Freiberg's Infraction: A New Surgical Procedure

An interpositional arthroplasty is described as a long-lasting solution for Freiberg's infraction of the metatarsal head. The tendon of the extensor digitorum longus is used for adequate surfacing and as a spacer. The deformed head is remodelled down to healthy bone with bevelling of its volar aspect to provide a smooth weightbearing surface covered by tendon tissue cushion. The results, analyzed on clinical and subjective bases, show evident relief of pain and improvement in activity level. The passive range of motion at the metatarsophalangeal joint (especially dorsiflexion) did not improve compared to its preoperative values, yet its quality was better (nonpainful in 85%). Radiographic study revealed a maintained metatarsophalangeal space after 11 to 27 months of follow-up. Of the 13 patients studied, 10 (77%) described the final outcome as excellent; 1 (7.7%), as good; and 2 (15.3%), as fair. (The Journal of Foot & Ankle Surgery 37(1):23–27, 1998)

Key words: Freiberg's infraction, metatarsophalangeal joint, interpositional arthroplasty, adolescent disorders, El-Tayeby's procedure

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Freiberg's infraction is an uncommon disorder occurring mostly in adolescents. The most common presenting symptom is chronic unilateral metatarsalgia (1). Chronic overloading is generally the offending cause, and several authors have postulated the longer length, increased weightbearing, or decreased mobility of the second metatarsus as the explanation for the overload (2, 3).

The anatomic evolution has five stages: subchondral bone march fracture, osteonecrosis without deformation, deformation by crushing or osteonecrosis, gradual cartilaginous tearing, and arthrosis (4).

Conservative treatment with orthoses (pads or stiff-soled shoes) has provided little benefit for relief of pressure over the metatarsal head (1). Surgical treatment in the form of metatarsal head resection (5), articular cartilage elevation and grafting (2), metatarsal osteotomy (4), and interpositional arthroplasty (6) using the capsule has also been performed.

The aim of this study is to report the results of an interpositional arthroplasty that uses the tendon of the extensor digitorum longus of the affected toe.

Material and Methods

During the period from June 1994 to August 1996, 13 adolescents (4 boys and 9 girls), 13 to 17 years of age, were operated on in the Alexandria Insurance Hospital for School Children. The second metatarsal head was affected in 11 patients and the third metatarsal head in 2 patients. The main presenting complaint was chronic metatarsalgia, usually located over the corresponding metatarsal head, which was broad and tender on palpation. Radiologic examination revealed different grades of distructive changes in the involved metatarsal head.

The main indication for surgery was chronic pain surrounding the involved joint. Radiologic examination was performed to confirm the diagnosis. Conservative measures to relieve pressure over the metatarsal head were not tried in this study.

Surgical Procedure

A 5-to-7-cm. longitudinal incision was centered over the metatarsophalangeal joint. The extensor digitorum longus tendon was exposed and was severed 5 cm. proximal to the joint level. Capsulotomy was performed, the collateral ligaments were released, and the toe was distracted and acutely flexed (Fig. 1*A*, 1*B*). The entire metatarsal head thus exposed was then remodelled by removing all the rough edges and bony spicules down to healthy bone. The undersurface of the metatarsal head was bevelled as shown in Figure 1*C*, rendering the sharp volar aspect smooth and flat. The distal stump of the severed extensor tendon was then reflected distally and interposed within the metatarsophalangeal joint so as to cover the remodelled head down to the bevelled weightbearing surface, tucked there by a suture to the plantar plate, and then reflected back and sutured to the periosteum on the dorsal aspect of the metatarsal bone (Fig.

