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ARAŞTIRMA / RESEARCH

Extra-articular dorsal closing-wedge osteotomy in the treatment of late-stage Freiberg disease: clinical outcomes

İleri evre Freiberg hastalığında eklem dışı dorsal kapama kama osteotomisi: klinik sonuçlar

Osman Çiloğlu[1], Tuğhan Kalkan[2], Muhsin Dursun[3], Hakan Çiçek[1], Fırat Seyfettinoğlu[1], Ümit Tuhanioğlu[1]

[1]Saglık Bilimleri University Adana Numune Training and Research Hospital, Dept. Orthopaedic Surgery, Adana, Turkey
[2]Çukurova State Hospital, Department of Orthopaedic Surgery, Adana, Turkey
[3]Ortadoğu Hospital, Department of Orthopaedic Surgery, Adana, Turkey

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Abstract

Purpose: The aim of this study was to evaluate the results of dorsal close wedge osteotomy in addition to the debridement application on Freiberg disease in terms of functional recovery and pain relief.

Material and Methods: Sixteen patients diagnosed with Freiberg disease (11 female,5 male) were included in the study and their articular surfaces were evaluated using direct roentgenogram and magnetic resonance imaging following the physical examination. The evaluation of the patients' articular surface was based on Smilie Classification. The cases were evaluated previous to surgery and in the 12th week of the postoperative period using visual analogue scale (VAS) to determine pain levels and using American Orthopaedic Foot and Ankle Society score (AOFAS) score to assess their functional recovery.

Results: According to Smilie Classification, two cases were grade 2, six cases were grade 3, seven cases were grade 4 and one case was grade 5. The average dorsiflexion amount of the patients was 22 degrees (between 0 and 38) in preoperative period. It increased to 42 degrees on average (between 20 and 70) in the 12th week after the operation. The enlargement in arthroses and the swelling in metatarsophalangeal arthrosis due tosynovitis improved aesthetically in the 12th week after the operation.

Conclusion: The application of dorsal close wedge osteotomy in addition to debridement in the case of Freiberg disease is effective in the adjustment of the articular surface, in maintaining metatarsal length, in increasing the articular's functionality.

Key words: Freiberg disease, osteotomy, osteochondrosis.

Öz

Amaç: Bu çalışmanın amacı Freiberg hastalığında debridman uygulamasına ek olarak dorsal kapalı kama osteotomisinin sonuçlarını fonksiyonel iyileşme ve ağrı açısından değerlendirmektir.

Gereç ve Yöntem: Freiberg hastalığı teşhisi konulan 16 hasta (11 kadın, 5 erkek) çalışmaya dahil edildi. Hastaların fizik muayene sonrasında direk röntgenogram ve manyetik resonans görüntüleme ile eklem yüzeyleri değerlendirildi. Hastaların eklem yüzeyi değerlendirilmelerinde Smilie sınıflaması kullanıldı. Olguların ameliyat öncesi, ameliyat sonrası 12. haftada vizüel analog skalası (VAS) ile ağrı açısından ve American Orthopaedic Foot and Ankle Society (AOFAS) skoru ile fonksiyonel açıdan değerlendirmesi yapıldı.

Bulgular: Yapılan değerlendirmede Smilie sınıflamasına göre 2 olgu evre 2, 6 olgu evre 3, 7 olgu evre 4 ve 1 olgu ise evre 5 idi. Hastaların ameliyat öncesi ortalama dorsifleksiyon miktarları 22 derece (0 – 38 derece arası) iken ameliyat sonrası 12. haftada ortalama dorsifleksiyon miktarları 42 derece (20–70 derece arası) idi. Metatarsofalageal eklemdeki sinovite bağlı şişlik ve eklemdeki genişlemede ameliyat sonrası 12. haftada kozmetik açıdan düzelme saptandı.

Sonuç: Freiberg hastalığında eklem debridmanı ile birlikte uygulanan dorsal kapalı kama osteotomisi eklem yüzeyinin uyumunun yeniden sağlanması ve metatars uzunluğunun korunması ile semptomların azaltılması ve eklem fonksiyonunun arttırılmasında etkili bir yöntemdir.

