Freiberg's Infraction — Treatment with Metatarsal Neck Dorsal Closing Wedge Osteotomy: Report of Two Cases

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Freiberg's infraction is a disease of avascular necrosis that most commonly involves the head of the second or third metatarsal. Several mechanisms have been proposed for its pathogenesis, but stress overloading is the most widely accepted etiology. Nonoperative treatment is thought to be effective in the early stages but not in the late stages of the disease. The methods of operative treatment for symptomatic Freiberg's infraction remain controversial. We report two cases of late stage Freiberg's infraction treated by metatarsal neck dorsal closing wedge osteotomy with good results, and we infer that this operation may be recommended for patients with symptomatic Freiberg's infraction in whom conservative treatments have little effect.

Key Words: Freiberg's infraction, metatarsal neck dorsal closing wedge osteotomy
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Freiberg's infraction is an uncommon disease that is usually overlooked. The diagnosis is based on localized pain over the metatarsophalangeal joints (MTPJs) and characteristic radiologic findings. It usually responds to conservative treatment if the articular surface is preserved. However, surgical intervention is usually needed if there is joint collapse in the metatarsal head.

Case Presentations

Case 1

A 36-year-old woman complained of pain and stiffness in the right third MTPJ of 2 years' duration. She had no history of previous trauma or sport injury. The symptoms were most noticeable when her right foot pushed off during walking. During the previous 3 months, the pain had become more severe with localized swelling. She was referred to our center due to persistent pain despite conservative treatment. Physical examination revealed local tenderness over the right third MTPJ, combined with swelling and limitation of motion range. Roentgenography revealed collapse and flattening of the right third metatarsal head with subchondral sclerosis (Figure 1A). It was a stage V lesion according to the Smillie classification [1]. Due to failure of conservative treatment, the patient underwent a metatarsal neck dorsal closing wedge osteotomy.

Under epidural anesthesia, the patient was placed in the supine position. The right lower extremity was prepared and draped in the sterile manner. Intraoperative hemostasis was achieved by means of a pneumatic tourniquet inflated after exsanguinations. A 3–5 cm longitudinal incision centered at the right third MTPJ was made. The underlying soft tissues

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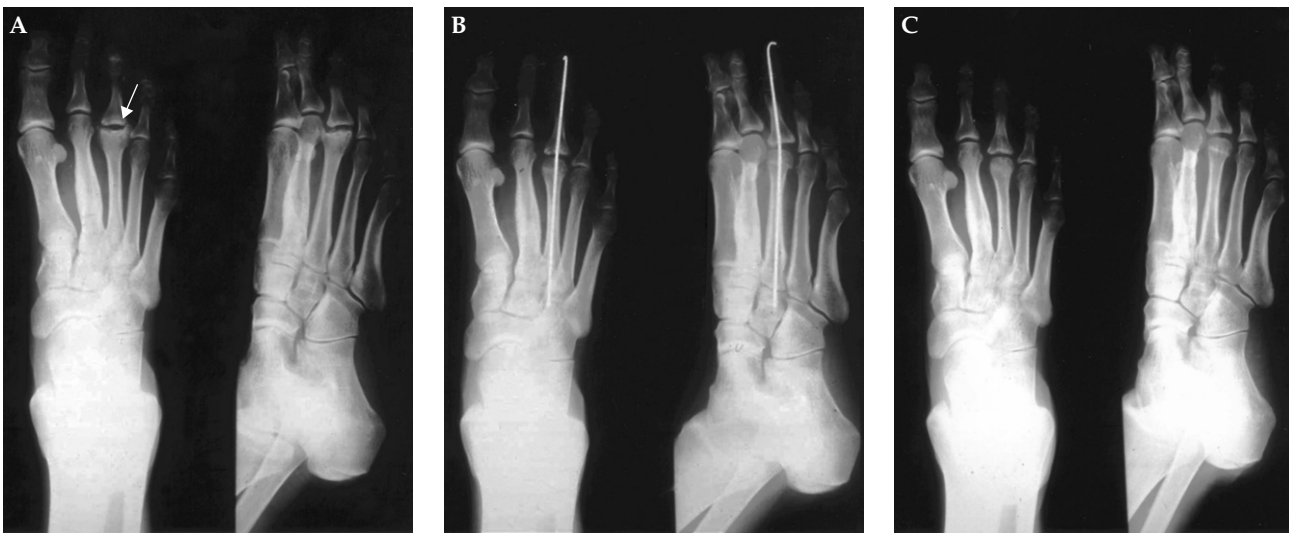

