A simple surgical technique for treatment of Freiberg’s disease

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ABSTRACT

Background: Of all the osteochondrosis, Freiberg’s disease is reported to be the fourth most common, exceeded by Köhler’s disease, Panter’s disease, and Sever’s disease. This disease usually occurs in the 2nd metatarsal head and relatively in the 3rd and 4th metatarsal heads.

Objective: The purpose of this study was to evaluate the outcome of debridement, synovectomy, dorsal closing wedge osteotomy and pin fixation for Freiberg’s disease treatment.

Methods: Ten female patients, mean age 18.3 years; (ranged 14–24 years) were treated by the above mentioned technique. The main presenting symptom was pain on walking or sport; affected their daily life and activities and was not improved by non-surgical treatment. The second metatarsal head was affected in all patients. Halve of patients had a history of trauma. According to Smillie’s classification, four patients were type V and six patients were type IV. Mean follow-up period was 19.2 months (range 6–36 months).

Results: Were assessed by the Lesser Metatarsophalangeal-Interphalangeal (LMPI)Scale by Kitaoka et al. At the final follow up, scoring was changed from (44–76) with an average 57 to (66–100) with an average 80. There was no case of infection, avascular necrosis, arthritis or pseudoarthritis.

Conclusion: We founded that dorsiflexion osteotomy of the metatarsal head is presented as a logical procedure that is simple, reliable, not destructive, and capable of good results regardless of the stage of the disease.

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1. Introduction

Freiberg’s disease refers to a painful condition mostly affecting the 2nd metatarsal head. This is the bony ‘knuckle’ in the ball of the foot behind the 2nd toe. The term is also used when the 3rd or 4th metatarsal bones are affected, though these are much less common [1].

Most commonly, it is found in young females with a ratio of 1 male:5 female. It is also more common in patients whose first metatarsal is shorter than the second metatarsal, which increases the weight on the second metatarsal head [2].

Because the second toe frequently is the longest and the second ray is the least mobile, excessive pressure on the metatarsal head on weight bearing could cause repetitive micro-fractures, loss of blood supply to the subchondral bone, collapse of this cancellous bone, and cartilage deformation. Synovitis accompanies the process, and if it is prolonged and severe, limitation of motion, especially in extension results. With this loss of extension of the metatarsophalangeal joint, weight bearing causes abnormal stress to be applied to the metatarsal shaft, which becomes widened from bicortical thickening. In addition to irregular ossification of the primary ossification center of the metatarsal head and widening of the metatarsal shaft, osteochondral fragmentation can occur around the metatarsal head [3].

Reasons for undertaking this study are the following:

1. Failure of non-surgical methods in stage IV and V.
2. Limited numbers of published articles about Freiberg’s disease.
3. There is no conclusive evidence in the literature about the best method of treatment of this disease.

“The authors have obtained the patient's informed written consent for print and electronic publication of the case report.”

2. Patients and methods

Between May 2009 and October 2011, 10 female patients with Freiberg’s disease of the second metatarsal head were operated on. The main presenting symptom was pain on walking affected their daily life activities. Surgery was done after failure of non-surgical
treatment (medical pain controllers, modification of activities, semirigid orthoses, metatarsal bars (Fig. 1), and short leg walking cast with a toe extension). Age of patients ranged between (14–24 years) with an average 18.3 years. Approximately, half of the patients could recall a definite history of trauma; usually of a minor nature. Patients were assessed both clinically and radiologically using the Lesser Metatarsophalangeal–Interphalangeal (LMPI) Scale by Kitaoka et al. (Table 1) [4] and Smillie’s classification (Table 2) [5]. Pre-operative Score was (44–76) with an average 57 and according to the Smillie’s classification six patients were type IV and four patients were type V Freiberg’s osteochondrosis. Postoperative follow-up period ranged from 6 to 36 months with an average 19.2 months.

2.1. Indications for surgery

The only indication for surgery is persistence of severe pain that affects walking and daily life activities, and which was not improved by using non-surgical methods of treatment for more than three months [6].

2.2. Contra-indications of surgery

A pre-existing deformity in the 2nd toe (hallux valgus deformity or malunion) [7].