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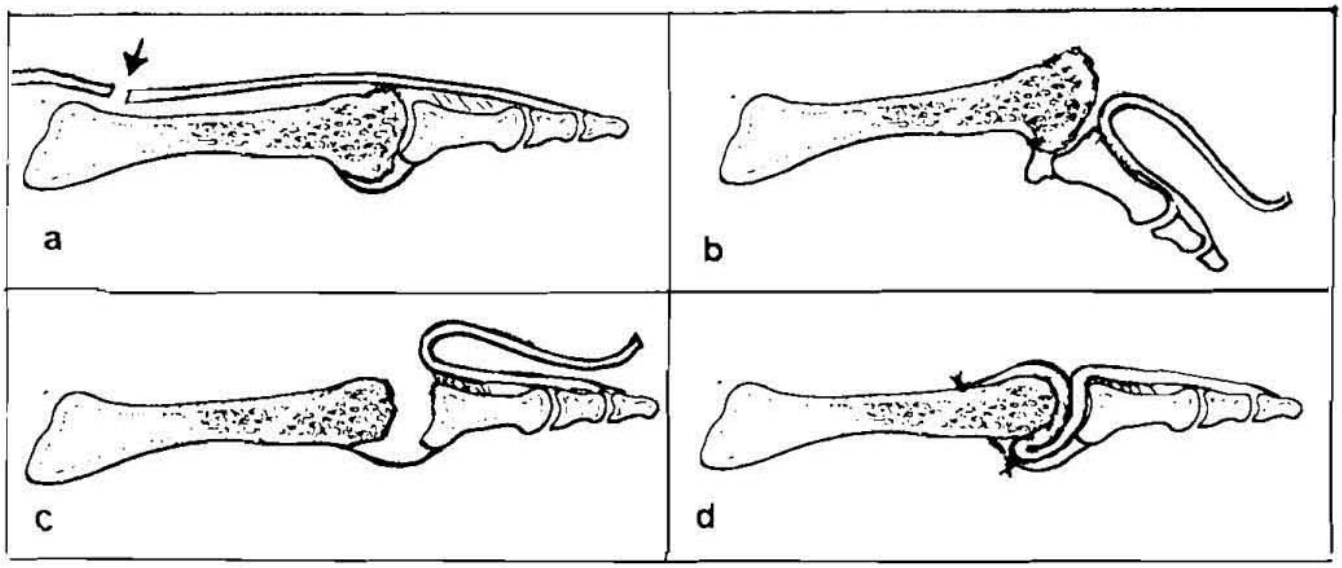

FIGURE 1 Steps of the operation. *A*, The extensor digitorum longus is severed 5 cm. proximal to the joint level. *B*, Capsulotomy is performed, the collateral ligaments are released, and the toe is distracted and acutely flexed. *C*, The exposed metatarsal head is remodelled by removing all bony spicules down to bleeding bone and bevelling the plantar aspect of the metatarsal stump. *D*, The extensor digitorum longus tendon spacer is tucked to the undersurface of the metatarsal stump, then sutured to the periosteum of the metatarsal.

1*D*), ending with two layers of tendon tissue between the proximal phalanx and the remodelled head. For the second metatarsal head, the proximal stump of the severed extensor tendon was sutured to the extensor tendon of the third toe; for the third metatarsal head, the severed tendon was sutured to that of the fourth toe. The skin was sutured, and dressing and plaster were applied and retained for 2 weeks. Four weeks later, active movement was started with cushoning provided for the affected metatarsal head.

Results

The period of follow-up ranged from 12 to 27 months with an average of 16 months. The criteria for evaluating the results were modified from those used by Lavery and Harkless (6) and were both subjective (pain relief, activity level, and patient satisfaction) and objective (the quality and degree of metatarsophalangeal motion and any transfer metatarsalgia) (Table 1).

Pain Relief (Table 1)

Preoperatively, pain was the main complaint and was severe and constant in four patients, severe with activity in eight patients and moderate with activity in one patient. Postoperatively, complete relief of pain was achieved in seven patients, and was described as mild with activity or prolonged walking in three, and moderate with activity in the other three. However, pain relief should not be expected following the removal of plaster.

TABLE 1 Evaluation of the results

Type of Evaluation	Preoperative	Postoperative
Subjective evaluation (modified from Lavery and Harkless)		
Pain		
No pain	0	7
Mild with activity	0	3
Moderate with activity	1	3
Severe with activity	8	0
Severe constant	4	0
Activity level:		
Normal	0	10
Restricted sports	0	1
Restricted squatting	3	2
Restricted walking	10	0
Patient satisfaction:		
Excellent		10
Good		1
Fair		2
Poor		0
Clinical evaluation		
Range of motion (quality):		
Nonpainful		11
Painful at the extreme of movement		2
Crepitus		0
Range of motion (degree):		
Full		0
Diminished		13
Transfer metatarsalgia:		
Yes		0
No		13

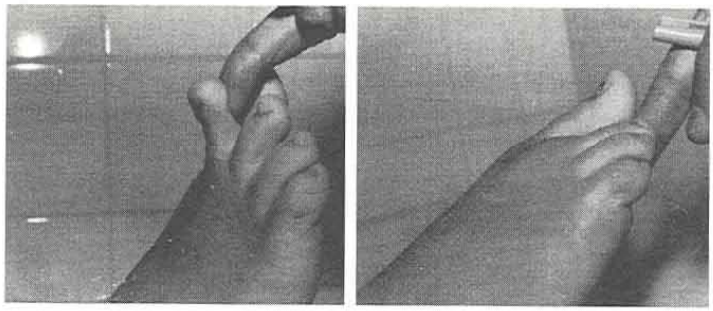

FIGURE 2 Restricted movement of the toe at the metartarsophalangeal joint. No postoperative improvement in the range of movement should be expected.

