LESSER METATARSAL HEAD RESURFACING PROCEDURE FOR FREIBERG'S INFRACTION

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Freiberg's disease is an osteochondrosis or avascular necrosis of a lesser metatarsal head resulting in degeneration of the metatarsophalangeal joint. This is a problem that is commonly misdiagnosed and a cause of pain for patients. It usually occurs in the second decade of life but can occur in middle-aged patients as well. It is more commonly seen in females. Symptoms include painful, limited range of motion of the lesser metatarsophalangeal joint. Several mechanisms have been suggested in its pathogenesis. Freiberg first described the entity and believed single impact trauma was the underlying cause.[1] Repetitive biomechanical stress is the most widely accepted etiologic theory where the chronic micro-trauma and overload of the metatarsal head leads to fracture and collapse of the metatarsal head in an area of decreased or loss of circulation to the collapsed area.[2] Other theories blame dorsal impingement of the second metatarsal similar to that of hallux limitus.[3] Finally, a congenital predisposition has been proposed.[4]

Freiberg's disease should be considered in patients with pain, swelling, capsulitis and metatarsalgia of the lesser metatarsal heads. Smillie classified the clinical progression of the disorder into 5 stages depending on the condition of the affected metatarsal head. Stage I is characterized by a subtle fracture of the subchondral epiphysis. Stage II exhibits collapse of the dorsal and central portion of the metatarsal head. Radiograpically this appears as flattening of the metatarsal head. In stage III, there is progressive collapse evidenced by depression and widening of the metatarsal head with subchondral cystic changes. In stage IV, there is loose body formation at the periphery and complete central separation of the articular cartilage. In stage V, end stage degenerative joint disease has developed with marked flattening and widening of the head along with joint space sclerosis and narrowing.[5] This classification is beneficial in directing treatment options based on the stage of the disease.

Unfortunately many times this condition will not respond to conservative treatment or go undiagnosed. If untreated, destructive joint changes may lead to a painful degenerative arthritis requiring surgical intervention. There have been several different surgical procedures described in the treatment of Freiberg's disease.[1-15] If there is collapse and early arthritis noted (Smillie stage I, II, and possibly III), there are procedures used to salvage the joint such as cancellous grafting of the subchondral bone of the metatarsal head,[2,3,5] osteochondral grafting,[6,7] core decompression,[8] or dorsiflexory osteotomy where, the cartilage from the bottom of the joint is tilted upwards to resurface the joint and remove the damage cartilage on the top of the joint.[9]

When the joint is more severely arthritic (Smillie III, IV, and V) a joint destructive procedure will be required. In more advanced cases, the spurs are removed and the metatarsal head is shortened to decrease the abnormal stress going through the area (partial metatarsal head resection).[10] The area is either filled with a tendon graft from the extensor digitorum brevis or an implant.[11-14] Both hemi-implants and total joint implants have been described.[11,12] In cases of progressive arthritis, the metatarsal head can also be resurfaced. Initially this was described for the first metatarsal head.[16,17] But this can also be utilized for end stage lesser MPJ osteoarthritis in Freiberg's infarction as well. This newer resurfacing technique has allowed rapid recovery and dramatic improvement in pain and function in advanced cases where a joint destructive procedure will be necessary. The surgical technique and an operative clinical case are presented.

SURGICAL TECHNIQUE

Under your anesthesia of choice an incision is made just dorsal medial to the extensor digitorum longus tendon from the metatarsal neck distal to the base of the phalanx. Anatomic dissection follows through the skin into subcutaneous tissue taking care to avoid and address neurovascular structures. Dissection then proceeds to the deep fascia over the extensor tendon. After release of the deep fascia medial to the extensor tendon the extensor tendon is retracted laterally. Next a longitudinal capsular and periosteal incision is made. Elevate the capsule and periosteum off the bone working from within the joint. Perform a complete release of the capsule and collateral ligaments and so you can visualize the entire joint. A McGlamry elevator may be beneficial to release adhesions plantarly (Figure 1).

