Arthrodesis for traumatic flat foot

Tarsometatarsal and medial longitudinal arch fusion by inlay grafting,11 feet followed for 1.5 years

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We examined 11 feet, 18 (11–30) months after simultaneous tarsometatarsal and medial longitudinal arch fusion to stabilize a residual mobile flat foot resulting from an injury. All had solid fusion and the surgical correction of the flat foot deformity was maintained. At the follow-up, we rated 6 feet as excellent and 5 as good. Mechanically, simultaneous arthrodesis of the tarsometatarsal joint and the longitudinal arch of the foot seem better than isolated arthrodesis of the tarsometatarsal joints.

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Dislocation and fracture dislocation of the tarsometatarsal joints often cause chronic pain. Residual planus or planovalgus deformity is common, but varus deformity occurs occasionally (Brunet and Wiley 1987). Fusion is recommended for patients whose primary treatment has failed (Hardcastle et al. 1982, Goossens et al.1983, Johnson and Johnson 1986).

Johnson and Johnson (1986) reported a specific fusion technique. The reports by Sangeorzan et al. (1990) and Horton and Olney (1993) address fusion techniques that allow for stable correction of the deformity.

We present a new technique for reliable arthrodesis of the midfoot and studied the outcomes after reduction and simultaneous tarsometatarsal and medial longitudinal arch fusion of a residual mobile flat foot deformity after failed initial treatment of a tarsometatarsal fracture dislocation.

Patients and methods

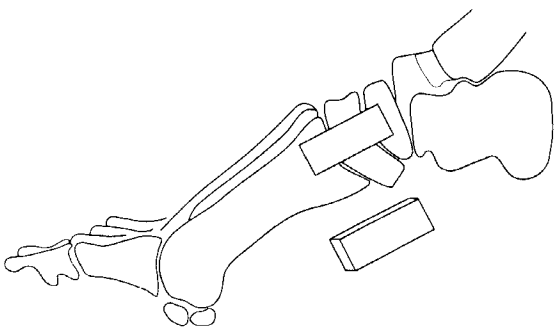
From 1991 to 1993, we treated 10 women and 1 man with symptomatic mobile flat feet by tarsometatarsal and medial longitudinal arch fusion.

The cause of the mobile flat feet was failure of the initial treatment of inversion type fracture-dislocation injuries of the medial tarsometatarsal joint. 5 patients had first-stage injuries and 6 had second-stage injuries, based on the classification by Wilson (1972) (Ta-

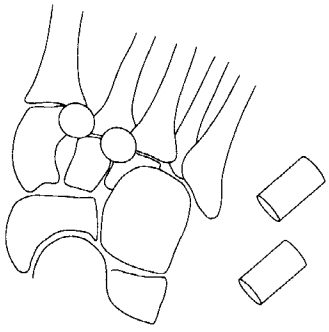
Table 1. Classification and scoring of tarsometatarsal injuries

Type		Typical displacement
Classification according to Wilson (1972)		
Forefoot eversion (pronation)	First stage	Medial dislocation of first metatarsal bone alone
	Second stage	Medial dislocation of first metatarsal bone and dorsilateral dislocation of the 4 lesser metatarsal bones
Forefoot inversion (supination)	First stage	Dorsilateral dislocation of up to 4 lesser metatarsal bones
	Second stage	Dorsilateral dislocation of all 5 metatarsal bones
Plantar-flexion alone		Dorsal subluxation of base of second metatarsal and/or coronal fracture-dislocation of base of first metatarsal bone
Classification according to Quénu and Küss (1909), Hardcastle et al. (1982)		
Type A	Total incongruity of the tarsometatarsal joint	
Type B	Incongruity of part of the joint	
Type C	Divergent pattern (either partial or total incongruity)	
Clinical score (Arntz et al. 1988)		
Excellent	No disability or limitation	
Good	Occasional slight limitations, which do not interfere with work or spare-time activities, including athletics	
Fair	Restricted activity, normal gait, able to work, but participation in sports and walking on the toes difficult	
Poor	Normal daily activity limited, unable to walk on toes	

Figure 1. The technique involves exposing the medial arch of the foot and the tarsometatarsl joint, reduction and fusion.



Cancellous-cortical slot inlay graft to stabilize the medial column of the foot according to Hoke (1921).



Cancellous-cortical dowel inlay graft to stabilize the reduced tarsometatarsal joint according to Johnson and Johnson (1989).

ble 1). According to the modified classification by Quénu and Küss (1909) and Hardcastle et al. (1982), 5 patients had type B injuries and 6 patients had type A injuries.

The mean age of the patients at the time of the injury was 41 (16–69) years and their mean age at arthrodesis was 50 (29–70) years. 8 right feet and 3 left feet were affected. The mean follow-up time after arthrodesis was 18 (11–30) months.

