Original Article

Results of two different surgical techniques in the treatment of advanced-stage Freiberg's disease

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Abstract

Background: Freiberg's disease is an osteochondrosis most commonly seen in adolescent women and characterized by pain, swelling and motion restriction in the second metatarsal. The early stages of this disease can be managed with semirigid orthoses, metatarsal bars and short leg walking cast. Number of operative methods are suggested which can be used depending on the pathophysiology of the disease, including abnormal biomechanics, joint congruence and degenerative process. We evaluated the outcomes of the patients with Freiberg's disease who were treated with dorsal closing-wedge osteotomy and resection of the metatarsal head.

Patients and Methods: 16 patients (11 female, 5 male) with a mean age of 24.5 (range 13–49 years) years who underwent dorsal closing wedge osteotomy or resection of the metatarsal head were included in this retrospective study. Second metatarsal was affected in 13 and third metatarsal in three patients. According to the Smillie's classification system, ten patients had type IV osteonecrosis and six patients had type V. The results of the patients were evaluated using the lesser metatarsophalangeal-interphalangeal (LMPI) scale.

Results: According to the LMPI scale, the postoperative scores for the osteotomy and excision groups were 86 (range 64–100) and 72.6 (range 60–85), respectively. In the osteotomy group, mean passive flexion restriction was 18° (range 0°–35°) and mean passive extension restriction was 12° (range 0°–25°). Mean metatarsal shortening was 2.2 mm (range 2–4 mm) in the osteotomy group as opposed to 9.8 mm (range 7–14 mm) in the excision group. Significant pain relief was obtained in both groups following the surgery.

Conclusions: The decision of performing osteotomy or resection arthroplasty in the patients with advanced-stage Freiberg's disease should be based on the joint injury and the patients should be informed about the cosmetic problems like shortening which may arise from resection.

Key words: Metatarsal, dorsal closing-wedge osteotomy, Freiberg's disease, metatarsal, osteochondrosis, resection
MeSH terms: Osteonecrosis, metatarsus, osteotomy, arthroplasty

Introduction

Freiberg's disease is an osteochondrosis most commonly seen in adolescent women and characterized by pain, swelling and motion restriction in the second metatarsal. It is less common in the third and fourth metatarsals.[1,2] While the etiology of the Freiberg's disease remains obscure, repeated microtrauma is considered to be the cause for development of this disease.[2,3]

Since the second metatarsal is the longest and the least mobile, excessive pressure on the metatarsal head can lead to impaired blood supply to the subchondral site, as well as chondral collapse and necrosis accompanied by synovitis. If the synovitis is severe, it may lead to swelling and motion restriction, especially in extension. Subsequently, osteochondral fragmentation may occur at the metatarsal head.[4-6]

The early stages of this disease can be managed with semirigid orthoses, metatarsal bars and short leg walking cast.[3] If the pain is not relieved by these methods, a number of operative methods are suggested which can be used depending on the pathophysiology of the disease, including abnormal biomechanics, joint congruence and degenerative process.[1,5,7,8]

We evaluated the clinical outcomes of the cases of advanced-stage Freiberg's disease who were managed

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with dorsal closing wedge osteotomy or resection of the metatarsal head.

Materials and Methods

16 patients (11 female, 5 male) with a mean age of 24.5 years (range 13–49 years) who underwent dorsal closing wedge osteotomy or resection of the metatarsal head due to advanced stage Freiberg's disease between 2007 and 2012 were included in this retrospective study. The main presenting symptom was pain on daily activities such as standing, walking and running. 6 had mild, 6 had moderate and 4 had severe pain in daily activities. Second metatarsal was affected in 13 and third metatarsal in 3 patients. All of the patients had a history of trivial trauma and four patients had previously undertaken joint debridement. The initial treatment was based on conservative methods including rest to the part analgesic and anti-inflammatory medications along with metatarsal bar or splint. Since the patients remained unresponsive to conservative treatment for more than three months, the patients underwent dorsal closing wedge osteotomy or resection of the metatarsal head. Average time taken from onset of the first symptom to surgery was 6 months. The decision of surgical method was based on the preoperative radiological studies and the cartilage damage during surgery. Osteotomy was performed in the patients with good joint congruency and the ones who had sufficient plantar cartilage to perform the procedure.

Figure 1: X-ray of a 24-year-old female patient anteroposterior view showing (a) Freiberg's disease advanced stage in 2nd metatarsal head (b) resection of 2nd metatarsal head

Resection was done in the patients with impaired joint congruency and severe cartilage damage [Figure 1].

