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ORIGINAL ARTICLE

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Replacement of the first metatarsophalangeal joint with a Swanson implant accompanied by open-wedge osteotomy of the first metatarsal bone for hallux valgus in rheumatoid arthritis

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Abstract Hallux valgus is very common in rheumatoid arthritis (RA) and mostly accompanied by varus deformity of the first metatarsal bone, which is often corrected in surgeries for hallux valgus in nonarthritic condition, but rarely in RA. We performed the replacement of the first metatarsophalangeal (MTP) joint with a Swanson hinge toe implant accompanied with open-wedge osteotomy of the first metatarsal bone, aiming at reconstruction of a functioning first MTP joint without recurrence of hallux valgus. Fifteen feet of 11 patients with RA were studied with a mean follow-up period of 45.1 months. The American Orthopaedic Foot and Ankle Society (AOFAS) scale improved significantly from 39 points preoperatively to 81.7 at the last follow-up. The hallux valgus angle (HVA), angle between the first and second metatarsal bones (M1/2), and that between the first and fifth (M1/5), measured on standing anteroposterior radiographs, decreased significantly from 49.8°, 16.7°, and 34.4° preoperatively to 10.9°, 8.7°, and 22.2° at the last follow-up, respectively. Union of the corrected first metatarsal bone was recognized in all cases and no such problems as infection, dislocation, or implant fracture were observed. These data suggest that replacement of the first MTP joint with a Swanson implant accompanied with open-wedge osteotomy of the first metatarsal bone can be a useful option for hallux valgus in RA.

Key words Hallux valgus · Open-wedge osteotomy · Rheumatoid arthritis · Swanson implant

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Introduction

Hallux valgus deformity, which impairs walking ability with severe pain, is a common disorder in rheumatoid arthritis (RA). Cosmetic considerations are also a problem for patients when the deformity becomes severe. It is mostly accompanied by varus deformity of the first metatarsal bone as recognized in hallux valgus in nonarthritic condition.

Although correction of varus deformity of the first metatarsal bone is today's established concept in surgical treatment for hallux valgus in nonarthritic condition, the predominantly performed surgery for hallux valgus in RA is either resection arthroplasty or arthrodesis of the first metatarsophalangeal (MTP) joint, both of which sacrifice the joint function. Simple replacement of the first MTP joint is also performed, but implant problems are common.

To tackle this problem, we developed a new method of surgical treatment for hallux valgus in RA. We aimed at sufficient correction of hallux valgus without sacrificing the joint function or recurrence of the deformity. Our procedure consists of two parts: (1) correction of varus deformity of the first metatarsal bone with open-wedge osteotomy; and (2) reconstruction of a functioning first MTP joint by replacement with a Swanson flexible hinge toe implant (Wright Medical Technology, Arlington, TN, USA). In this article, we report our mid-term clinical outcomes of this procedure.

Patients and methods

Patients

From September 1997 to June 2005, 17 feet of 13 patients with RA were operated on for hallux valgus; of these, two patients died before the last follow-up. Therefore 15 feet of 11 patients (2 men; 9 women) were studied with a minimal follow-up period of 1 year. Mean age at operation was 59.5 (range, 50–75) years and mean follow-up period was 45.1 (14–74) months. No criteria for operation were determined

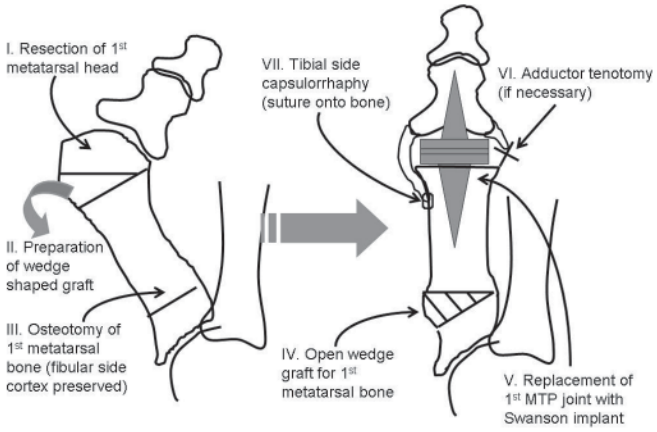

Fig. 1. Surgical procedure, detailed in "Patients and methods" in the text, is demonstrated schematically

such as deformity level, severity of joint erosion, or patient's activity.