For the evaluation, we used the clinical score of Arntz et al. (1988) (Table 1). In the radiographic examination, we studied the anteroposterior and lateral weight-bearing radiographs.

Statistics

The Student t-test and the Mann-Whitney U-test for paired measures were used to analyze the Hibbs angle and the distance between the medial cuneiform and the fifth metatarsal. The level of statistical significance was set at 0.05.

The operation

We used a 8–10 cm dorsomedial incision to expose the naviculo–medial cuneiform–first metatarsal joints. Then a dorsal longitudinal incision in the midfoot was made to the cuneiform–metatarsal base and a curette was used to denude the cartilage from the joints to be fused (Table 2). At this point, the foot was mobile enough to allow for correction of the deformity. Next, the foot and the distal end of the first metatarsal were forced into pronation and equinus. Whilst holding them in this position, a rectangular block of bone was resected from the navicular, medial cuneiform and the first metatarsal bones, across the joints ($1 \times 1.5 \times 5.5$ cm) with an oscillating saw. A piece of cancellous-cortical bone block was obtained from the anterior iliac crest and was fitted as an inlay graft into the rectangular gap to bridge the joints. Small fragments of bone were patched into unfilled spaces. Next, the cuneiforme mediale–intermediate– laterale–metatarsale I–II joints and, if needed, the metatarsale III joints were exposed. Using a bone biopsy set, a 7.5 mm-sized plug of cartilage and bone was excised from the desired joint. A similar full-thickness cancellous-cortical dowel graft from the anterior iliac crest, obtained by the same trephine, was inserted into the hole. As many cylinders as were needed to complete the arthrodeses were obtained. The fusion was secured with crossed K-wires, which were removed 3 months later.

After soft-tissue closure over the graft and application of a dressing, a below-knee cast was applied, with the forefoot in pronation equinus position and the heel in varus position. 10 days after surgery, the sutures were removed and a non-weight-bearing cast was applied for about 1 month. This was followed by a full weight-bearing cast in neutral position for 2 months. Thereafter, the patients were instructed to wear sturdy shoes fitted with leather-cork arch supports for elevation of the medial column for half a year.

Preoperative assessment

Preoperatively, all patients had pain on weight bearing and 8 patients complained of slight persistent pain at rest. All had difficulty in descending stairs and walking on uneven surfaces. 9 patients could not stand or walk on tip-toe. 2 could, with difficulty. 8 patients had a marked flatfoot and 3 a flattening of the medial arch. 3 patients showed a slight limp and 8 a marked one. According to the score of Arntz et al. (1988), none of our patients was rated excellent or good, 2 were rated fair and 9 poor (Table 2).

The degrees of arthrosis were: grade 1 in no patient,

Table 2. Clinical and radiological data of the 11 patients

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	54	f	r	r	–	p	g	–	+	s	II	A	137	132	8	2–3	+15	–1	+10	a, b
2	53	f	l	r	–	p	g	–	+	m	I	B	142	135	5	2	+14	+2	+9	a
3	56	f	l	w	–	f	e	(+)	+	m	III	B	133	130	4	3	+15	+10	+10	a
4	29	f	r	r	–	p	e	–	+	s	II	A	139	135	6	2	+15	+4	+7	a, b
5	67	f	r	w	+	f	g	(+)	(+)	m	I	B	133	132	2	3–4	+11	+6	+9	a
6	70	f	r	r	–	p	e	–	+	m	I	A	138	132	8	1–2	+18	–1	+8	a, b
7	46	f	r	r	+	p	g	–	(+)	m	I	B	145	132	5	1–2	+12	+5	+9	a
8	52	f	r	r	–	p	g	–	+	m	II	A	139	132	9	1–2	+15	–3	+14	a, b
9	45	f	l	r	–	p	e	–	+	m	I	B	140	122	7	3–4	+15	+4	+10	a, b
10	32	m	r	w	–	p	e	–	+	s	II	A	138	127	6	3–4	+15	+4	+11	a, b
11	50	f	r	r	–	p	e	–	+	m	II	A	137	130	10	3–4	+17	+6	+10	a, b