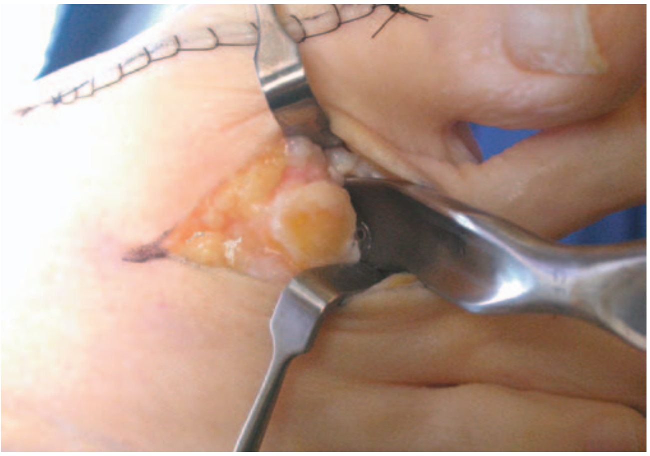

Figure 1. AVN of the second metatarsal head. After a complete release of the capsule and collateral ligaments the second metatarsophalangeal joint is exposed revealing the Freiberg's osteochondral changes. Notice the missing cartilage on the end of the bone. A McGlamry elevator is beneficial to release adhesions plantarly allowing visualization of the entire joint.

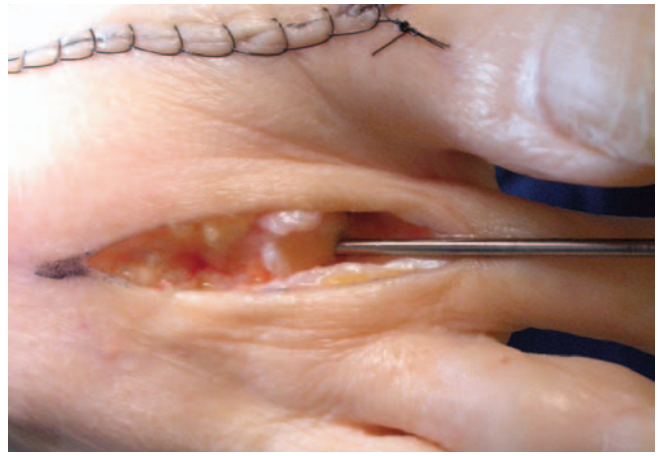

Figure 2A. An intramedullary guide wire is inserted perpendicular into the center of the metatarsal head.

Figure 2B. Fluoroscopy ensures that the guide wire is in the center of the shaft of the metatarsal in both the dorsal to plantar and medial to lateral directions.

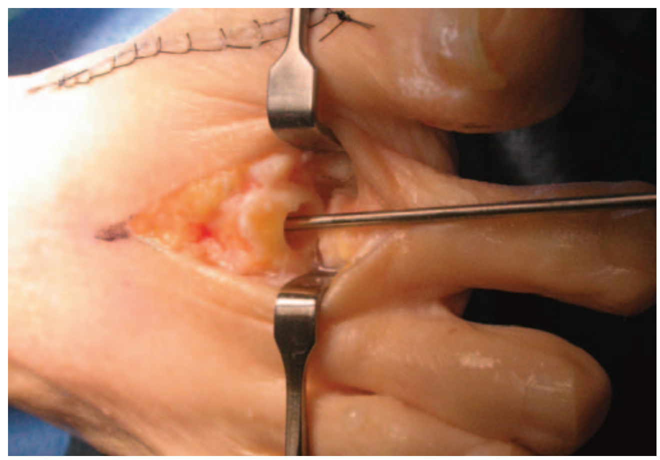

Figure 3. After the cannulated double-step drill is used down to the plantar articular surface of the metatarsal head the debris is removed from the metatarsal head revealing a central canal.

After exposing the MPJ, one can implant the Arthrosurface HemiCAP metatarsal head resurfacing implant. First, insert a guide wire intramedullary perpendicular into the center of the metatarsal head. Using fluoroscopy, ensure that the guide wire is in the center of the shaft of the metatarsal in both the dorsal to plantar and medial to lateral directions (Figure 2). Use a cannulated double-step drill over the guide wire until the plantar articular surface of the metatarsal head is flush with the proximal shoulder of the drill. Use the plantar cartilage as the reference for depth determination since this cartilage is the only normal articular surface remaining (Figure 3).

Proceed to insert the cannulated tap and tap it until the etched depth mark on the tap is flush with the plantar articular surface of the metatarsal head. Insert the taper post over the guide wire until the etched line on the driver is flush with the articular surface. If one desires decompression of the joint, drive the taper post deeper into the metatarsal head by continuing a clockwise turn. The taper post moves 1 mm proximal for every quarter turn of the driver (Figure 4). Use the trail cap with the taper post at this time to check the apex height of the final implant relative to the native articular surface.