Figure 1. *(A) Preoperative radiograph shows collapse and flattening of the third metatarsal head (white arrow). (B) Postoperative radiograph: the third metatarsal neck dorsal closing wedge osteotomy was performed and transfixed with 1.2 mm Kirschner wire. (C) Radiograph at the 24-month follow-up shows good union of the osteotomy and preservation of the joint space.*

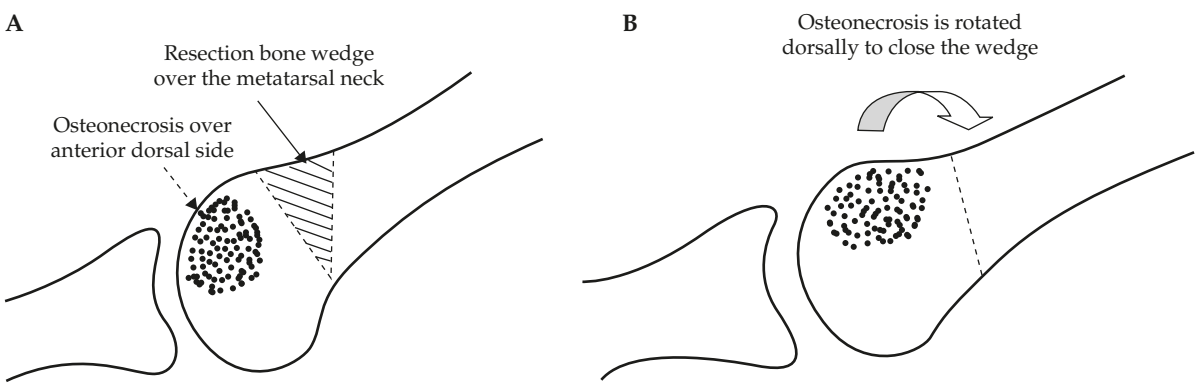

Figure 2. *(A) Metatarsal neck dorsal wedge osteotomy; (B) the bone wedge was closed by rotating the plantar cartilage dorsally.*

were bluntly dissected along the incision. The extensor digitorum longus tendon and the neurovascular structures were retracted bilaterally to expose the joint capsule. The right third MTPJ was then opened via longitudinal capsulotomy, and the metatarsal neck and head were inspected. By using an oscillating saw, wedge osteotomy was performed at the level of the metatarsal neck (Figure 2A). The bone wedge was then closed (Figure 2B) and transfixed with one 1.2 mm Kirschner wire (Figure 1B). The wound was copiously irrigated and closed by simple interrupted suturing in layers. Postoperatively, the right third MTPJ was protected from any weight-bearing effect by using a metatarsal pad. The Kirschner wire was removed after 6 weeks, and partial weight-bearing exercises with an active range of motion were recommended. After bone union was noted in the follow-up radiograph, full activity with full weight bearing was permitted.

At 24 months postoperatively, the patient had no pain and normal functional activity had returned. Radiographic examination showed good articular space preservation and fair joint congruity (Figure 1C). Although there was mild limitation in the range of motion compared to the adjacent toes, the patient was satisfied with the clinical result of the operation.

Case 2

A 33-year-old woman had suffered from right foot bunion pain with second toe metatarsalgia for 1 year.