Surgical procedure

The tibial side of the first MTP joint as well as the first metatarsal bone is approached. The capsule is incised making a rectangular flap with the base at the proximal phalanx for capsulorrhaphy afterward. Then the first metatarsal head is excised by approximately 20 mm (Fig. 1, I), during which wedge-shaped bone with approximately 10 mm base of cortical bone is prepared for bone graft thereafter (Fig. 1, II).

Next, the proximal part of the first metatarsal bone is osteotomized from the tibial side while the fibular side cortex is preserved not to be separated (Fig. 1, III). Then the osteotomized site is widened slowly and varus deformity of the first metatarsal bone is corrected in an open-wedge manner with previously prepared bone graft (Fig. 1, IV). One or two staples are often used for stabilization of the correction.

Thereafter, replacement of the first MTP joint with a Swanson hinge toe implant is performed according to the manufacturer's instructions (Fig. 1, V). A grommet is not used in this series. Adductor hallucis tenotomy is performed if a valgus trend of the hallux is still observed (Fig. 1, VI), and finally tibial side capsulorrhaphy of the first MTP joint is performed by suturing the capsule, which has been prepared in advance as a rectangular-shaped flap, onto the first metatarsal bone (Fig. 1, VII). In our procedure, lesser toes are often operated on simultaneously; resection of the metatarsal head was performed in three feet and shortening of the metatarsal bone with MTP joint reduction in 12 feet. Also, arthrodesis of the interphalangeal (IP) joint of hallux was performed in one foot.

Evaluation

For clinical assessment, the American Orthopaedic Foot and Ankle Society (AOFAS) Hallux Metatarsophalangeal-Interphalangeal Scale[1] was calculated preoperatively and at the last follow-up. For radiographic assessment, a standing anteroposterior radiograph was taken preoperatively and at the last follow-up for measurement of the hallux valgus angle (HVA), the angle between the first and second metatarsal bones (M1/2), and that between the first and fifth (M1/5). The hallux valgus angle was measured at the intersection of the longitudinal bisection of the first metatarsal bone and proximal phalanx of hallux (Fig. 2A). Two intermetatarsal angles, M1/2 and M1/5, were measured at the intersection of the longitudinal bisection of two metatarsal bones, the first and second (Fig. 2B), and the first and fifth (Fig. 2C), respectively. For data analysis, preoperative data and those at the last follow-up were statistically compared using the Wilcoxon signed rank test, and P values of less than 0.01 were recognized as significant.

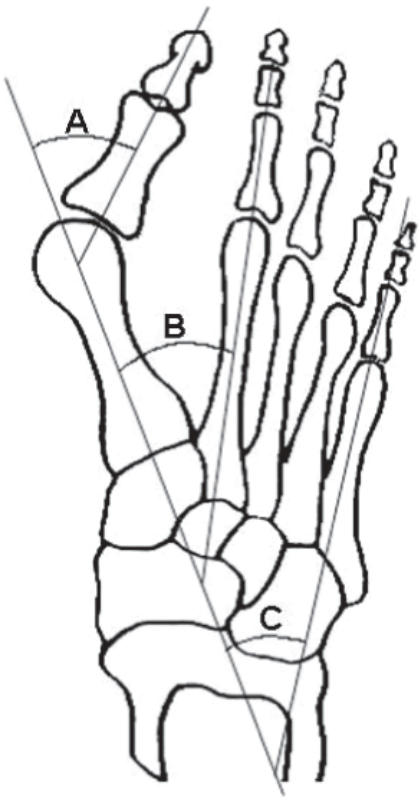

Fig. 2. Hallux valgus angle (HVA), angle between the first and second metatarsal bones (M1/2), and that between the first and fifth (M1/5) were measured on standing anteroposterior radiograph preoperatively and at the last follow-up. *A*, HVA; *B*, M1/2; *C*, M1/5

Results

Mean AOFAS score significantly improved from 39 (range, 29–54) points preoperatively to 81.7 (67–95) at the last follow-up (Fig. 3). Of the assessed interests, all but footwear, MTP motion, and IP motion demonstrated significant improvement.