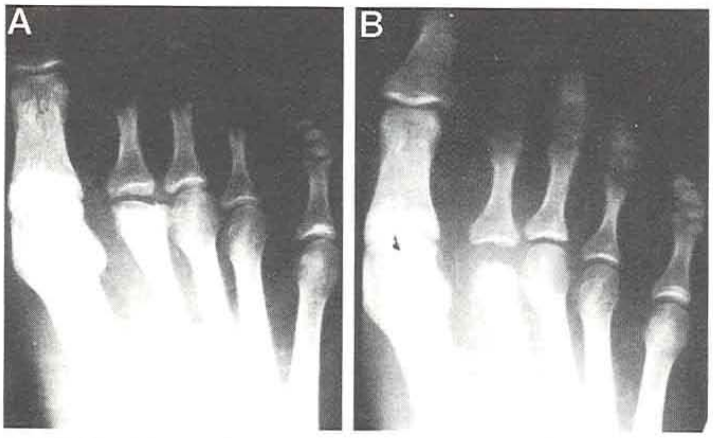

FIGURE 3 Pre- and postoperative radiologic study of one of the cases with excellent results. The metatarsal stump is remodelled and the joint space is maintained compared with that in the adjacent toes.

Activity Level

Preoperatively, the daily activities were restricted in 10 patients because of painful walking and in three patients because of pain on squatting or going up or down stairs. Postoperatively, an improvement in the level of activity was evident in 10 patients. On the other hand, one boy had to give up football and two girls could not wear high-heeled shoes nor squat without restriction.

Range of Motion of the Metatarsophalangeal Joint

It was important that the operation should not produce a stiff metatarsophalangeal joint. Postoperatively the range of motion was diminished to the same preoperative degree when compared to the normal range in the adjacent toes. Dorsiflexion was more restricted and more disabling to the patient (Fig. 2). At the same time, passive movement of the affected toe at the metatarsophalangeal joint was painless in 11 patients and only slightly painful at extreme dorsiflexion in 2 patients. Transfer lesions or calluses were not seen postoperatively.

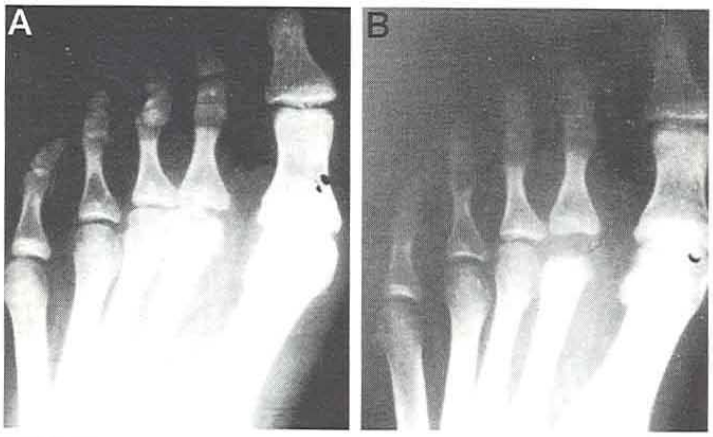

FIGURE 4 Pre- and postoperative radiologic study of a second case with excellent results. The metatarsal stump is remodelled and the joint space is maintained compared with that in the adjacent toes.

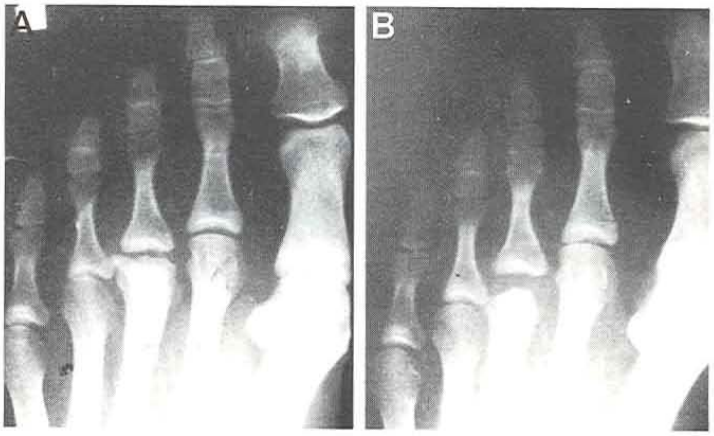

FIGURE 5 Pre- and postoperative radiologic study of a third case with excellent results. The metatarsal stump is remodelled and the joint space is maintained compared with that in the adjacent toes.

FIGURE 6 A lateral view of an excellent result showing a maintained third metartarsophalangeal joint space and a remodelled, well bevelled metatarsal head.

