



Corrective Osteotomy of The Metatarsal Bone in The Treatment of Patients with Freiberg's Disease

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ABSTRACT

The study includes 11 patients with Freiberg's disease aged 17 to 21 years. Considering the late treatment of patients, all patients were recommended to undergo surgical treatment. 10 patients underwent intra-articular dorsal closed-angle wedge-shaped osteotomy with fixation with metal wires, 1 patient underwent arthroplasty of the metatarsophalangeal joint with transposition of an osteochondral autograft. The used method of surgical treatment ensures the restoration of the sphericity of the metatarsal head and the congruence of the metatarsophalangeal joint, which not only shortens the treatment time, but also has a positive effect on the restoration of the function of the metatarsophalangeal joint.

Key words: Freiberg's disease, metatarsophalangeal joint, angle-closure wedge-shaped osteotomy, arthroplasty.

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INTRODUCTION

Freiberg disease (1914, Köhler described the disease only in 1920), avascular necrosis of the head of metatarsal. Avascular necrosis of the head of second metatarsal ranks fourth among the most common osteochondrosis [2]. Classical localization is the head of the second metatarsal (68%), although other metatarsals' affection can be observed as well, the third (27%), fourth (3%), the fifth is extremely rare, and the cases of multiple or bilateral lesions can be encountered as well [1,10]. The longer and less mobile second metatarsal is subject to larger stress during walking and sports activities with the formation of edema, which also contributes to blood circulatory disturbance; chronic diseases and prescription of steroid drugs are the risk factors [3,13].

Freiberg disease is diagnosed by X-ray examination, the best is the 45-degree oblique view, expansion of joint space may be the first visible sign. The disease outcome made through X-ray findings are depression of articular facet, presence of free articular bodies, fragmentation, and sclerosis [19]. Classifications of Freiberg disease are usually based on disturbed circulation (circulatory inefficiency) and radiographs, for example, Smillie [16], this classification can be used in prognosis and planning of the treatment [17].

Conservative treatment is especially effective in the early stages of Freiberg disease [8]. Surgical treatment depends on the stage of degenerative changes of articulations (diarthroses) and includes following: decompression [5], debridement [6], perichondral plastic repair [15], metatarsal osteotomy [11,12,18] and arthroplasty [14]. Closed-angle wedge (cuneiform) osteotomy of metatarsus [9] is a reliable procedure with good results, the purpose of which is to relieve excess pressure under metatarsal head, which can be achieved by shortening or raising the metatarsal head, in order to rotate the articular facet, improve congruence, which theoretically, can restore blood supply to the metatarsal head, preventing further deformity and collapse [2,7]. Intra-articular dorsal closed-angle wedge osteotomy allows to reduce metatarsalgia more than with extra-articular osteotomy, which often results in excessive elevation of metatarsal head [4], redirects the articular facet allowing the intact (noninvolved) plantar cartilage to articulate with proximal phalanx. In addition, dorsal closed-angle wedge osteotomy gives the same results as extra-articular osteotomy in the range of motion of metatarsophalangeal joint. Joint arthroplasty is the definitive (final) option in advanced stage of disease, but possible implant failure and risk of synovitis exist because typical patient is an adolescent girl with a high level of physical activity.

MATERIAL AND METHODS.

In the Department of Hand and Foot Surgery of the Republican Specialized Scientific and Practical Medical Center of Traumatology and Orthopedics, 11 patients with Freiberg disease were hospitalized for the period from 2019 to 2021. Of these, 10 women (90.9%), whose average age is 20.8 years (from 17 to 31 years) and 1 man (9.1%), whose age is 30 years. Regarding the lesion, an approximately equal distribution was observed, while in one case (9.1%) there was a multiple lesion of heads of metatarsals of both feet. There is a following distribution of patients according to the Smillie classification: stage I and II were not observed, stage III - 2 cases (20.0%), stage IV - 7 cases (70.0%), stage V - 1 case (10.0%).