A medical co-morbidity disease that prevent surgical intervention like: diabetes associated with peripheral neuropathy, peripheral vascular occlusive disease and immunocompromised patient.

Previous 2nd toe pathology or surgery (infection, tumor, etc.) [8].

3. Operative technique

Operation was done under general or regional anesthesia. Patient was placed supine. A tourniquet was applied. A dorsal 3 cm skin incision was placed on the midline of the metatarsophalangeal joint. The metatarsal shaft and metatarsophalangeal joint were exposed. The extensor hood was incised just medial to the extensor tendon and the extensor digitorum longus and brevis were retracted laterally. The joint capsule was longitudinally opened at the midline; the hyperplastic synovium was removed and debridement of loose fragments was done [6].

Then a dorsal closing-wedge osteotomy was done over the distal normal metaphysis with sufficient bone removal to bring the healthy planter part of the metatarsal head into articulation with the phalanx. The lesion was not removed, but rotated proximally and dorsally. The osteotomy site was fixed with two 1.6 mm K-wires (cross pinning) (Fig. 2). Then the joint capsule was roughly sutured and the skin incision closed [7] (Fig. 3).

4. Postoperative care

The foot was immobilized in a short leg walking cast for 6 weeks, then the cast and pins were removed and weight bearing was

Table 1

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

Table 2

Smillie’s classification [10].

<table>
<thead>
<tr>
<th>Staging</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage I</td>
<td>The earliest sign is fissuring of the epiphysis. Radiographic changes at this stage may be so subtle that they are missed with routine radiographs.</td>
</tr>
<tr>
<td>Stage II</td>
<td>Later central depression of the articular surface becomes evident as subchondral cancellous bone is resorbed. The articular cartilage hinges on an intact plantar bridge.</td>
</tr>
<tr>
<td>Stage III</td>
<td>The central depression is seen to be resulting in medial and lateral projections at the margins. The plantar hinge remains intact at its plantar isthmus.</td>
</tr>
<tr>
<td>Stage IV</td>
<td>This stage demonstrates that the central portion has sunk below the surface and is free of the plantar hinge, thus becoming a loose body. Fractures of the medial and lateral projections are present, with folding of the projections over the central loose body.</td>
</tr>
<tr>
<td>Stage V</td>
<td>The final stage shows marked flattening and deformity of the metatarsal head with secondary degenerative changes. The central loose body may have been resorbed at this stage. The shaft of the metatarsal becomes thickened and dense.</td>
</tr>
</tbody>
</table>
commenced. All patients were advised not to run until 8 weeks after surgery [7].

5. Postoperative assessment

Patients were assessed radiologically for healing of osteotomy site, and clinically through using (LMPI) Scale by Kitaoka et al. [4]. Patients were assessed for presence of any complication. The Mann–Whitney U test was used to verify the differences in results. Differences were considered significant when p value < 0.05.

6. Results

6.1. Radiologically

Solid healing of all osteotomies was observed at an average of 10 weeks (range 8–16 weeks). Also, there was no evidence

Fig. 2. Osteotomy technique [2].

Fig. 3. (Case presentation): (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 which were removed from the joint, i.e. (hypertrophied synovium). (e) Six weeks after operation (note complete union and healing of the metatarsal head). (f) Post-operative clinical assessment.
of displacement, osteolysis, sinus formation, or progression of osteonecrosis at the final follow-up.

6.2. Clinically

According to Kitaoka et al. scoring system; at the final follow up, scoring was changed from (44–76) with an average 57 to (66–100) with an average 80 (Table 3). Pain relief was complete and all patients were able to enjoy daily life activities, which were not possible before surgery. Loss of MTP joint passive flexion was 15° (range 0–30°), and loss of MTP joint passive extension 10° (range 0–30°) with no gait disturbance (Table 3). The metatarsal bone was shortened by 2.4 mm (range 2–4 mm), with no complaint of pain transfer to the adjacent metatarsals (Table 3). There was no case of infection, avascular necrosis, arthritis or pseudoarthritis.