As for radiographic evaluation, all measured angles significantly decreased; mean preoperative HVA, M1/2, and

M1/5 were 49.8 (range, 33–63), 16.7 (10–22), and 34.4 (28–42) degrees, respectively, and those at the last follow-up were 10.9 (range, 2–19), 8.7 (3–19) and 22.2 (12–35) degrees, respectively (Table 1). Union of the corrected first metatarsal bone was recognized in all cases, and no loosening, dislocation, or fracture of the Swanson implant was noted. However, one foot demonstrated a radiolucent zone within the proximal phalanx adjacent to the Swanson implant, which was obvious 8 months after the surgery but did not demonstrate progression after that time.

Callus related to MTP or IP joint of hallux had been recognized in 11 feet before the surgery, but they all had disappeared after the surgery and were not recognized at the last follow-up. However, one foot demonstrated newly developed symptomatic callus after the surgery, in which case the radiographic result was the worst; HVA, M1/2, and M1/5 were 19°, 19°, and 35°, respectively, at the last follow-up.

Neither deep nor superficial infection was observed. Also, neither silicone synovitis nor lymph node inflammation was noted. No revision surgery has so far been performed or planned. A case with bilateral operations is demonstrated in Fig. 4: the right foot of a 57-year-old male patient.

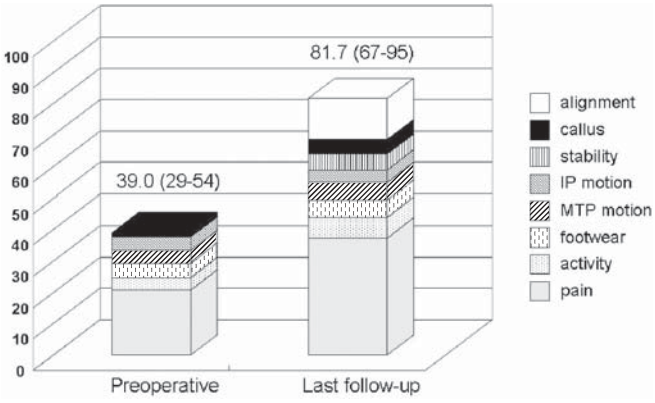

Fig. 3. American Orthopaedic Foot and Ankle Society (AOFAS) Hallux Metatarsophalangeal–Interphalangeal Scale was calculated preoperatively and at the last follow-up. The values are given as the mean with the range in parentheses. The improvement of the scale was statistically significant ($P = 0.0006$) by Wilcoxon signed rank test. *IP*, interphalangeal; *MTP*, metatarsophalangeal

Table 1. Angles on standing anteroposterior radiographs

	Preoperative	Last follow-up	*P* value
HVA (degrees)	49.8 (33–63)	10.9 (2–19)	0.0022
M1/2 (degrees)	16.7 (10–22)	8.7 (3–19)	0.0032
M1/5 (degrees)	34.4 (28–42)	22.2 (12–35)	0.0022

Angles measured on standing anteroposterior radiographs are demonstrated. HVA, hallux valgus angle; M1/2, angle between the first and second metatarsal bones; M1/5, angle between the first and fifth metatarsal bones. The values are given as the mean with the range in parentheses. The decrease of each angle from preoperative to the last follow-up was statistically significant ($P < 0.01$) by Wilcoxon signed rank test