Once the taper post is in place, utilizing three-dimensional mapping of the metatarsal head can help establish the curvature of the patient's metatarsal head surface geometry. After fully seating the centering shaft in the cleaned taper of the fixation component, place the contact probe over the centering shaft and use the probe tip to map the normal articular surface of the metatarsal head. There are 4 contact areas (dorsal, plantar, medial, and lateral). Usually the plantar surface and either the medial or

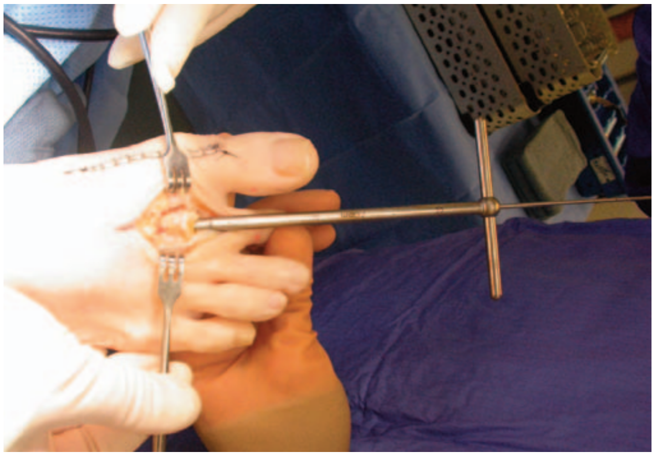

Figure 4A. A cannulated tap is inserted until the etched depth mark on the tap is flush with the plantar articular surface of the metatarsal head.

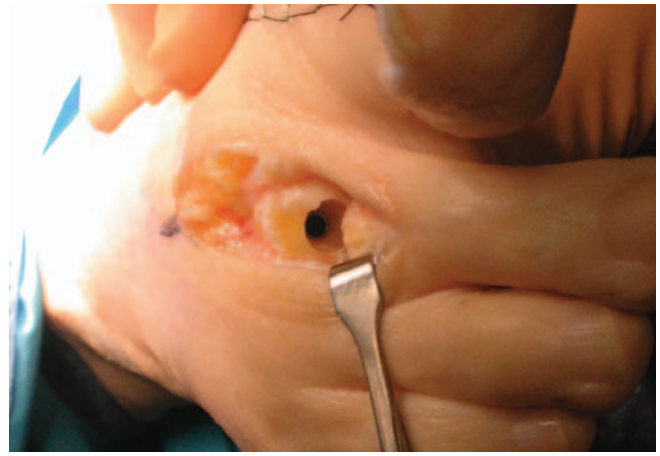

Figure 4B. Shows the final appearance of the tapered post into the metatarsal.

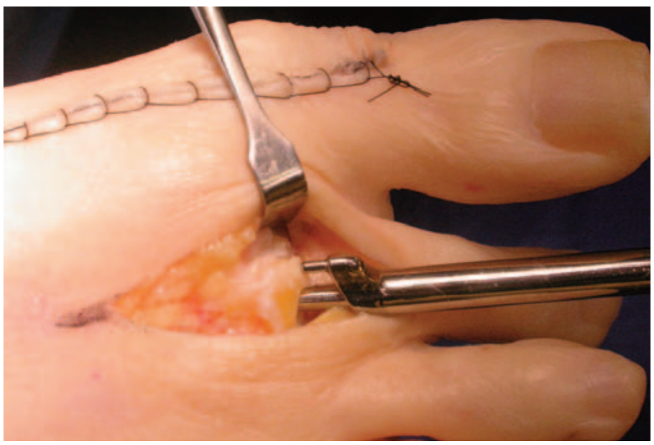

Figure 5A. Three-dimensional mapping of the metatarsal head is used to establish the curvature of the patient's metatarsal head surface geometry.

Figure 5B. The dimensions of the joint offsets are measured in the plantar and medial/lateral surfaces measure dimensions of the joint offsets in the plantar and medial/lateral surfaces.

lateral side of the joint still have healthy articular cartilage. Now proceed to measure dimensions of the joint offsets in the plantar and medial/lateral surfaces (Figure 5).

The product comes with a sizing card with offset measurements, which one uses to select the appropriate shaped implant and corresponding reamer. One would reinsert the guide pin into the taper post after removing the centering shaft and contact probe. Prepare the implant bed in the metatarsal head by using the corresponding reamer based on the offset measurements (Figure 6). When reaming, it is important that the reamer is running at full speed before contacting the metatarsal head. This prevents shearing or shattering of the bone or remaining articular surface.