Figure 3. *(A) Preoperative radiograph shows hallux valgus deformity and Freiberg's infraction of the second metatarsal head. The second metatarsal head flattening deformity is also shown (white arrow). (B) Postoperative radiograph: the hallux valgus was treated with modified Mitchell osteotomy and the second metatarsal was treated with metatarsal neck dorsal closing wedge osteotomy. (C) Good union of the osteotomy and preservation of the joint space.*

Initially, these symptoms occurred only after excessive walking or exercise, but progressed to occur during normal walking. She denied having any previous trauma or sport injuries. Physical examination showed joint effusion in the right first and second MTPJs, and tenderness was elicited over both joints by deep palpation. The range of motion of the right second MTPJ was painfully limited. The radiograph showed hallux valgus deformity, flattening, and collapse of the right second metatarsal head (Figure 3A). The second metatarsal was also a stage V lesion according to the Smillie classification.

Under the diagnosis of right foot hallux valgus and Freiberg's infraction of the second metatarsal head, the patient underwent modified Mitchell osteotomy to correct the bunion deformity and metatarsal neck dorsal closing wedge osteotomy for osteonecrosis of the right second metatarsal head (Figure 3B). The surgical technique of hallux valgus was based on the method proposed by Kuo et al [2] in 1998, and the right second metatarsal osteotomy was performed by the procedure described in the first case. The surgical findings were similar to those of the first patient, including bony erosion over the dorsal side of the metatarsal head, head flattening, subchondral sclerosis, and osteonecrosis. Postoperative care was the same as that for the first case. At 30 months postoperatively, this patient had good symptomatic relief and functional preservation. Joint space preservation was shown on follow-up radiography (Figure 3C). She appreciated the results of the operation despite some limitation of the range of motion in the right second MTPJ.

Discussion

Freiberg's infraction is an uncommon form of osteonecrosis affecting the metatarsal head and it was first described by Freiberg in 1914. The prevalence is predominant in females, especially during the adolescent period. It commonly involves the second metatarsal head, but other metatarsal involvements have also been reported. Gauthier and Elbay [3] reported 88 cases with the diagnosis of Freiberg's infraction who were surgically treated. They found that the second metatarsal was involved in 68% of cases, the third in 27% of cases, the fourth in about 3% of cases, and the fifth metatarsal in only one case. Maresca et al [4] also reported a case of Freiberg's infraction involving bilateral first metatarsals treated in arthroscopy. In our report, the third metatarsal was involved in the first case, and the second metatarsal was involved in the second patient.

There are many reported causes predisposing to the disease, but abnormal stress over the metatarsal head seems to be the major factor. Smillie [1] suggested stress overloading as the mechanism of the disease, since the majority of cases are active adolescent females. Gauthier and Elbay [3] found that the lesion was localized in the metatarsal head that was subject to the greatest amount of weight. Wiley and Thurston [5] studied the arterial supply to the metatarsal heads of six cadavers and concluded that a predisposing vascular pattern, in addition to the significant stress distribution, was likely to produce the osteonecrosis of the second metatarsal head. These studies would explain the pathogenesis of the disease and that was also true in our cases. In the first case, although the patient denied any history of trauma, hypertrophy of the right second metatarsal shown in the radiograph (Figure 1A) strongly implied a previous stress fracture, which might result in abnormal load shifting from the second metatarsal to the third one. In the second case, the hallux valgus deformity would result in abnormal load transfer and induce pressure overloading over the right second metatarsal head. Thus, we consider that this might be a predisposing factor to Freiberg's infraction.

