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Technical note

Second phalanx shortening osteotomy. An innovative technique for long second toe syndrome

A. Albert*, B. Ferre , J. Cazal , M. Maestro

Institut Monégasque de Médecine et Chirurgie Sportive (IM2S), 11, avenue d'Ostende, 98000, Belgium

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ABSTRACT

Long second-toe syndrome, although frequent and disabling, has been little described. Current surgical techniques often lead to loss of function. Based on anatomical and biomechanical observations, the present study reports a second phalanx shortening osteotomy technique. The procedure is relatively non-invasive, involving self-stabilizing segment resection osteotomy of the second phalanx. Results for the first 23 feet undergoing the procedure were analyzed retrospectively. Assessment comprised clinical examination, radiography and AOFAS and FAAM scores. Mean follow-up was 19 ± 9.9 months. Second phalanx shortening osteotomy proved reliable, respecting the biomechanics of the toe.

1. Introduction

In long second toe syndrome, the second toe is longer than the hallux and third toe. Symptoms derive from this abnormal length and the resulting shoewear issues: claw or hammer toe, corns on the joints or digital pulp, ungual lesions, and pain [1]. Data are sparse for the syndrome and specific treatment [1,2]. Conventional surgical procedures for long second toe, claw toe or hammer toe, such as resection arthroplasty or proximal interphalangeal (PIP) arthrodesis [1,3], fail to respect the biomechanics of the toe, including joint and intrinsic and extrinsic tendons, while arthrodesis at least partially abolishes mobility. These techniques are debatable, especially if the deformity is reducible and in young patients, as they all impair active function.

To optimize conservation of functional anatomy, we describe a shortening osteotomy of the second phalanx.

1.1. Technique

A transverse dorsal surgical approach centered on the phalanx was extended distally and proximally in an S. The central skin was resected along a length corresponding to the pre-operatively planned bone resection (Fig. 1A, F). The appropriate resection length, ranging between 3 and 6 mm, was estimated from clinical and radiographic examination, with the aim of achieving a length identical to that of the first toe after correction of deformity. The extensor apparatus was sectioned longitudinally. The shaft was exposed using two 4 mm wide double-angled retractors, introduced subperiosteally, to minimize tissue dissection and spare the extensor digitorum longus. Osteotomy was then performed, using a 3 or 5 mm oscillating saw. Proximal osteotomy was performed first, conserving the plantar cortical bone (Fig. 1B and C), while the distal osteotomy included the full thickness of the phalanx. The central segment of the phalanx was resected by bone nibbler, conserving the plantar cortical bone and the flexor digitorum brevis with its insertion. The plantar cortical bone served as support for the distal fragment, which was raised and impacted against the proximal diaphyseal fragment (Fig. 1D). Stability was reinforced by painstaking closure of the extensor apparatus by resorbable 2.0 cross suture (Fig. 1E), and then of the skin. The resultant stability avoided the need for screw or pin fixation.

Postoperative care included 2 weeks' tubular fatty dressing, renewed after 1 week. A molded silicone orthosis was then fitted for 1 month, worn day and night. Sandals or broad sports shoewear was prescribed.

1.2. Preliminary series

Results were analyzed for the first 23 second-phalanx osteotomies performed in our department, in 15 females (22 feet) and 1 male patient, with a mean age of 52 years (range, 16–69 years) (Table 1).

Most of the patients (20 feet) presented concomitant forefoot pathology, mainly hallux valgus (17 feet). All were operated on by a single surgeon (MM).

* Corresponding author. Tel.: +32/81726900.
E-mail address: a1.albert@belgacom.net (A. Albert).