Clinical and radiological staging of the cases was based on the Smillie's classification system[1] [Table 1] and the lesser metatarsophalangeal-interphalangeal (LMPI) Scale modified by Kitoaka *et al*. [Table 2].[7] According to the Smillie's classification, 6 of our patients were type V, and 10 of them

Table 1: Smillie clasification system for Freiberg's disease

Stage	Description
I	Fracture through the epiphysis, no radiolocal findings
II	Central depression in the metatarsophalengeal joint. The articular cartilage hinges on an intact plantar bridge
III	Central depression that leads to medial and lateral projections at the margins with an intact plantar hinge
IV	Central portion frees from the intact plantar hinge, forming a loose body with associated fractures of the medial and lateral projections
V	Flattening of the metatarsal head with secondary degenerative changes

Table 2: Lesser metatarsophalangeal–interphalangeal scale

Item	Degree
Pain (40 points)	
None	40
Mild, occasional	30
Moderate, daily	20
Severe, almost always present	0
Function (45 points)	
Activity limitations	
No limitations	10
No limitation of daily activities, limitation of recreational activities	7
Limited daily and recreational activities	4
Severe limitation of daily and recreational activities	0
Footwear requirements	
Fashionable, conventional shoes with no insert	10
Comfort footwear, shoe insert	5
Modified shoe or brace	0
MTP joint motion (dorsiflexion plus planterflexion)	
Normal or mild restriction (75° or more)	10
Moderate restriction (30-74°)	5
Severe restriction (less than 30°)	0
IP joint motion (planterflexion)	
No restriction	5
Severe restriction (less than10°)	0
MTP-IP stability (all directions)	
Stable	5
Definitely unstable or able to dislocate	0
Callus related to lesser MTP-IP	
No callus or asymptomatic callus	5
Callus, symptomatic	0
Alignment (15 points)	
Good, lesser toes well aligned	15
Fair, some degree of lesser toe malalignment observed, no symptoms	8
Poor, severe malalignment, symptoms	0

were type IV. Based on the LMPI scale, the preoperative scores for the osteotomy and excision groups were 58 (range 44–80) and 50.8 (range 40–58), respectively.

Operative procedure

All the operations were performed under spinal anesthesia and in the supine position with tourniquet control. One hour prior to surgery, single dose of 1 g first generation cephalosporin was used for prophylaxis. The metatarsal head was approached by a 3-cm dorsal incision through the metatarsophalangeal joint. Using the dorsal longitudinal method, the extensor digitorum longus and brevis muscles of the affected toe were moved laterally following the medial excision of the extensor tendons. The joint capsule was longitudinally incised on the medial aspect and cheilectomy was performed. All the osteophytes were removed and synovectomy was done. The metatarsal head was positioned medially and dorsal closing-wedge osteotomy was performed on the distal metaphysis. The metatarsal head was tilted approximately 15° to the dorsal aspect, and when the joint congruency was achieved between the metatarsal head and proximal phalanx, the osteotomy was stabilized using two crossed Kirschner wires (K-wires) under fluoroscopic control. In the resection group, following a 5 mm resection of the articular surface of the metatarsal head, the capsule was sutured and the soft tissues were closed in layers. The foot was immobilized in a short leg walking cast in all the patients. In the osteotomy group, the cast and pins were removed at 6 weeks and tolerable weight bearing was commenced. In the patients who received debridement and excision of the metatarsal heads the cast and pins were removed at 2 weeks and weight bearing was started. All the patients underwent clinical and radiographic followup at 2 and 4 weeks, 2 and 6 months and then every 12 months. The osteotomy site healing and metatarsal shortening were evaluated by means of anteroposterior and oblique X-ray images.

Statistical evaluations were based on descriptive statistics methods (average, standard deviation, frequency) and functional improvement was assessed using the Wilcoxon test with SPSS 18.0 for Windows 7 (SPSS version 18 statistical software, SPSS Inc, Chicago, Illinois, USA). A $P < 0.05$ was considered significant.

