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Management of Freiberg Disease: Extra Articular Dorsal Closing Wedge Osteotomy

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Abstract

Freiberg disease is caused by osseous infraction at the head of a metatarsal; the exact etiology is unknown. The disease is more common in females and athletes. The goals of treatment are early identification to place the patient in conservative therapy to allow healing and prevent progression to advanced arthritis. Extra-articular dorsal closing wedge osteotomy has been used with successful results for Freiberg disease; however, there has been concern regarding the technical difficulty. In the treatment of Freiberg disease, effective results can be achieved by dorsal closing wedge osteotomy in maintaining articular adjustment and metatarsal length, in pain relief, in almost pain-free mobility. Dorsal closing wedge osteotomy of metatarsal neck aided with synovectomy, thorough debridement of lesion gives good results in Freiberg's disease. Fixation of the osteotomy site with K-wires or another method of fixation provides adequate stability. Thorough debridement of the joint restores congruity of the metatarsophalangeal joint. The operative technique is simple, less costly, little operative complications and the results are very good.

Keywords: Freiberg Disease, Dorsal wedge, Osteotomy, Management.

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1. Introduction

Freiberg disease is a form of avascular necrosis (AVN) in the metatarsal. It was first described in 1914 by Alfred H Freiberg, who reported six cases of young women presenting with a painful limp and discomfort localized to the second metatarsal[1]**.** All six patients had similar radiographic findings, which showed a collapse of articular surface of the second metatarsal head. In three patients, intra-articular loose bodies were seen. Of the six women, four were younger than 18 years [2]. Because Freiberg believed that the etiology most likely was trauma, he used term infraction. He postulated that condition was partially caused by excessive length of the second metatarsal. Which, when combined with an ineffective first ray complex, led to an overload of second metatarsal and subsequent articular collapse [3]. Since Freiberg's original description, multiple authors have written about this uncommon condition, which has since come to be known as Freiberg disease. (First referred to as Freiberg infraction, it has also been referred to, inaccurately, as Freiberg infarction) [4]. Although Freiberg disease was originally described more than a century ago, the etiology and most appropriate treatment remain controversial.

A trial of conservative treatment can be implemented for most patients presenting with Freiberg disease [5]. If such treatment fails, multiple surgical options exist, including débridement, bone grafting, osteotomy, core decompression, and osteochondral plug transplantation [6]. There remains controversy as to what represents the most appropriate approach to the treatment of Freiberg disease. Current recommendations have been based on small series of patients treated by various methods, and there is no clear therapeutic consensus [7]**.** A trial of conservative treatment can be implemented for most patients presenting with Freiberg disease. Whereas some stage I, stage II, and stage III lesions may resolve spontaneously, patients who do not respond to conservative measures may require surgery, as patients with stage IV and stage V lesions [8]. Aside from the recommendation of conservative management in the pediatric population and in patients with early-stage lesions, no true contraindications for the treatment of Freiberg disease exist [9]. Further investigation through prospective, multicenter analysis would best guide future treatment options [10].

I. Medical Therapy

Various suggestions regarding conservative therapy for Freiberg disease have been put forth in literature, depending on the stage and the acuteness of onset of pain [11]. A period of appropriate nonoperative conservative management is indicated for all patients presenting with Freiberg disease. Regardless of the treatment method chosen, the goal of therapy is to rest the joint to allow inflammation and mechanical irritation to resolve [12]. In patients presenting with severe pain of an acute nature, a non-weight bearing cast may provide sufficient relief during the acute phase. In other persons, a short-leg walking cast or hard-sole shoe may be more appropriate. Typically, the initial period of immobilization lasts 4-6 weeks [13]. In patients with chronic complaints, less restrictive options, such as shoe

modifications in the form of inserts with metatarsal bars or pads, rigid shanks, or a rocker's bottom, may be helpful. Activity modification during exacerbations may help to prevent the aggravating symptoms of pain and swelling [14]. Medications may be helpful for pain but should not be used to allow increased activity. Nonsteroidal anti-inflammatory drugs (NSAIDs) are used commonly for pain, but cautious use is recommended. Although sufficient human studies are lacking, NSAIDs have been shown to delay stress fracture healing in rats [15]. Hoskinson reported on the long-term results (average, 12 years) of conservative treatment on a series of 16 patients. Eleven of the 16 patients were completely pain-free at the final follow-up; however, all 16 had some restriction in range of motion (ROM) [16].