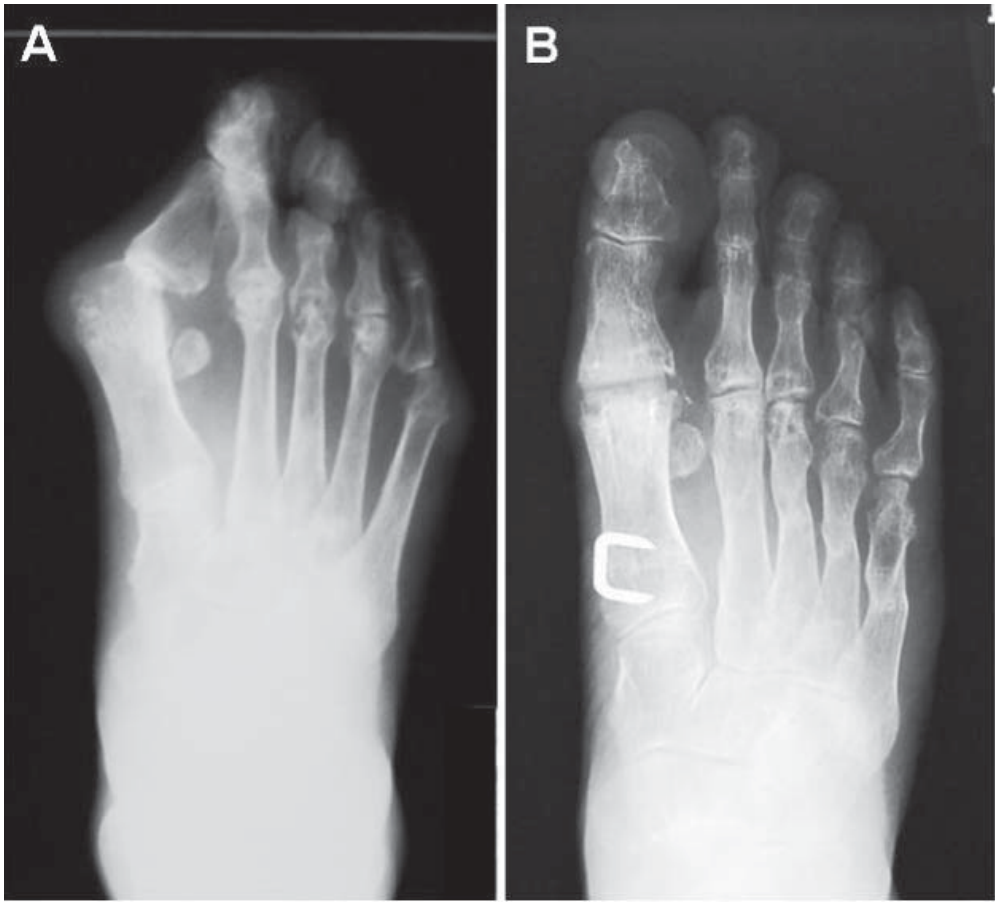

Fig. 4A,B. The right foot of bilateral operations is demonstrated. A 57-year-old male patient with 45 months' follow-up. **A** Preoperative; **B** the last follow-up. Surgery for lesser toes, shortening of metatarsal bone with reduction of metatarsophalangeal joint, was performed simultaneously in this case

Discussion

It is well known that foot deformities involve almost all patients with RA,[2] and among the deformities, hallux valgus is very common with disease progression,[3,4] the pain, and dysfunction from which severely impairs the patient's daily life.[5] Hallux valgus in RA is mostly accompanied with varus deformity of the first metatarsal bone,[3,4] which is also almost always present and thus is often surgically corrected in hallux valgus in nonarthritic condition.[6,7]

Nowadays, however, resection arthroplasty or arthrodesis of the first MTP joint is predominantly performed as surgery for hallux valgus in RA, and little attention seems to be paid to varus deformity of the first metatarsal bone. Because of the arthritic progression of the first MTP joint, surgery for nonarthritic hallux valgus including the correction of the first metatarsal varus is expected to result in failure or early recurrence in rheumatoid feet. Indeed, our previously reported Lapidus' method also resulted in recurrence of hallux valgus.[8]

On the other hand, frequently performed surgeries for hallux valgus in RA, mentioned above, still leave some imperfection. In the literature, resection arthroplasty often seems to result in recurrence or inadequate correction of hallux valgus. Average HVA at the follow-up was reported to be 27° after Kates arthroplasty[9] and was 22.3° after Hoffman procedure.[10] However, Vahvanen et al. stated that patients' subjective evaluation of surgery was mostly satisfactory in spite of the objective result of recurrence of hallux valgus.[11]

More recently, Fuhrmann and Anders reported not only an increase of HVA after the Keller and Hueter-Mayo procedure (26.7° to 34.4° and 23.7° to 28.1°, respectively), but also a lack of plantar flexion of hallux.[12] From these findings regarding complications, resection arthroplasty may not be the first choice for hallux valgus deformity in RA. As for arthrodesis, this procedure seems to be preferred in Western countries,[13] but a fixed hallux makes it impossible to bend the toe on walking and is thus inconvenient in such countries as Japan where people do not wear shoes in the home.