A Age
B Sex
C Flatfoot
  r right
  l left
D Pain preoperatively
  r at rest pain
  w when walking
E Pain at follow-up
F Overall function preoperatively
  p poor
  f fair
G Overall function at follow-up (Arntz et al. 1988)
  e excellent
  g good
  f fair
  p poor
H Stand on tiptoe preoperatively
  + yes
  (+) difficult
  – no
I Stand on tiptoe at follow-up
J Limp preoperatively
  s slight
  m marked
K Classification (Wilson 1972)
  I forefoot-inversion first stage
  II forefoot-inversion second stage
  III direct crushing injury
L Classification (Quénu and Küss 1909)
M Hibbs angle (°) (1919) preoperatively
N Hibbs angle (°) at follow-up
O Residual displacement metatarsal I/II (mm)
P Degree of arthrosis (Arntz et al. 1988)
  0 normal
  1 slight narrowing of the joint space
  2 moderate narrowing of the joint space accompanied by the formation of osteophytes
  3 severe loss of the joint space
  4 complete loss of the joint space and ankylosis
Q The mean flattening of the medial longitudinal arch. Dist. between 5th metatarsal and med. cuneiform uninjured side (mm) (Faciszewski et al. 1990)
R The mean flattening of the medial longitudinal arch preoperatively (mm)
S The mean flattening of the medial longitudinal arch at follow-up (mm)
T Tarsometatarsal joint fusion by dowel inlay graft
  a metatarsal I-II space
  b metatarsal II-III space

grade 2 in 5, grade 3 in 2, and grade 4 in 4 patients. The average Hibbs angle was 138° (133°–145°), compared to 126° (122°–130°) on the uninjured side ($p < 0.01$). The mean residual displacement of the first and second metatarsal bones was 6 (2–10) mm. The mean flattening of the medial longitudinal arch of the injured foot was +3.2 (–3 to +10) mm, compared to +14.7 (+11–+18) mm on the uninjured side ($p < 0.01$).

Results

At the follow-up, none of the patients had pain at rest. 2 complained of pain before a change of weather. 9 patients were able to walk on tip-toe, 2 found it difficult. According to the scoring by Arntz et al. (1988), the result was excellent in 6, good in 5 patients and fair or poor in no patient.

The medial column of the foot showed in each case a reasonably good shape and there were no marked deformities of the forefoot. No patient had a limp and none required specially fitted shoes.

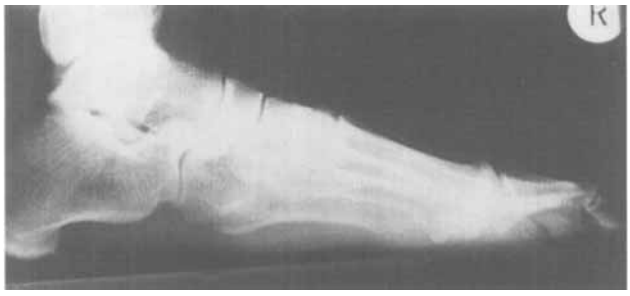
All patients showed solid fusion and had maintained the surgical correction of the flat-foot deformity. The mean Hibbs angle was 130° (122°–135°) ($p < 0.01$). The mean flattening of the medial longitudinal arch was 8.7 (7–14) mm ($p < 0.01$).

Discussion

Failure of the initial treatment of tarsometatarsal fracture dislocations may result in painful and deformed feet (Faciszewski et al. 1990). Arntz et al. (1988), Hardcastle et al. (1982) and Wilson (1972) have demonstrated a direct relationship between the outcome and initial anatomical reduction. Symptoms seldom improve after 1–1.5 years. For severely deformed feet, fusions are recommended (Hardcastle et al. 1982, Sangeorzan et al. 1990). Goossens et al. (1983) recommended primary fusion in patients with delayed diagnosis of the injury.

Only a few reports present detailed techniques for the fusion. Cross-pins or staples have been recommended by Goosens et al. (1983) and Thompson and Mann (1986). Johnson and Johnson (1986) reported on a dowel arthrodesis technique for arthrosis of the tarsometatarsal joint. Sangeorzan et al. (1990) described a fusion technique involving rigid internal fix-

Figure 2. Case 7. Anteroposterior and lateral weight-bearing radiograph of a mobile flat foot.



Preoperative weight-bearing radiograph: Hibbs angle of 145°; Note the decreased distance (5mm) between the medial cuneiform and the fifth metatarsal due to a break at the naviculo-medial cuneiform-first metatarsal joint.

Postoperative weight-bearing radiograph: Hibbs angle of 132°; 9 mm distance between the medial cuneiform and fifth metatarsal after reduction and fusion.

ation with 3.5- or 4.0-mm screws for compression across the midfoot joints to be fused, often without the need for an additional bone graft. Horton and Olney (1993) reported on a medial one third plate for arthrodesis. These 2 techniques not only made successful fusion possible but also allowed for correction of residual deformity.

We agree with Sangeorzan et al. (1990) and Horton and Olney (1993) who stated that the reduction of residual deformity is the most significant predictor of a good outcome. Our study presents a technique for reliable arthrodesis of the midfoot, which allows a reduction of a residual mobile flat foot deformity by fusion of the medial tarsometatasal joint and addition restores the medial longitudinal arch of the foot. The simultaneous arthrodesis of the midfoot improves the static and dynamic condition of the foot and seem better than isolated arthrodesis.

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