II. Surgical Therapy

The progression of Freiberg disease is variable with regard to time course and severity. Whereas some stage I, stage II, and stage III lesions may resolve spontaneously, patients who do not respond to conservative measures and patients with stage IV and stage V lesions may require surgery. Smillie believed that it was possible to restore joint congruity in early lesions (stages I-III) with surgery [4].Several surgical options have been advocated in past. Simple débridement and loose body removal were originally described by Freiberg. Other described procedures, including various osteotomies, elevation of the depressed metatarsal head with bone grafting, core decompression, metatarsal head excision, shortening of metatarsal, proximal phalanx hemiphalangectomy, total small-joint arthroplasty, and various combinations of above, have implemented [3]. No consensus exists as to which surgical procedure is the most appropriate for patients with symptomatic Freiberg disease. Common to all of these procedures is the goal of diminishing pain and restoring joint function [6]. Most studies have included small numbers of patients and have not stratified by age or stage of disease, making it difficult to draw conclusions about potential effectiveness of these procedures.

Relative rarity of condition makes it difficult to perform prospective analyses [17]**.** Helal and Gibb suggested one pattern for management of Freiberg disease. They suggested grafting and elevation of collapsed articular surface for patients with stage I or stage II disease [18]. For later-stage lesions (stages III-V), they suggested tailoring treatment to patient's symptoms. They recommended using an osteotomy to treat patients with pressure metatarsalgia and using replacement arthroplasty to treat patients suffering from arthritic symptoms of pain with joint motion [19]. Although these recommendations may provide guiding principles, it is important to recognize that at present, there is no consensus as to which procedure works best for all patients [20]. In general, if conservative treatment fails, least destructive and invasive procedures should be considered first for patients with early-stage disease, with more invasive joint-altering procedures reserved for advanced cases or for patients in whom other forms of treatment have failed [21].

➢ *Debridement*

Freiberg's original monograph reported that two of his six patients had good results with debridement. The report only infers that these two patients presented with advanced-stage disease on the basis of the presence of loose bodies [22]. Subsequent authors also advocated simple debridement as an effective treatment for Freiberg disease. However, staging of the lesions, as well as a detailed assessment of results, has not commonly been reported, making it difficult to make recommendations based on the currently available data [3]. Erdil et al reported on 14 patients with advanced-stage disease of the second metatarsal; they found joint debridement and metatarsal head remodeling to be safe, simple, and effective in alleviating symptoms [23]. Simple debridement can be combined with other procedures. Hoskinson described 12 patients treated with various surgical procedures, including excision of the metatarsal head (n = 4), hemiphalangectomy (n = 4), and debridement with loose-body excision (n = 4). He believed that the best results were seen following simple debridement, but he warned about drawing conclusions from such limited numbers [24].

➢ *Bone grafting*

In an attempt to restore joint congruity, Smillie described a procedure in which a cancellous bone graft was used to elevate the depressed metatarsal articular surface. The technique involved creating a slot in metatarsal shaft through which sclerotic bone could be drilled [25]. The metatarsal articular surface then elevated and supported by a bone graft. The authors recommended this procedure for stage I, II, or III lesions in which an intact cartilage flap is present [26]. In 1987, Helal and Gibb reported on 25 patients with Freiberg disease; 11 of these patients treated with a modification of Smillie's original procedure. Authors reported eight patients to be clinically and radiographically normal at 3-8 years following surgery. Three patients demonstrated expanded metatarsal heads radiographically, and two of three reported pain with running or wearing high-heeled shoes [27].

➢ *Osteotomy*

Several different osteotomies have been described. The common goal of all osteotomies is to redirect the loading of the metatarsophalangeal (MTP) joint away from damaged area of articular surface. The two basic procedures are dorsal closing wedge osteotomy and shortening osteotomy [28].

- ***Dorsal closing wedge osteotomy***

Gauthier and Elbaz were the first to describe a dorsal closing wedge osteotomy for the treatment of Freiberg disease. They reported results from 53 patients who were treated with a dorsiflexion osteotomy of the neck of the metatarsal [29]. As described, the dorsal closing wedge osteotomy reoriented the intact cartilage on the plantar surface to articulate with base of the proximal phalanx. The authors reported stable results with no complications. In 35 of the 53 cases, postoperative arc of motion averaged 80° [30]. Al-Ashhab et al, in a series of 10 patients, showed that dorsiflexion osteotomy of metatarsal head was a simple procedure that was capable of good results in stage IV and stage V disease [31]. Chao et al reported results from 13 patients with all stages of Freiberg disease who were treated with dorsal closing wedge osteotomy combined bony and soft tissue released. Temporary fixation with the Kirschner wires (K-wires) utilized in all patients. The patients all had follow-up visits at an average of 40 months [32]. The results, as graded by the American Orthopaedic Foot and Ankle Society (AOFAS) lesser toe metatarsophalangeal-interphalangeal scale, were as follows: The four patients reported excellent results, seven good results, and two poor or fair results [33].