Although not so widely performed as resection arthroplasty and arthrodesis, simple replacement of the first MTP joint without correction of varus deformity of the first metatarsal bone has also been performed.[14,15] In spite of mostly favorable clinical results with the preservation of a functional first MTP joint, however, a high incidence of implant fracture was reported.[16] These limitations of previous procedures led us to design a new procedure, not completely novel but one that combined several useful methods.

In this study, our procedure demonstrated not only clinically satisfactory results, but also sufficient correction of hallux valgus without recurrence thus far. Furthermore, the mean angles measured on radiographs were within normal limits after surgery.[17] However, one foot demonstrated newly developed symptomatic callus after the surgery, which was at the medial side of the base of the proximal phalanx of hallux. In this case, all angles measured on radiographs had already been noted as the worst immediately after surgery without subsequent progression, indicating surgical correction was insufficient not only for hallux valgus but also for splaying deformity. Because splaying deformity strongly correlated with hallux valgus in our previous study regarding the natural course of rheumatoid foot deformities,[4] correction of both deformities should be of importance in surgical realignment of rheumatoid feet.

Miller et al. performed arthroplasty using a Swanson implant in the first MTP joint of geriatric hallux valgus and observed a 6.4° correction of M1/2.[18] However, they also performed resection of a medial bony prominence of the first metatarsal head, and the first metatarsal bone axis used for measurement of postoperative M1/2 was different from the preoperative one. When using the original axis, the correction was 4.79°, which was relatively small as compared to 8° in our procedure. From the fact that M1/2 could be corrected to a certain extent only by arthroplasty with a Swanson implant, however, preoperative M1/2 could be a surgical indication for open-wedge osteotomy of the first metatarsal bone.

Gould previously reported excellent clinical outcomes after a similar procedure to ours with 3–5 years' follow-up, but he also demonstrated a considerably high rate, 67%, of mild recurrence of hallux valgus.[19] This might have been because he designed the hallux to be even with or slightly longer than the second toe. In our series, we designed the hallux to be even with or slightly shorter than the second toe, and no recurrence of hallux valgus has yet been noted. Therefore the length balance of two toes after surgery, the large and second toes, could be another important factor concerning the recurrence of hallux valgus. Needless to say, however, it is uncertain whether the length balance really has a direct relationship with the development of hallux valgus, although the first metatarsal length has long been presumed to be a possible etiologic factor in hallux valgus.[20] Broughton et al. performed arthroplasty using a silastic ball spacer with the aim of maintaining hallux length but failed in shortening of the hallux by 2 mm or more in almost half the patients.[21] Nevertheless, they observed no relation between postoperative hallux length and clinical outcomes including appearance of hallux.

In this study, one foot demonstrated a radiolucent zone around the Swanson implant. This might be because we did not use a grommet in this study. Swanson et al. demonstrated a significantly lower rate of implant fracture as well as greater bone preservation around the implant by use of a grommet in metacarpophalangeal joints in hands.[22] Although no evidence of loosening or fracture of implants has yet been recognized in our cases, careful attention must be paid to these. As a matter of fact, we now use a grommet in the same procedure.

Two possible limitations can be pointed out. One is an insufficient number of cases and the other is the length of the follow-up period. Because favorable results have been obtained clinically as well as radiographically in this study, we think we can now perform this procedure on more cases. Needless to say, however, we should conduct a stringent postoperative follow-up. In conclusion, our procedure, re-

placement of the first MTP joint with Swanson implant accompanied with open-wedge osteotomy of the first metatarsal bone, can be a useful surgical option for hallux valgus in RA with satisfactory mid-term clinical and radiographic outcomes.

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