo Y, Takao M. Freiberg's disease(19).

### Evaluation

The diagnosis of Freiberg's disease can be confirmed by physical examination and radiographs. On radiographs of the loaded foot, mild changes may be found in the early stages of the presentation of the pathology (noted by a widening of the joint space due to effusion) that may be shown 3 to 6 weeks after the onset of

symptoms. As the pathology progresses, bone density in the subchondral region increases and the metatarsal head flattens. Oblique radiographs allow a better evaluation of the dorsal aspect of the metatarsal head, achieving a full assessment in identifying flattening of the metatarsal head in subtle cases. As the disease progresses, later findings include central joint depression, free



bodies and metatarsal head sclerosis. In addition, reactive thickening of the metatarsal diaphysis may be found as a late response to abnormal stress. The final stages of this disease show joint space narrowing and arthrosis(4,14,20,21).

Although usually described intraoperatively by structural changes seen in the metatarsal head by Smillie, these features are radiographically evident and have been adapted non-operatively. The staging system presents 5 stages:

1) Cleft fracture in the ischemic epiphysis, the cancellous bone in the fracture appears sclerotic. Compared to the adjacent metaphysis, the epiphysis shows the absence of blood supply.

2) Absorption of the cancellous bone occurs proximally, the central cartilage sinks into the head while the margins and plantar cartilage remain intact. This results in an altered contour of the articular surface.

3) Further absorption occurs and the central portion sinks deeper, forming larger bilateral projections. The plantar cartilage remains intact.

4) The central portion remains sinking, so the plantar hinge gives way. The peripheral projections fracture and fold over the central portion. The anatomy cannot be restored.

5) There is osteoarthritis with flattening and deformity of the metatarsal head. Only the plantar portion of the metatarsal cartilage preserves the original contour of the head. The free bodies are reduced in size and the metatarsal shaft is thickened and dense.

MRI can also be used to assess these individuals and can aid in the early detection of Freiberg's disease when radiographs are normal. MRI will show alterations in the marrow signal with an edema-like signal located in the head of the affected metatarsal. As the disease progresses, osteonecrosis-like alterations are generated and seen in other anatomic parts. Alterations include a hypointense signal on T1-weighted images and mixed hypointense and hyperintense signals on T2-weighted images with flattening of the involved metatarsal head, best seen on sagittal images. Nuclear medicine bone scans are useful to assess at early presentation or when there are no appreciable changes on radiographs. The first changes on bone scans are a photopenic surface surrounded by increased radiotracer uptake and a pattern typical of early avascular necrosis. In later stages, they will be diffuse hyperactivity secondary to revascularization, bone repair and progression to arthritic involvement of the metatarsophalangeal joint(14,20,21).

### Treatment

Conservative treatment should be attempted initially to relieve symptoms and decrease epiphyseal deformity to restrict progression to arthritis regardless of the severity of the disease. Activity modifications, protected weight-bearing such as a stiff-soled shoe, fracture boot or cast, in addition to modifications in footwear use and anti-inflammatory medications are used in this early treatment. Modifications in footwear use can be with metatarsal bar orthoses created to relieve the painful metatarsal head, which has been shown to help sufferers respond without long-term disability. The use of bisphosphonates is a new

alternative that shows promising results. A single injection of 5 mg of intravenous zoledronic acid followed by 70 mg weekly of oral alendronate for 1 year has removed symptoms and slowed the progression of early stage avascular necrosis of the second metatarsal head(14,20,22).

Most individuals with Smillie stages 1 to 3 have a good response to conservative treatment and show successful long-term results, however, there are a number of surgical techniques described for the treatment of Freiberg's disease, if conservative treatment fails, these are usually reserved for those with Smillie stage 4 and 5 disease. At the moment there is not much consensus on which procedure should be performed primarily. According to Carmont et al, surgical alternatives have been divided into two categories: altering abnormal physiology and biomechanics or restoring joint congruency/arthritic sequelae found in the later stages of the disease. Procedures aimed at restoring joint congruency are debridement, osteotomy, grafting and arthroplasty. Procedures aimed at modifying abnormal physiology are central decompression and corrective osteotomies. Among the various joint preserving procedures, Gauthier's osteotomy is probably the most popular and has the longest reported follow-up, this procedure is an intra-articular dorsal closure wedge osteotomy, in which diseased cartilage is removed and healthy plantar cartilage is redirected into the central joint. This technique was free of complications and showed a high satisfaction rate in all individuals(11,14,23).

As the pathology progresses, treatment may require a joint-destructive procedure. As with other procedures, an effort must be made to remove the avascular portion. However, this may result in significant shortening of the metatarsal. Therefore, interpositional arthroplasty is among the procedures of choice for advanced disease. The procedure involves the interposition of a soft tissue autograft, extensor digitorum longus tendon, extensor digitorum brevis tendon or allograft into the compromised joint. The technique reduces the requirement for artificial implants while maintaining finger length, with a success rate of about 90%(24,25).

Modified Weil osteotomy is thought to be a useful method for the treatment of Freiberg's disease, in the early and even later stages. It improves pain symptomatology as well as improving function by shortening the metatarsals and restoring metatarsal phalangeal joint congruency(1).

### Differential Diagnosis

Depending on the clinical presentation, we have several such as neuroma, stress fracture, plantar plate tear or other inflammatory arthritis such as rheumatoid arthritis or gout. Radiographs allow us to distinguish these entities. The classic finding of Freiberg's disease is flattening of the metatarsal heads on radiography which confirms the diagnosis(14).

Prognosis and Complications.



Generally, individuals with Smillie stages 1 to 3 respond adequately to conservative management and have great success. Individuals who show high grades usually undergo surgery to restore joint congruence and limit progression to arthritis. Possible complications include progression to advanced arthritis with associated pain and limited range of motion(14).

#### Postoperative.

Postoperative protocols change according to the wide variety of surgical techniques available. Individuals undergoing joint preserving techniques, such as Gauthier dorsiflexion wedge osteotomy, are usually allowed partial heel weight bearing or a forefoot offloading shoe for 3 weeks following surgery, however, individuals undergoing joint destructive procedures may not be required to be weight bearing for a short period of time. Physical therapy is indicated after the affected individual is fully weight-bearing. A rehabilitation approach that includes metatarsophalangeal joint range of motion and walking retraining is recommended(14,26).

## CONCLUSIONS

Freiberg disease is an osteochondrosis of the metatarsal bone heads, commonly found in the second or third metatarsal and common in women and athletes. Osteochondroses are a group of disorders resulting from a lesion of the epiphysis that modifies endochondral ossification and generates irregularity in the articular surface. The pathophysiology of Freiberg's disease is multifactorial. Affected individuals present with pain and swelling located in the affected metatarsal head area of the forefoot. Diagnosis can be confirmed by physical examination and radiographs. Conservative treatment should first be attempted to relieve symptoms and decrease epiphyseal deformity to restrict progression to arthritis regardless of the severity of the disease. There are a number of surgical techniques described for the treatment of Freiberg's disease if conservative treatment fails.

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