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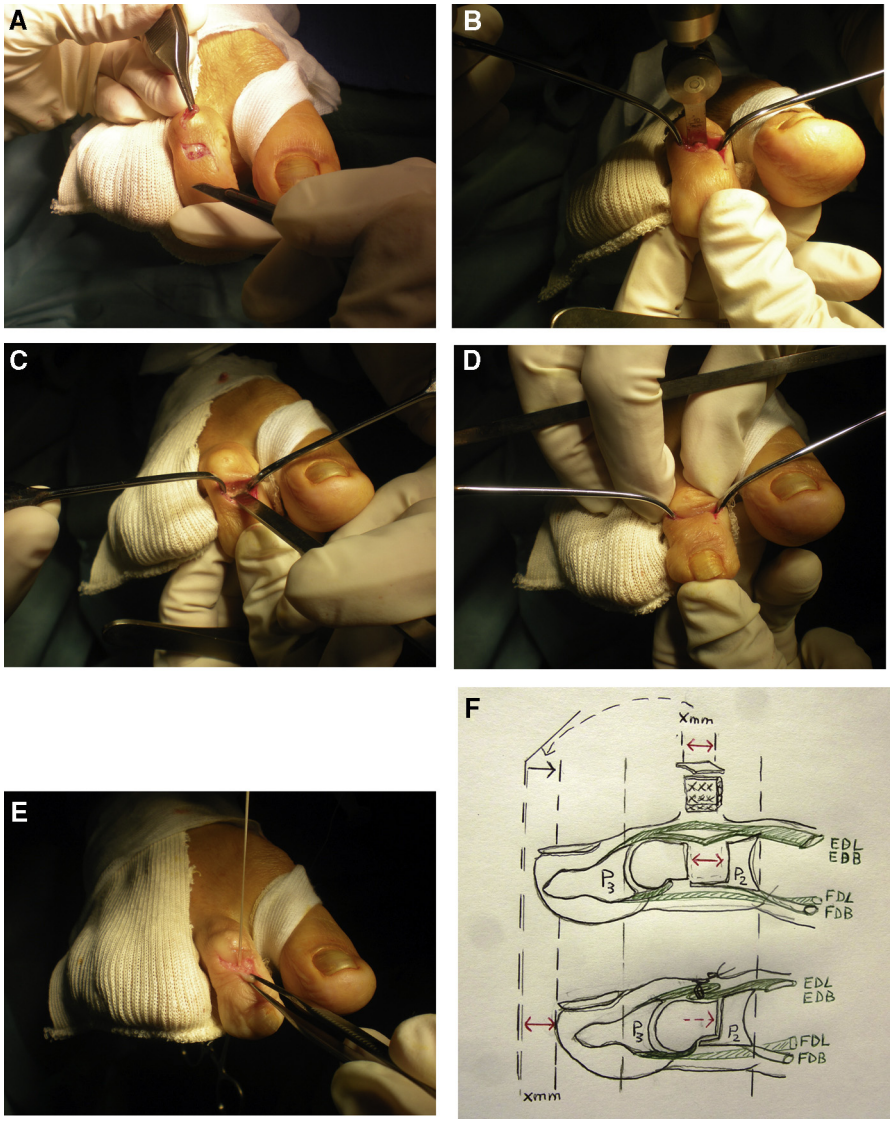

Fig. 1. Photographic and diagrammatic representation of the osteotomy technique.

Two patients (2 feet) had no follow-up consultation, but all responded to the satisfaction questionnaire. Mean follow-up was 19 ± 9.9 months (range, 5–34 months). Clinical examination assessed interosseous and flexor muscle force (weak versus normal to strong), stability, alignment and toe mobility. Range of motion (ROM: metatarsophalangeal [MTP], proximal interphalangeal [PIP] and distal interphalangeal [DIP]) was compared contralaterally, or to reference values (respectively 15°, 45° and 25°) in bilateral cases. Postoperative AOFAS [4] and FAAM [5] scores were calculated. Subjective data were recorded: satisfaction, subjective loss of force, and esthetic appearance. Fusion and alignment were assessed on AP and lateral weight-bearing radiographs at 8 weeks (Fig. 2).

All osteotomies showed consolidation.

Mean ROM loss was 12° for MTP and PIP and 8° for DIP (SD respectively 20°, 29° and 19°) (Table 1).

All patients stated that they would recommend the procedure.

2. Discussion

Arthrodesis and resection arthroplasty techniques induce stiffening, impaired force, instability and malalignment [1]. Flexion force is, however, an important factor in gait, as the toes are in ground contact through three-quarters of the cycle, exerting pressure comparable to the metatarsal head. Impaired toe function thus increases pressure under the corresponding metatarsal head [6].

Alternative techniques have therefore been proposed. Metatarsal shortening osteotomy should be reserved for metatarsalgia [7]. Kuwada and Dockery [8] were the first to describe simultaneous segmentary resection of the first 2 phalanxes, requiring an extensive surgical approach and temporary K-wire fixation. In 2002, our team described a shortening osteotomy of the first phalanx of the second toe, with intramedullary K-wire fixation [2]; the first phalanx being longer, it seemed to be best suited for shortening to conserve MTP and interphalangeal motion, but the procedure leaves the extensor sling on the back of the first phalanx and the flexor and extensor tendons at risk of fibrosis, with consequent stiffness and intrinsic and extrinsic muscle impairment.

Theoretically, the advantage of second phalanx osteotomy is the absence of any lesion to the extensor sling, involved in the toe's ground pressure in the propulsion gait phase. Also, the flexor digitorum brevis insertion to the base of the second phalanx is better conserved, maintaining excentric contraction during propulsion.

Table 1
Data.