Anahtar kelimeler: Freiberg hastalığı, osteotomi, osteokondrosiz.

Yazışma Adresi/Address for Correspondence: Dr. Osman Çiloğlu, Sağlık Bilimleri Üniversitesi, Adana Numune Eğitim ve Araştırma Hastanesi, Ortopedi ve Travmatoloji Kliniği, Adana, Turkey. E-mail: osmanciloglu@gmail.com
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INTRODUCTION

Freiberg disease was first defined by Alfred H. Freiberg in 1914 who discovered the disease to be caused by the over length of the second metatarsal. Freiberg disease is the idiopathic osteochondosis of the metatarsal head. The symptoms of the disease such as rigidity in metatarsophalangeal articular, reduced mobility, swelling due to synovitis and the pain affect the patients' daily lives negatively[1,2,3].

Frieberg's disease is the fourth most common osteochondrosis following Kohler disease of the tarsal navicular, Panner disease of the capitellum and Sever disease of the calcaneus[4].

Conservative treatment alternatives such as the application of a pad to metatars or the use of a recovery splint to reduce the pressure in metatarsal head are available in addition to anti-inflammatory treatments given in the early phases of Freiberg disease[5,6].

For the cases where conservative treatments would be ineffective or insufficient, some surgical treatments have been developed. Among these, the most common alternatives are debridement, retrograde drilling, core decompression and subchondral autograft, resection interposition of arthroplasties (e.g. metatarsal head resection, resection of proximal phalanges articular surface), osteochondritis tissue implantation, osteotomies and joint replacements[5-8]. Though no treatment modality has become the gold standard, closing-wedge osteotomy has been widely performed with good results[9]. Dorsal closing-wedge osteotomy was first diagnosed in 1979 by Gauthier and Elbaz[2]. Kinnard and Lirette[3] displayed successfull results in 1991 using the same technique[10].

Two types of closing wedge osteotomy (intra-articular and extra-articular) have been supported by a number of authors. In intra-articular osteotomy, less secure fixation from a small remaining intact portion of the metatarsal head and avascular necrosis may be disadvantages. Despite concern for excessive elevation of the metatarsal head, extra-articular closing-wedge osteotomy has the advantage of more secure fixation at the normal metaphyseal osteotomy site, compared with intra-articular osteotomy[9].

Various methods have been reported for fixing osteotomy sites. In the report by Gauthier and Elbaz[2], cerclage wire was used to fix the osteotomy site; however, tendinitis occurred in the extensor tendon, and wire removal was required. Kinnard [3] used an absorbable suture, but these types of sutures are reportedly too weak for fixing. Chao[11] used a temporal cross-pinning of Kirschner wire (K-wire) for fixation[7]. Although the procedures associated with this method are simple, the removal of metal objects is required, and early range of motion (ROM) training cannot be conducted[12].

Figure 1. Tenderness and swelling over the metatarsal head

In this respect, the present study aims to determine the effects of extrarticular metatarsal close wedge osteotomy using temporary Kirschner wires (K-wires) as joysticks to assist in achieving and maintaining reduction during cross-pinning in Freiberg patients whose situations did not improve after receiving conservative treatments. We evaluated the results in terms of pain relief and functional recovery.

MATERIAL AND METHODS

Sixteen patients (11 female and 5 male) with late stage Freiberg disease (stage 2 to5) who operated with extra-articular dorsal closing-wedge osteotomy using Kirchner wires between 2008 and 2011 at Adana Numune Training and Research Hospital were included in the study. The average age of the patients was 17.5 (from 14 to 23). The study was approved by the Ethics Committee and performed in accordance with ethical standarts of the Helsinki Declaration. Additional informed consent was taken from the patients.