Slowly advance the reamer over the guide pin while maintaining a proper axis to prevent bending of the wire. Exert gentle pressure to prevent aggressive reaming and the reaming will stop upon contact with the top of the taper post. Remove the guide pin and reamer, and clean the taper and the frayed edges of the articular surface. Place a trial implant that matches the offset measurement into the taper post to ensure proper fit and orientation of the implant. Confirm the fit of the trial implant by ensuring that it is equal with the edges of the surrounding articular surfaces (i.e., the plantar and medial/lateral surfaces) (Figure 7). Perform a cheilectomy of the metatarsal head over the trial implant to avoid damaging the actual implant.

The Arthrosurface HemiCAP metatarsal head resurfacing implant is available in 12-mm and 15-mm diameter sizes to accommodate most metatarsal heads. Surgeons will use a 15-mm implant most commonly in the first metatarsal head and a 12-mm implant in the lesser metatarsal heads. Once one has confirmed the proper fit of the trial implant, remove the trial implant and clean the area again by focusing on the taper to ensure proper seating of the final implant.

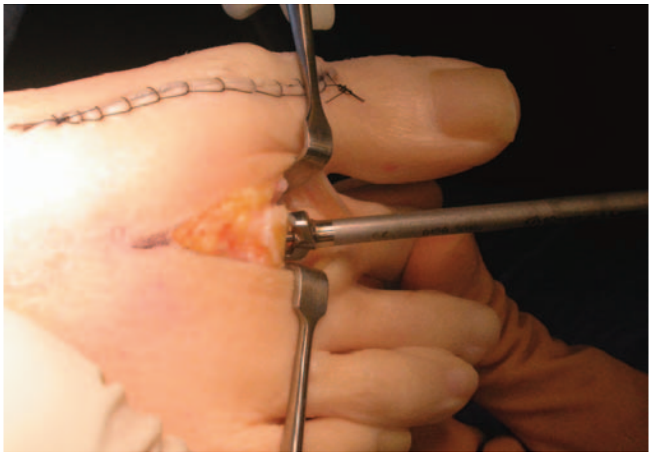

Figure 6. The implant bed in the metatarsal head is prepared by using the corresponding reamer based on the offset measurements.

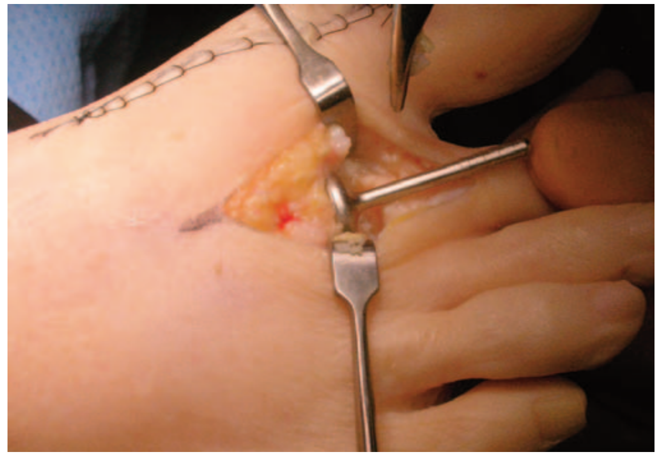

Figure 7. Shows a trial implant that matches the offset measurement into the taper post to ensure proper fit and orientation of the implant.

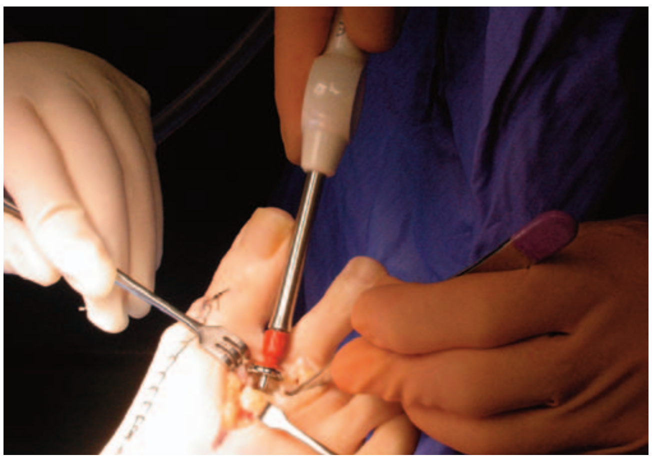

Figure 8. A suction-holding device holds the actual implant with correct medial to lateral and dorsal to plantar orientation.