Figure (1): (a) Pre-operative Freiberg's disease of the 2nd metatarsal. **(b)** Intra-operative hypertrophied synovium and articular cartilage destruction. **(c)** Intra-operative 2nd metatarsal head. **(d)** Parts that were removed from the joint, i.e. (hypertrophied synovium). **(e)** Six weeks after the operation (note complete union and healing of the metatarsal head). **(f)** Post-operative clinical assessment [34].

- ***Shortening osteotomy***

Another osteotomy reported for the treatment of Freiberg disease is shortening osteotomy. The basis for use of a shortening osteotomy is observation that when involved, second metatarsal often is the longest of metatarsals.
Several authors believe that this subjects the involved metatarsal to repetitive injury and abnormal loading. With shortening, overloading of the metatarsal is reduced, as are symptoms [35]. Smith et al described a shortening osteotomy in which the metatarsal was shortened by approximately 4 mm. Of the 16 patients treated in their series, 15 had complete pain relief; however, seven of the 16 patients experienced stiffness of the involved ray, with four patients unable to place the toe flat when standing [36]. Two minor complications occurred, with one sinus requiring re-exploration and one hardware failure occurring despite union. Advantages cited by the authors included the ease of the procedure, avoidance of damage to the metatarsal head, and apparent remodeling of the articular surface, as seen radiographically in most cases [37].

➢ ***Arthroplasty***

- ***Resection arthroplasty***

Resection arthroplasty, though advocated in the past, has fallen out of favor for the initial treatment of Freiberg disease. Open and arthroscopic techniques have been described [38].Two of the described methods are resection of the base of the proximal phalanx or of the metatarsal head. Resection can be combined with soft-tissue interposition arthroplasty or even syndactylization of the toes, or it can be performed without these other procedures [39]. Hoskinson reported on eight patients treated with resection arthroplasty, both hemiphalangectomy, and resection of the metatarsal head, and found that only three had a satisfactory result, with residual symptoms and deformity limiting the remaining five [40]. Resection arthroplasty is an inherently destructive procedure. With these procedures, several authors have expressed concerns about the development of transfer lesions as a result of rendering the affected metatarsal incompetent. Additionally, potential complications from any of the resection techniques include progressive hallux valgus and excessive shortening [41].

- ***Total small-joint arthroplasty***

Total small-joint arthroplasty using a silicone prosthesis has also described for treatment of Freiberg disease. Potential complications are similar to those for resection arthroplasty; other potential problems, inherent in implants themselves, include synovitis, infection, and dislocation [42]. Several implants are available commercially. Most of these implants originally developed for use in hand. Potential advantages over resection arthroplasty include maintenance of length, improved joint motion, and better weight distribution if condyles are preserved. Newer MTP-specific implants may prove to better than previous implants, but there remains a need for long-term data [43]. Other options for replacement arthroplasty, including a titanium hemiarthroplasty and total ceramic arthroplasty, have explored in recent years for high-stage lesions. Similar to silicone implants, these newer devices present possible complications, including implant loosening, bone erosion, infection, and a stiff, floating toe. [44].

- ***Interposition arthroplasty***

As a consequence of the lack of consistent results with both resection and small-joint arthroplasty, there has been some interest in interposition arthroplasty. Unfortunately, this procedure too has yielded mixed, unreliable results [45].

➢ ***Other procedures***

Talathi and Kamath described core decompression for the treatment of early-stage lesions. In their procedure, the metatarsal head is drilled multiple times with a .045-in. Kirschner wire (K-wire), with satisfactory results (somewhat analogous to drilling for osteochondritis dissecans) [46]. Maresca et al described arthroscopic drilling in a patient with bilateral stage II disease, with evidence of restoration of the joint surface and satisfactory results at 2 years. Although such results are encouraging, further investigation is warranted into potential usefulness of such procedures [28]**.** Miyamoto et al performed osteochondral plug transplantation for late-stage Freiberg disease in four female patients (average age, 12 years); plug was harvested from a non-weight-bearing site of the upper lateral femoral condyle of ipsilateral knee. The average AOFAS score improved from 70.8 points preoperatively to 97.5 points postoperatively [47]. Magnetic resonance imaging (MRI) at 6 months after surgery showed an osteochondral plug–subchondral bone interface, but the healing of the plug was confirmed at 12 months in all patients. At 12 months, two patients had a normal International Cartilage Repair Society Cartilage Repair Assessment score, and two had a nearly normal score [48]. Several investigators have found osteochondral autologous transplantation to be equal or possibly superior to dorsal closing wedge osteotomy for treatment of Freiberg disease [49].

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