All the patients had some degree of pain, tenderness and swelling over the metatarsal head, and the radiographs revealed the characteristic flattened an widened appearance of the metatarsal head (Figure

1). Patients with rheumatoid arthritis and neurogenic pes cavus were excluded from the study. Diagnosis was confirmed using radiographs to determine the extent of bone necrosis. Only those with obvious radiographic evidence of disease (stage 2 or above) were included in this study. All the patients had received conservative treatments previous to the study and none of them could recover. Twelve of them had 2nd grade metatars and four had 3rd grade metatars. All of them had symptoms of swelling in the metatarsophalangeal, sensitivity and reduced mobility.

Surgery technique

Ten of the patients received local anesthesia whereas six of them had general anesthesia. All the patients were operated by the same surgeon on in the supine position and in a tourniquet. Following the necessary preparations, a longitudinal incision was used to reach the extensor tendon through metatarsophalangeal dorsal. Then, the extensor tendon was moved to the fibular side. Joint capsule was opened at dorsal and the joint was debrided (Figure 2).

Figure 2. The same patients images during the operation. Cartilage damage can be seen.

Following this operation, dorsal close wedge osteotomy was applied to metatarsal head and the metatarsal head on the undamaged cartilage plantar surface was turned into dorsal. As a result of this, the adjustment between the proximal phalangs and the arthrosis was maintained. Also, two cross kirshner pins were implanted in order to determine osteotomy (Figure 3). All patients were also implanted with a postoperative short-leg splint.

The patients were asked to come to check every two weeks and once in a month after a certain period. The splints were removed two weeks after the operation and fixation pins were taken out in the fourth week. The patients were allowed to move actively and to apply limited weight at the end of the fourth week. They were allowed to apply full weight in the eighth week

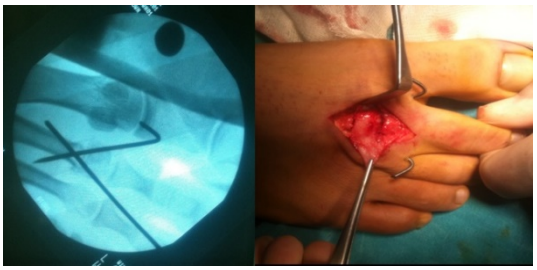

Figure 3. Extra articular metatarsal close wedge osteotomy using kirschner wires for fixation

Evaluation of patients and operative parameters

In 1994, the American Orthopaedic Foot and Ankle Society (AOFAS) developed clinical rating scales to establish standards for assessment of foot and ankle surgery. The AOFAS clinical rating system consists of rating scales that correspond to anatomic regions of the foot and ankle: ankle-hindfoot scale, midfoot scale, hallux metatarsophalangeal-interphalangeal scale and lesser metatarsophalangeal-interphalangeal scale [13] (Figure 5).

The AOFAS clinical rating system is now widely used worldwide as a benchmark standard rating scale, and many studies report AOFAS scores to support their conclusions regarding the outcome of surgery [14].

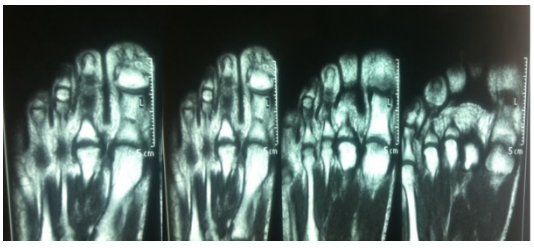

Figure 4. The MRI of the 18-year old patient in Smilie Grade 3.

For clinical evaluation in the study, the lesser toe metatarsophalangeal- interphalangeal scale developed by the American Orthopaedic Foot and Ankle Society (AOFAS) was used for objective assessment. Range of motion (ROM) of the metatarsophalangeal (MTP) joint was also evaluated.

Visual analogue scale (VAS) was used for assessment of pain relief or aggravation.

All of the patients were evaluated before the operation and in the 12th week after the operation. Each participant then had a physical examination by one examiner to complete the objective data for the scales. The patients were observed 14 months on average (between 9 and 19 months).