7. Discussion

Of all the osteochondroses, Freiberg's disease is reported to be the fourth most common, exceeded by Köhler's disease, Panner's disease, and Sever's disease [6].

The progression of Freiberg disease is variable in time course and severity. While 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 [5].

There are many operative techniques; to treat Freiberg's disease, which include: (1) resection of the metatarsal head, (2) elevation of the depressed fragment of the metatarsal head and bone grafting of the defect, (3) resection of the base of the proximal phalanx with syndactylization of the second and third toes, (4) joint debridement and metatarsal head remodeling, (5) arthroplasty, (6) metatarsal neck shortening osteotomy, without exposing the joint and the osteotomy was fixed with a mini fragment T-plate, (7) osteo-articular transfers, or what are commonly called OATS (Osteochondral Autogenous Transfer System) procedures and (8) dorsal closing wedge osteotomy of the metatarsal head [1,3,6–8].

Herein in our study, dorsiflexion osteotomy of the metatarsal neck is presented as a logical, simple procedure that preserve articular surface and give good results regardless of the stage of the disease, with minimal limitation of motion of MP joint which did not affect the over all function. This conclusion was validated with that of Katcherian, 1994 [2]. In addition, patient must be informed before surgery that some permanent limitation of motion is usual occurrence after operation. Because motion in the affected joint frequently is limited anyway, this usually is not a restraint to surgery. Solid union was achieved in all cases, as osteotomies were done though the distal metaphysis (normal cancellous bone with a rich blood supply). Pain relief was complete as the hyperplastic synovium was removed, debridement of loose fragments was done and normal articular surface was brought in contact with the proximal phalanx. There were 5 patients with a history of trauma, and their p value was >0.05, so trauma was of insignificant difference.

All patients age was below 24 years, but we noticed that the younger the patient the greater the improvement in Kitaoka et al. scoring system [4], as in younger patients osteotomy healed faster, better remodeling and patient was returned to activity earlier. Also, it was noticed that, the more severe stage of the disease is accompanied by more decrease in the outcome score due to the fact that in type V, there was massive articular cartilage destruction.

In comparison to other studies, Gauther and Elbaz [9] in their study on 53 patients treated by dorsiflexion osteotomy founded only one patient who had pain, while Kinnard and Lirette [10] reported 3 patients experiencing mild discomfort with athletic activities out of 15 patients who were treated with dorsiflexion osteotomy. Chao and co-workers [8], reported 2 poor results from 13 patients with all stages of Freiberg's disease who were treated with dorsal closing wedge neck osteotomy. Lee et al. [11] reported 12 patients with dorsal wedge osteotomies fixed with absorbable polyglycolide pins. Eleven patients were satisfied with the results and would have the surgery again. Remodeling occurred in most joints. There was one delayed union with persistent swelling and it was the only dissatisfied patient. Capar et al. [12] using the same technique on 19 cases, Poor results were seen in 2 patients with type V disease and one patient with type IV disease. In all these studies union occurred in all cases even if it was delayed, pain was relieved in most of the patients and most of the patients returned to their normal activity.

8. Limitations of this study

Concerning to Freiberg's disease, there is still much to be learned about the etiology and treatment of this condition. The disorder's relative rarity and varied presentation have made it difficult to obtain a sufficient population for study purposes. Current recommendations have been based on small series of patients treated by various methods, and no clear consensus as to the most appropriate management exists. Further investigation through prospective or multicenter analysis is needed to guide future treatment options.

9. Conclusion

In patients who have Freiberg's disease, dorsal closing wedge osteotomy of the metatarsal neck associated with debridement and synovectomy; restores congruity of the metatarsophalangeal joint, and fixation with crossing K-wires pins provides adequate fixation. The simple operative technique, little operative complications and good operative results denote that operation is a useful one for treating this disease. Also it was concluded that the more advanced disease stage is always associated with a lesser final
outcome, and the younger patient age is always accompanied by higher final score.

Authorship

This work represents the original efforts of the investigators. All authors contributed to study design, data collection, data interpretation, and manuscript development.

Disclosure

The authors declare no conflicts of interest.

References