Patient Satisfaction

Ten patients described the final outcome as excellent (Figs 3–5), one as good, and two as fair. The "fair" outcome was for two girls who presented with severe, constant pain and an activity level limited to restricted walking. The final result was mild pain on activity, with restricted squatting and inability to wear high-heeled

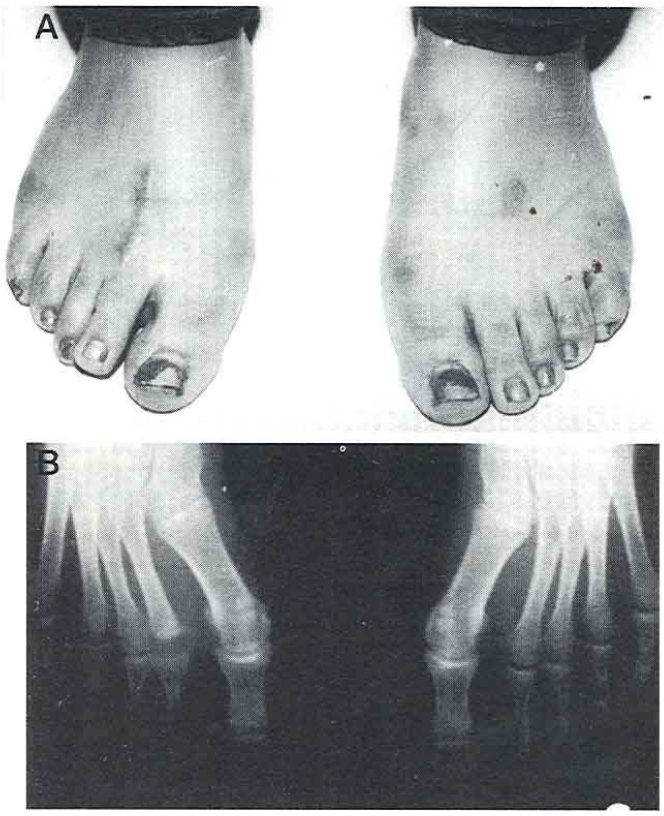

FIGURE 7 Late follow-up appearance and radiographic study of the right foot with second metatarsal head infraction, showing maintained length of the second toe.

shoes. The second metatarsal head was affected in both patients.

Radiologic Evaluation

The postoperative radiologic examination following removal of plaster and at follow-up revealed no shortening of the affected toe. The soft tissue interval between the base of the proximal phalanx and the remodelled metatarsal head was maintained, indicating adequate soft tissue interposition (Figs. 6, 7).

Complications

Weak extension of the second toe was observed in eight patients following removal of plaster. Gradual improvement in active extension to almost normal power was evident at follow-up. This result did not bother the patients and did not interfere with their normal activities.

Hyperthesia over the skin incision was a complaint in two patients, mostly on wearing shoes. The skin scar was adherent to the underlying soft tissues in one of them. The condition was improving gradually at follow-up.

Discussion

Several surgical procedures have been proposed for surgical treatment of Freiberg's infraction. It seems that both the articular cartilage elevation and bone grafting (2), and the dorsiflexion osteotomy (4) procedures are attempts to preserve an already deformed head that would need some radical interference later.

In this study, a simple interpositional arthroplasty procedure using the tendon of the extensor digitorum longus of the affected toe is described. A 5-cm. stump of the tendon provided an adequate spacing tissue between the base of the proximal phalanx and the remodelled head. The tendon was fashioned to cover the bevelled plantar aspect of the head, which provided a smooth cushion for weightbearing. This technique is different from that of Lavery and Harkless (6), who used a capsular flap that seemed to be short and thin and did not allow easy coverage of the undersurface of the head, which they kept unbevelled. Also, the single layer of thin capsular tissue did not offer adequate interpositional spacing.

Sproul *et al.* (1) preserved the plantar half of the metatarsal head to prevent transfer metatarsalgia. In this study, minimal plantar bevelling of the remodelled head provided a smooth, flat weightbearing bony surface covered by soft tendon tissue that actually compensated for the bevelled bone segment.

There was evident improvement in pain especially after long periods of follow-up, with higher levels of activity. The metatarsophalangeal range of motion did not improve but remained the same as its preoperative range, especially with respect to dorsiflexion. This result interfered with squatting and going up or down stairs in two girls, and wearing of high-heeled shoes was painful which limited their final satisfaction.

Accordingly, an improvement in the range of motion should not be expected, yet the quality of motion was painless in 11 patients (85%). Sproul *et al.* (1) claimed restoration of 80% of normal joint range of motion following metatarsophalangeal joint debridement in their series (11 feet), whereas Lavery and Harkless observed diminished range of motion in all of their patients (9 feet) (6).

In some patients, weak extension of the affected toe was observed but was restored gradually by the preserved extensor digitorum brevis. Using the long extensor as a spacer also serves to eliminate axial compression forces on the joint.

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