Their preoperative state was evaluated on the basis of direct roentgenogram and magnetic resonance imaging (MRI). The direct roentgenogram results of the patients showed that they had flattening on the metatarsal head, stenosis in joint spaces and arthrosis symptoms of varying degrees. On the other hand, MRI evaluation showed that cartilage tissue on metatarsal head was intact but there was damage in various degrees in the dorsal and central locations (Figure 5).

Figure 6. In the examinations in the 12th week, it was observed that swelling in metatarsophalangeal articular cosmetically disappeared of the cases.

Smilie Classification [1] was utilized in the analysis of X-ray and MRI of the patients. According to the Smilie classification; The stages of deformity from 1 through 5 based on radiographic findings. *Grade one:* fissure fracture in subchondral epiphysis, *grade two*: collapse and flattening in the center of metatarsal head, *grade three*: when the collapse is in the center and the sides and flattening is severe**,** *grade four*: presence of loose bodies in arthrosis, *grade five*: stenosis in joint spaces and degenerative arthrosis.

As a result of the evaluation of the cases, we identified that two cases (12.5%) had grade 2 osteochondrosis, six cases (37.5 %) had grade 3, seven cases (43.7 %) had grade 4 and one case (6.3 %) had grade 5 osteochondrosis. The treatment plan for all patients was dorsal close wedge osteotomy. Radiographic bone union was defined as bridging of the osteotomy by callus in 3 views. Change in configuration of the head of the metatarsal was also assessed. Radiographs were reviewed by 2 independent examiners to verify bone union and change of the head

Statistical analysis

A Wilcoxon signed-rank test was used for comparison of preoperative and postoperative clinical examination parameters, including visual analogue scale and range of motion. *P* value less than 0.01 was considered statistically significant.

RESULTS

The average for union duration was 14 weeks (between 10 and 16) for all patients and there were no symptoms of infection, pseudoarthrosis, or loss of reduction or recurrent osteonecrosis in any of the cases. In the examinations in the 12th week, it was observed that swelling in metatarsophalangeal articular cosmetically disappeared in all of the cases (Figure 6).

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 such as employment responsibilities, limitation of recreational activities	7
Limited daily and recreational activities	4
Severe limitation of daily and recreational activities	0
Footwear requirements	
Fashionable, conventional shoes, no insert required	10
Comfort footwear, shoe insert	5
Modified shoes or brace	0
MTP joint motion (dorsiflexion plus plantarflexion)	
Normal or mild restriction (75° or more)	10
Moderate restriction (30°-74°)	5
Severe restriction (less than 30°)	0
IP joint motion (plantarflexion)	
No restriction	5
Severe restriction (less than 10°)	0
MTP-IP stability (all directions)	
Stable	5
Definitely unstable or able to dislocate	0
Callus related to hallux 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, obvious symptomatic malalignment	0

Figure 5. The lesser toe metatarsophalangeal-interphalangeal scale developed by the American Orthopaedic Foot and Ankle Society (AOFAS) .

While the average VAS score of the patients was 8.5 ± 0.5 (between 8 and 9) in the preoperative phase, it decreased to 1.1 ± 0.71 (between 0 and 2) on average in the 12th week after the operation. The decrease in the VAS score of the patients in the postoperative period was statistically significant ($p<0.001$). The patients were observed to become considerably more active without any pain. They were also evaluated for functionality using AOFAS score in preoperational period and in the 12th week after the operation. The mean result for AOFAS score was 56.1 ± 5.9 (between 42 and 69) before the

operation and it increased to 90.75 ± 6.2 (between 74 and 97) in the postoperative period. The increase in AOFAS score was also statistically significant (p<0.001) (Table 1).

Table 1. Pre operative and post operative AOFAS and VAS scores

	Preoperation	Post-operation	P value
AOFAS	56.1 ±5.9	90.75 ± 6.2	<0.001
VAS	8.5±0.5	1.1 ± 0.71	<0.001

AOFAS: American Orthopaedic Foot and Ankle Society ; VAS: Visual Analogue Scale score.