The common presenting symptom of Freiberg's infraction is localized pain in the involved joint. The pain gets worse when the patient does the push-off action during walking or is standing with the greatest pressure over the joint. Physical examination usually reveals local swelling, tenderness, and limited range of motion actively or passively. Sometimes, loose bodies in the involved joint would be palpated through its range of motion. The diagnosis is usually made according to the characteristics of roentgenography. Hill et al [6] reported the roentgenographic characteristics of the course of Freiberg's infraction. They described the first radiographic manifestation as widening of the joint space. With disease progression, the subchondral bone density increased, the metatarsal head flattened, and subchondral bone infractions surrounded by a sclerotic rim would develop. In the late stage of the disease, the ischemic epiphyseal bone weakened and collapsed. With further time, loose bodies within the joint may form from the detached bone fragment.

Freiberg's infraction can be classified according to anatomic involvements [3] or pathologic changes [1]. There are no studies on prognosis in relation to disease stage; however, in the later stage, collapse of the metatarsal head and arthritic change of the joint were thought to be related to poorer prognosis. In the early stage of the disease when the articular surface is intact, nonoperative treatments that relieve pressure on the metatarsal head are effective [7]. Surgical intervention is usually indicated in patients with late stage disease or after failure of conservative treatments. Many kinds of methods have been proposed, including joint debridement and synovectomy [7], loose body removal [4], resectional arthroplasty, scraping with cancellous bone replacement [1], silicone prosthesis replacement [8], and metatarsal osteotomy [3]. However, no single procedure was able to yield good results with regard to both symptomatic relief and functional preservation. In the present report, both lesions were stage V lesions according to the Smillie classification [1]. We performed metatarsal neck dorsal closing wedge osteotomy on the basis that the superior and dorsal aspects of metatarsal head cartilage are frequently involved due to dorsal impingement caused by proximal phalange propulsion. The plantar aspect of the metatarsal head was not involved. Thus, the closing wedge osteotomy over the metatarsal neck with plantar articular surface rotation dorsally is effective in decompressing the necrotic lesion and restoring joint congruity. Both our patients were completely pain-free after 2 years postoperatively. In addition, radiographic examination showed preservation of the joint space and congruity.

There have been several reports of dorsal closing wedge osteotomy for Freiberg's disease. Gauthier and Elbay in 1979 [3] first reported good outcomes in 52/53 cases, and Chao et al in 1999 [9] also reported excellent prognosis in 11/13 cases. Gauthier and Elbay [3] used wire for internal fixation of the osteotomy, but it appeared to be difficult to apply and provided less rigid fixation. Chao et al [9] modified the surgery by using cross-pinning instead of wire for internal fixation; this had the advantages of rigidity of fixation and ease of technique. However, the migration of pins and skin irritation were concerns. We modified the fixation by using only one percutaneous pin. The advantages of our method include stable fixation, less technical demand, easy pin care, less skin irritation, and no complication of pin migration. The disadvantage of our method is the concern of arthrosis in the interphalangeal joint

and MTPJ. However, no such complication was found in our patients.

Metatarsal neck dorsal closing wedge osteotomy is a simple but effective method to treat Freiberg's infraction. It provided good symptomatic relief and functional preservation in our cases. Thus, we consider that it is the appropriate treatment for patients with symptomatic Freiberg's infraction. Good results can be attained even in lesions with metatarsal head collapse or arthritic change.

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弗萊堡氏壞死 — 以蹠骨頸楔狀矯正切骨術治療：二個病例報告

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弗萊堡氏壞死是種缺血性壞死疾病，常發生在第二或第三蹠骨頭部。過去有許多致病的機轉曾被提出，但過度的壓力是目前較被接受的說法。疾病早期可以使用保守療法，但是在晚期則需要手術治療，然而目前對於手術的方式仍存在著爭議。本文我們報告二個弗萊堡氏壞死的病例，患者在接受蹠骨頸楔狀矯正切骨術治療後，得到相當好的預後，而且我們建議在經保守治療無效的弗萊堡氏壞死病患，接受蹠骨頸楔狀矯正切骨術的治療是相當恰當的。

關鍵詞：弗萊堡氏壞死，蹠骨頸楔狀矯正切骨術

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