Results

Mean followup for 16 patients was 30.8 months (range 25–72 months). Osteotomy was performed in 11 and resection of the metatarsal head was performed in five patients. In the resection group, four patients had previously undertaken joint debridement. In the osteotomy group, solid healing was achieved in a mean period of 6 weeks (range 4–8 weeks) [Figure 2]. No superficial or deep wound infection was observed in any patient. According to the LMPI Scale, the postoperative scores for the osteotomy and excision groups were 86 (range 64–100) and 72.6 (range 60–85), respectively and the elevation in these scores was found significant (osteotomy group, $P = 0.003$; resection group, $P = 0.042$). In the osteotomy group, mean passive flexion restriction was 18° (range 0°–35°) and mean passive extension restriction was 12° (range 0°–25°). Mean metatarsal shortening was 1.8 mm (range 2–4 mm) in the osteotomy group as opposed to 9.8 mm (range 7–14 mm) in the resection group. No infection was observed in any patient and no nonunion was detected in the osteotomy group. In the patients managed with osteotomy, significant pain relief was obtained and all the patients started daily life activities, which they could not do before. In the resection group, four patients had significant pain relief in their daily life activities and only one patient had pain which was mimicking metatarsalgia. In this group, the most common complaints were metatarsal shortening and relevant cosmetic complaints.

Figure 2: X-ray of a 22 year old patient anteroposterior views showing (a) Freiberg's disease of 3rd metatarsal head (b) postoperative x-ray treated with osteotomy

Discussion

Surgery is the treatment of choice in patients with failed conservative treatment. The primary aim of surgery is to restore the joint in order to eliminate the pain and recover the range of motion. A number of surgical methods have been defined in the literature: resection of the metatarsal head (Giannestras), metatarsal head remodeling and joint debridement (Freiberg and Mann), resection of the base of the proximal phalanx and syndactylization of the second and third toes (Trott), elevation of the depressed fragment of the metatarsal head and bone grafting of the defect (Smilie), resection of the base of the proximal phalanx, resection of the metatarsophalangeal joint with cylastic prosthesis, and dorsal closing-wedge osteotomy of the metatarsal head.[1,6,8-14] Of these, joint debridement and metatarsal head remodeling are the most common ones, which have yielded successful results in the literature.[6]

Dorsal closing-wedge osteotomy was initially performed by Gauthier ve Elbaz and has become a conventional method ever since. This method has been performed many times and has yielded successful results.[14,15] The primary goal with this method is to restore the articular surface. Dorsal closing-wedge osteotomy is also considered useful in restoring blood supply at the metatarsal head and preventing potential collapses.[16] By modifying the method developed by Gauthier ve Elbaz, which involves the use of cerclage fixation following osteotomy, Chao *et al*. defined an extra-articular osteotomy, in which the articular surface is rotated to the proximal phalanx after the removal of defective articular surface.[11,12] Using the K-wires for the fixation of osteotomy line, the study reported the average shortening as 2.1 mm, joint flexion as 15° and loss of joint extension as 8°. Moreover, despite these rates, the authors reported no restriction in daily activities of the patients such as walking and running. In our study, the eleven patients who were managed with closing wedge osteotomy had a mean passive flexion restriction of 18° (range 0°–35°) and a mean passive extension restriction of 12° (range 0°–25°). mean preoperative score was 58 (range 44–80) and mean postoperative score was 86 (range 64–100). In this group, the patients had satisfactory outcomes in terms of pain relief and improvement of range of motion. These results were consistent with the ones in the literature.

Resection arthroplasty is another method suggested for the patients with stage IV or V. However, this technique is the least popular one since it causes metatarsal shortening.[4] In our series, four of the patients who were managed by this method had previously been performed with joint debridement due to Freiberg's disease. Although the pain relief was obtained in all of them, after a certain period of time (range 3–18 months), the pain relapsed in all the patients. All four patients had severe cartilage damage and thus underwent excision of the metatarsal head. Metatarsalgia is a common complication arising from the excision of the metatarsal head,[4] and it developed in one of our patients. By wearing appropriate footwear and obtaining supportive treatments, the patient had significant pain relief in daily life activities. The most common complaints in the resection group were metatarsal shortening and relevant cosmetic problems.[4] In our study, mean metatarsal shortening in the resection group was 9.8 and in this group, the most common complaints were metatarsal shortening and relevant cosmetic problems. Since Freiberg's disease is more common in women, cosmetic concerns are highly valued. Therefore, the patients to be managed with resection arthroplasty should be informed about the cosmetic problems like shortening and relevant cosmetic problems.

Conclusions

We conclude that the dorsal closing-wedge osteotomy and the resection arthroplasty are effective methods in the treatment of Freiberg's disease. The decision of surgical method should be primarily dependent on the cartilage damage. The resection arthroplasty should be used in severe cartilage damage and the dorsal closing-wedge osteotomy should be preferred if there is sufficient healthy plantar cartilage.

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