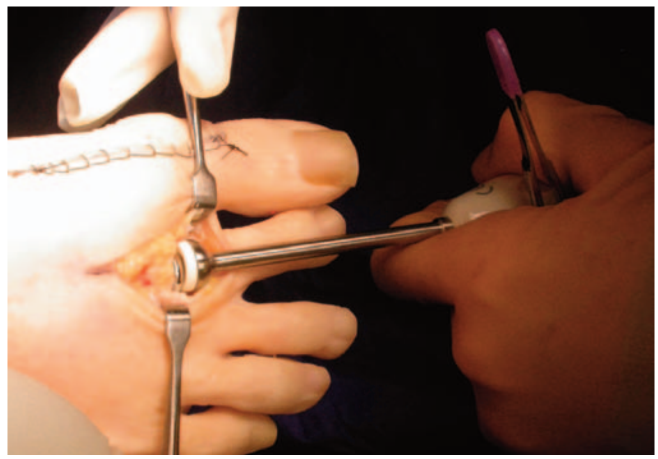

Figure 9A. After placing the implant, an impactor is used to seat the implant completely on the taper post and bone bed.

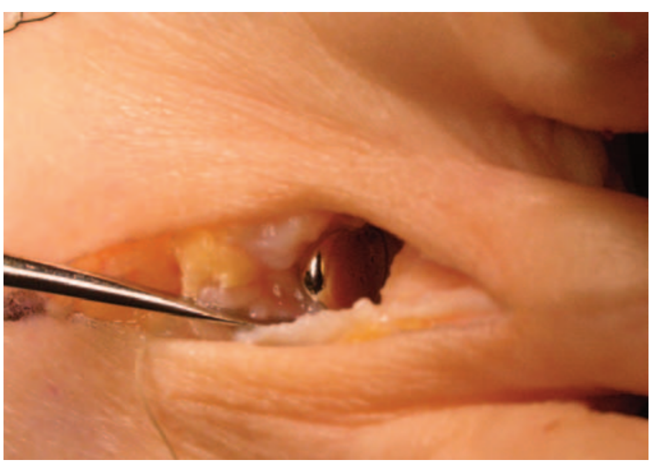

Figure 9B. Final appearance prior to closure.

Figure 10. Final appearance after closure.

A suction-holding device holds the actual implant with correct medial to lateral and dorsal to plantar orientation (Figure 8). After placing the implant, use an impactor to seat the implant completely on the taper post and bone bed (Figure 9). Once again, check the metatarsal head to determine if there is adequate bone resection. For some proximal phalanx pathology, some surgeons may need to perform a cheilectomy at the base of the proximal phalanx. Proceed to test the MPJ for range of motion intra-operatively. Closure is then accomplished in layers (Figure 10). Apply a compressive dressing and allow the patient to bear weight postoperatively from day one.

CONCLUSION

The Arthrosurface HemiCAP metatarsal head resurfacing implant technique is easy to perform and is minimally invasive with a low learning curve. Figures 11 and 12 show successful correction of an arthritic second MPJ due to Freiberg's osteochondrosis. This procedure allows removal of the diseased bone but at the same time requires minimal resection of subchondral bone and it preserves enough viable bone stock for an appropriate metatarsal parabola and for future treatment options if needed.

Figure 11A. Preoperative radiographic appearance (AP).

Figure 11B. Preoperative radiographic appearance (oblique).

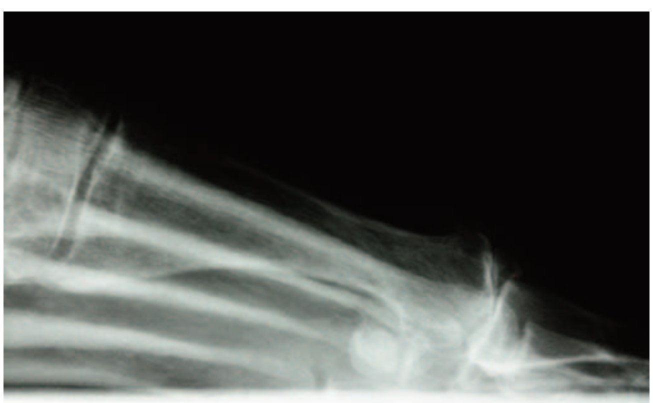

Figure 11C. Preoperative radiographic appearance (lateral).

Figure 12A. Postoperative radiographic appearance (AP).

Figure 12B. Postoperative radiographic appearance (oblique).

Figure 12C. Postoperative radiographic appearance (lateral).

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