Among all the patients, there was one observed with after surgical treatment condition (resection of metatarsal head), and this case was not classified according to the Smillie classification. All the patients underwent X-ray of the feet in anteroposterior and oblique projections, multislice spiral computed tomography (MSCT) was performed in 54.5% of the cases, along with severe degenerative changes in the joint which required careful preoperative preparation. After surgical treatment, a histological examination of the removed chondro-osseous segments and articular facets of the modified metatarsal head was performed. The patients also underwent a standard laboratory and instrumental tests, clinical research with assessment of motion range of the affected joint, and assessment of condition using the AOFAS questionnaire, with an average score of 64.7 (satisfactory).

RESULTS AND DISCUSSION

Considering the late patient encountering, the average period of encountering after beginning of manifestations of clinical picture is 1.6 years, severity of degenerative changes in the joint, high scale of disease progression according to the Smillie classification, all patients were recommended to undergo surgical treatment. Effect of conservative treatment in later stages, when sclerosis of metatarsal head begins, is even less, which once again emphasizes the need for timely treatment.

Considering that intra-articular dorsal closed-angle wedge osteotomy allows to expand the intact articular facet, and theoretically improve blood supply and prevent further collapse, this operation was performed in 10 cases (90.9%) in patients with Freiberg disease stage III-V according to the Smillie classification, while metal pins (wires) were chosen as the fixing method. Patient (9.1%), who had previously undergone resection of head of affected metatarsal, came with an obvious clinical picture of arthrosis of metatarsophalangeal joint despite the surgery.

Appealing the data from the sources of literature, resection of base of proximal phalanx and/or metatarsal head is a technically easy procedure, but has the risk of progression of talipes valgus, appearance of metatarsalgia and shortening of toe [8], which was observed in this patient. The patient underwent arthroplasty of metatarsophalangeal joint with transposition of osteochondral autologous graft to the place of removed head to restore congruence of the joint. As a result of histological study (Fig. 4), biopsy materials revealed the presence of layers of compact bone tissue with resorptive lesions, lysis, fragments of cartilaginous hyaline-fibrous tissue; full-blooded vessels are determined in cavernous tissue among the porous fibroreticular stroma; bone marrow elements were scarce, which indicates the progressive degenerative nature of the disease.

In postsurgical period patient's foot was fixed in a short plaster cast. Removal of a clamping metal structure was carried out after 4-5 weeks, after which patients were recommended to walk in orthopedic shoes or on crutches with partial unloading for a period of 2-3 weeks. Total period of treatment ranged from 3 to 5 months. Long-term results were studied in 8 (72.7%) patients, the follow-up period was 1.2 years after surgical treatment. Average AOFAS score after 3 months was 70.5 points (satisfactory), after 6 months – 81.5 points (good), after one year – 91.3 points (good) after surgical treatment. Clinical judgement of conditions showed a mean loss of 15° of plantar flexion and 10° of dorsiflexion. At the last follow-up, 7 (63.6%) patients were completely satisfied, consolidation after surgical treatment and sphericity of metatarsal head were achieved in all cases; one (9.1%) patient had satisfactory score due to plantar displacement of metatarsal head and development of metatarsalgia, which was resolved by using metatarsal pad over the course of 3 months.

Clinical case study. For the purpose of illustration below is the data of patient A. born in 1998. She turned to orthopedist with complaints of pain in the head of second metatarsal of right foot of significant intensity during physical exertion and walking, the complaints gradually progressed over 1.5 years. On examination, there was intumescence in second metatarsophalangeal joint (Fig. 1), palpation of the head of II metatarsal was painful, movements in joint were limited. Initial X-ray image showed narrowing of joint space, deformity of second metatarsal head, osteosclerosis, and fragmentation of head (Fig. 1).