The patients randge of motion (ROM) of metatarsophalangeal (MTP) joint was assessed in the pre and postoperative phases. While their dorsiflexion angles were 22 degrees on average (between 0 and 38) before the operation, it was 42 degrees (between 20 and 70) in the 12th week after the operation. As for plantar flexion angle, it was 42 degrees (between 28 and 55) in the preoperative period and 30 degrees (between 20 and 40) in the 12th week after the operation. It was identified that the patients' dorsiflexion movement space increased by 20 degrees (between 7 and 35) on average after the operation. However, there was a loss by 12 degrees on average (between 0 and 20) in plantar flexion.

DISCUSSION

The definite cause of metatarsal osteochondrosis is not known. Although micro-traumas are frequently held responsible, other reasons such as insufficient blood supply or second metatars being longer than the first are also commonly reported [1-3,15]. However, our patients did not have trauma stories and there was no record of osteochondrosis in other locations.

The reasons that the disease is an osteochondrosis and that there are no complaints in its early phases and therefore, no scintigraphy or MRI test results are available which lead to delay in diagnosis [16]. Owing to the difficulty of an early diagnosis, the disease is usually diagnosed in later phases, which mandates the use of more complicated techniques in operational treatment alternatives.

When diagnosed in early phases, the Freiberg disease can be effectively treated by conservative treatment methods or by simpler operational techniques. Among the operational techniques that can be applied in the early phases of freiberg disease, retrograde drilling, core decompression and grafting of metatarsal head are common. Smilie [1] (1967) reported that the application of core decompression accompanied by autograft to metatarsal head was effective in grades 1-3. He suggested that more aggressive treatment techniques should be preferred in later grades[17,18].

Among the treatment techniques that can be applied in later phases of Freiberg disease are syndactylism of the 2nd and 3rd toes, resection interposition arthroplasties (e.g. resection of metatarsal head, resection of proximal phalanges articular surface), osteochondrosis tissue implantation and osteotomies to reduce the pressure at joints (such as metatarsal shortening). In addition to these alternatives, dorsal close wedge osteotomy, which both restores the joint and reduces the pressure, is available[2,5,19].

Smith and Stanley [16] have reported that the application of metatarsal shortening and fixation with plate in 15 patients resulted in pain relief but caused permanent rigidity in MTF joint. However, this rigidity was reported not to affect the patients functionality [16]. Based on their experiences, they also stated that resection of metatarsal head led to an increased weight on the other metatarsal head and resulted in stress fractures in metatars [16]. Similarly, Hoskinson[20] has recorded that the patients complaints continued even after resection of metatarsal head or hemiphalangeal excision. Hoskinson and Smith have also affirmed similar negative results for resection arthtroplasty [16,20].

We have applied metatarsal dorsal close wedge osteotomy to 16 Freiberg disease patients whose cases did not improve after conservative treatments. In 1979, Gauthier and Elbaz [2] applied dorsal close wedge osteotomy to 53 cases and Kinnard and Lirette [3] used it for 15 cases. All of the cases were reported to improve with positive results. Gauthier used cerclage wire to fix osteotomy whereas Kinnard used soluble suture. Gu and Shi [21] applied 3-4 absorbable pins for fixation with the same technique. In their studies, they reported positive results for the cases in grades 2 and 3. Therefore, it is clear that the studies in literature indicate similar results to our study.

Unlike other studies, we used Cross Kirshner pin for osteotomy fixation for all our patients. We claim that since scraping of metatars from soft tissues is not required in cross kirshner fixation, no blood circulation hindrance was observed and we could attain a substantial fixation. We believe that availability of the operation technique in all grades and the almost full recovery of joint spacing are among the most important advantages of this technique. The only drawback is the need to remove Kirshner pins before the patients are allowed to mobilize. However, patients can easily tolerate this operation by the help of local anesthesia. Being a noncomparative study with a small sample was the limitation of the study. However, the procedure was performed prospectively using a careful regimen.

In the treatment of Freiberg disease, effective results can be achieved by dorsal close wedge osteotomy in maintaining articular adjustment and metatarsal length, in pain relief, in almost pain-free mobility.

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