Foot	Age	Gender	Side	Other pathology	Associated procedures	FU (months)	Flexor muscles	Interosseous muscles	MTP deficit (degrees)	PIP deficit (degrees)	DIP deficit (degrees)	AOFAS FAAM Postop
1	64	F	R	HV	Scarf	34	Weak	Normal	35	0	0	88–98
2	64	F	L	HV	Scarf	29	Weak	Normal	55	0	0	88–98
3	69	F	L	HR	Arthrodesis MTP1	29	Weak	Normal	40	70	0	70–96
4	57	F	L	/	/	29	Normal	Normal	5	0	5	90–98
5	57	F	R	/	/	29	Normal	Normal	5	0	10	90–98
6	37	F	L	HV	Scarf	28	Normal	Normal	30	0	10	100–100
7	59	F	L	HV	Scarf	25	Weak	Normal	15	0	10	100–99
8	59	F	R	HV	Scarf	25	Normal	Normal	15	0	10	100–99
9	42	M	R	/	/	23	Normal	Normal	0	75	15	83–98
10	41	F	R	HV	Scarf	23	Weak	Normal	10	10	60	90–100
11	61	F	L	HV	Scarf	20	Normal	Normal	0	0	0	85–95
12	52	F	L	HV	Scarf	20	Strong	Strong	10	10	10	100–100
13	45	F	R	HV	Scarf	18	Normal	Normal	15	15	5	100–100
14	45	F	L	HV	Scarf	18	Normal	Normal	15	15	0	100–100
15	57	F	R	HV	Scarf	14	—	—	—	—	—	90–94
16	39	F	R	HV	Scarf	13	Normal	Normal	30	0	10	100–100
17	64	F	R	HV	Scarf	9	—	—	—	—	—	100–99
18	52	F	L	HV	Scarf	9	Strong	Normal	0	30	30	85–99
19	59	F	R	HV	Scarf	8	Normal	Normal	0	0	0	100–100
20	68	F	L	HV	Scarf	8	Weak	Normal	5	30	0	95–99
21	68	F	R	Complex deformity	Scarf	8	Weak	Strong	5	35	15	95–99
22	16	F	R	HV	Scarf + Weil5	5	Normal	Normal	15	15	10	95–94
23	16	F	L	Complex deformity	Scarf + Weil5	5	Normal	Normal	15	15	10	95–94
Mean	51.8					18.6			12	12	10	93–98

HV: Hallux valgus; HR: Hallux rigidus.

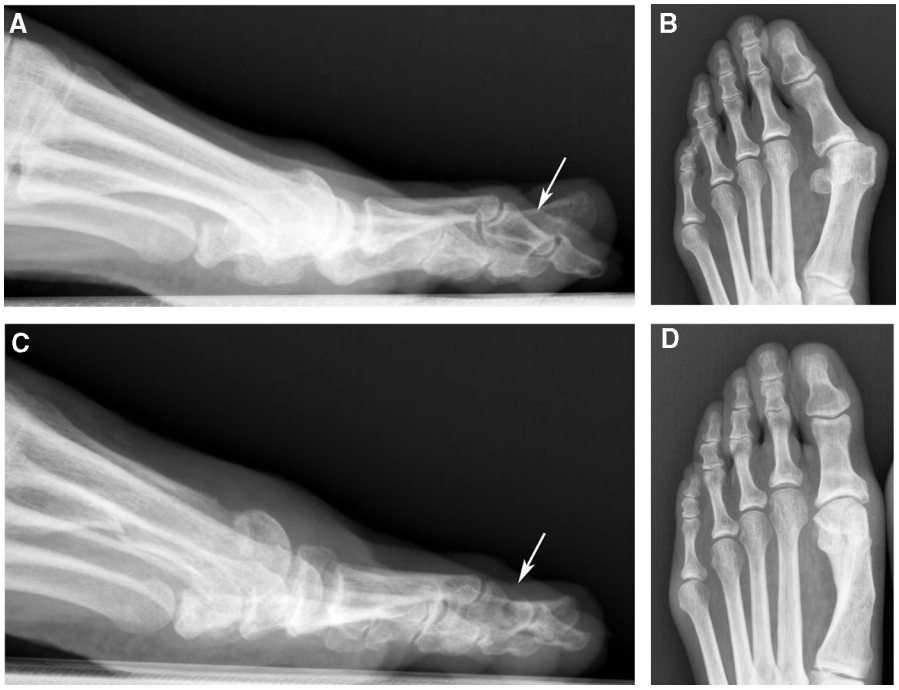

Fig. 2. Pre- (A and B) and post- (C and D) operative weight-bearing radiographs in a patient presenting with long second toe syndrome and painful hallux valgus, without metatarsalgia. The pre-operative view shows a 14-mm second phalanx and PIP flexion of 40°. The postoperative values at 20 months were respectively 11 mm and 19° (Table 1, foot 11).

The present results confirm benefit in terms of stiffness. Moreover, ground pressure was systematically conserved, indicating no impairment of the interosseous intrinsic muscles of the toe, an important factor in preventing plantar plate lesions. There was, however, in some cases (7 feet) flexor weakening, probably due to fibrosis under the osteotomy site or to relative lengthening of the flexor tendon. Finally, the absence of any implanted material limits the risk of complications.

Only 2 patients (3 feet) underwent second-toe surgery without any other associated forefoot procedures. This bears witness to the frequency of associated forefoot pathology. In clinical examination of the second toe, forefoot issues as whole should therefore be looked into.

The main technical difficulty relates to the minimally invasive approach. Thin double-angled retractors enable precision in the approach (Fig. 1), which is essential to a good result. Small incision with meticulous dissection are an integral aspect of the technique. The procedure appeared to be reliable, respecting the biomechanics of the toe. Validation needs to be conducted on a larger prospective series with comparison against conventional techniques.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

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