Figure 1. Appearance of foot, X-ray image of left foot

Patient was diagnosed with Freiberg disease of second metatarsal of left foot (Smillie stage IV) and surgical treatment was recommended named as "Debridement of second metatarsophalangeal joint of left foot. Dorsal intra-articular closed-angle wedge-shaped osteotomy of second metatarsal" (Fig. 2,3).



Figure 2. Intraoperative picture after arthrotomy (presence of freely lying osteochondrol bodies can be observed); after osteotomy, the head is fixed with metal (pins) wires; control radiographs

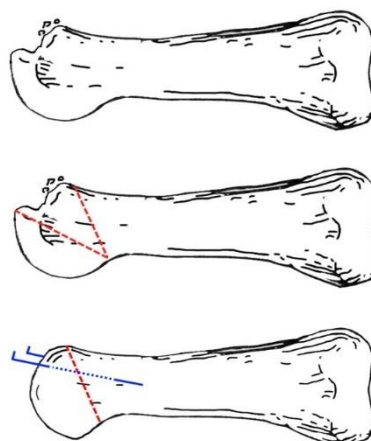


Figure 3. Scheme of surgical technique used for intra-articular closing wedge- osteotomy of metatarsal, osteosynthesis with pins.

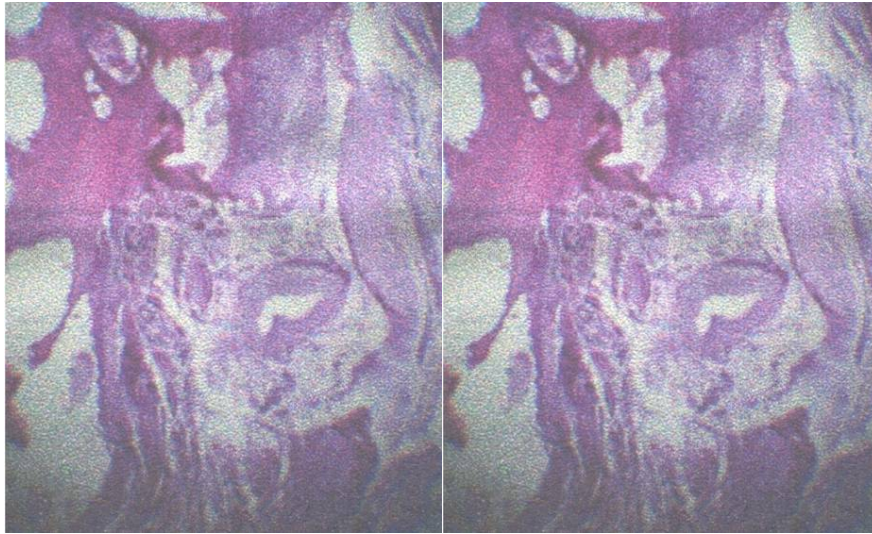


Figure 4. Results of histological examination

Patient underwent foot immobilization in a short plaster bandage, at the control examination after 1 month (Fig. 5), X-ray images showed signs of adhesion (bone union) and conservation of joint congruence, metal structure was removed, and recommendations were given for further rehabilitation.



Figure 5. X-ray images of left foot 1 month after surgery

After 6 months, control radiography showed that the shape of head of metatarsal is close to normal, joint space (articular cavity) is not expanded (Fig. 6). On examination, the patient has no complaints, area of metatarsophalangeal joint is not changed, palpation of metatarsal head is painless, movements in metatarsophalangeal joint are slightly limited.



Figure 6. X-ray images of left foot 6 months after surgery

CONCLUSIONS

1. Freiberg disease is a progressive degenerative disease, which with late diagnosis and lack of early treatment leads to osteoarthritis of metatarsophalangeal joint.
2. Method of surgical treatment used ensures restoration of sphericity of metatarsal head and congruence of metatarsophalangeal joint, which not only shortens the treatment time, but also has a positive effect on restoration of function of metatarsophalangeal joint.

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