Course of damage to the hallux over 5 years after forefoot resection arthroplasty in rheumatoid arthritis patients

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Abstract A retrospective study of 34 feet from 20 consecutive patients with rheumatoid arthritis was performed to investigate the development of damage to the hallux over 5 years after forefoot resection arthroplasty. Radiographically we analysed changes in two valgus angles and the interphalangeal joint (IP) damage of the hallux. These parameters were measured preoperatively, 12 months postoperatively, and at the latest follow-up. Although the average HVA (between the first metatarsal and the proximal phalanx) significantly decreased from 38.7° preoperatively to 8.66° postoperatively, the angle increased to 23.0° during the first 12 months following surgery. Further deterioration of the angle at the last follow-up was not detected (25.3°; $P=0.252$). The average IPV (between the proximal phalanx and the distal phalanx) angle significantly increased from 6.65° preoperatively to 12.1° 12 months postoperatively and thereafter slightly increased to 13.3° at the latest follow-up. The average of the Sharp/van der Heijde score of the IP joint significantly increased from 5.71 preoperatively to 8.58 12 months postoperatively and thereafter slightly increased to 9.65 at the latest follow-up. The deterioration and destruction process of the hallux after resection arthroplasty occurred soon after surgery, and the progression of the deformity was temporary.

Résumé L'étude rétrospective a porté sur 34 pieds chez 20 patients consécutifs présentant une arthrite rhumatoïde de façon à étudier l'évolution de la déformation du gros orteil, 5 ans après une résection arthroplastique de l'avant pied. Nous avons analysé de façon clinique et radiographique les angles des articulations du gros orteil. Ces paramètres ont été mesurés en préopératoire et en post-opératoire après 12 mois de suivi. L'angle métatarso phalangien était significativement amélioré passant de 38.7 en préopératoire à 8.66 en post-opératoire avec une amélioration de 23° durant les 12 mois suivant l'intervention chirurgicale. Il n'y a pas eu d'aggravation de cet angle au plus long recul. La moyenne de l'angle inter phalangien a été significativement augmenté de 6.65 en préopératoire à 12.1 en postopératoire. Le score moyen de Sharp et Van Der Heijde relatif à l'inter phalangienne a été significativement augmenté passant de 5.71 en préopératoire à 8.58 en post-opératoire. La destruction de l'articulation du gros orteil après résection arthroplastique survient précocement après la chirurgie et la progression de la déformation est très temporaire.

Introduction

Rheumatoid arthritis (RA) frequently causes painful forefoot deformities that can interfere with standing and walking. The metatarsophalangeal (MTP) joints are the most common sites of this disease, which presents with an aggressive synovitis, capsular distention, and collateral ligament integrity. Continued walking with soft tissue instability, articular cartilage destruction, and subchondral bone resorption leads to common rheumatoid forefoot deformities, including hallux valgus, hammering of the lesser toes, and subluxation and dislocation of the lesser MTP. As the proximal phalanges are displaced dorsally, the

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plantar fat pad is drawn distally, leaving a relatively thin, insufficient soft tissue cushion beneath the metatarsal heads, where painful, thickened plantar callosities frequently develop and impair the ability of the affected individual to walk. Weight is shifted away from the painful part of the foot, which necessitates the use of custom-made shoes. In many cases, however, it is difficult to manage these deformities with conservative methods, and surgery is often required.

Forefoot resection arthroplasty by various operative techniques has been widely recommended because most studies reported that a high percentage of the outcomes was satisfactory over the long term [1, 12, 14]. Some studies, however, reported a deterioration in the result over time, with a high recurrence rate for callosities and deformities, especially in the hallux [1, 9, 15]. Therefore, arthrodesis and implant arthroplasty of the first MTP joint have gained favour as alternatives to resection arthroplasty.

Some of these authors reached their conclusions about the outcomes from forefoot resection arthroplasties on the basis of written questionnaires or telephone surveys [1, 9]. Most studies included only a comparison of preoperative and postoperative radiographs in the final assessment, even if radiographic measurements were analysed; detailed radiographic outcomes of the forefoot resection arthroplasties have not been well documented.

The aim of this study was to assess the course of radiographic changes in the hallux over 5 years after resection arthroplasties in rheumatoid patients.

Materials and methods

Patients

Medical records at our institution were reviewed to identify patients with RA who underwent a resection arthroplasty of the forefoot between 1995 and 2000. The inclusion criteria were the presence of RA, severe forefoot pain due to a deformity with subluxation of two or more MTP joints and plantar callosities, and bone destruction in two or more MTP joints. We identified 20 patients (all women with a total of 34 feet that had been operated on) that had undergone a resection arthroplasty for the first MTP joint, combined with resection of the metatarsal heads of the lesser toes through a plantar approach. Functional classification of these patients at the time of surgery was as follows: three women in class I, nine in class II, and eight in class III. The average age of the patients was 59.5 years (range: 36 to 76 years old), and the mean duration that they had been diagnosed with RA was 15.0 years (range: 7 to 38 years). The average follow-up period was 6.59 years (range: 5 to 8.83 years).

Operative procedure

The operative procedure was a combination of the Mayo procedure for the hallux and the Hoffman procedure for the lesser MTP joint, as has been described previously [8, 11]. The great toe was approached dorsomedially, with oval resection of the skin and bursa as needed. The capsular flap between the extensor and abductor tendons includes the short extensor tendon, which was incised off the proximal phalanx. After a synovectomy, the metatarsal head was resected as far as necessary to achieve soft tissue release. The dorsal flap was closed as far as possible, replacing the extensor tendon more medially and the abductor tendon more dorsally. The hallux was fixed with Kirschner wire. For the lesser MTP joints, we used a plantar transverse elliptic excision of skin calluses and bursae, which was convex, distally and waved proximally to adjust the lengths of both flaps. The perforated plantar capsules were split longitudinally underneath the metatarsal heads, which were resected such that their alignment and length corresponded with each other. The interphalangeal (IP) joints were corrected by manipulation, and Kirschner wires were used as needed to preserve the alignment for 3 weeks after the operation. If possible, patients were allowed to walk using a non-weight-bearing heel. The Kirschner wires were removed after 3 weeks, and then all the patients were allowed to walk in a full weight-bearing manner.

Evaluation

Radiographic deformities

We measured three valgus angles of the hallux and second toe on plain anteroposterior (AP) radiographs (Fig. 1). The MTP valgus angles were formed by the intersections of the first metatarsal and the proximal phalanx (HVA), the second metatarsal and the proximal phalanx (MTP-2), and the first proximal phalanx and the distal phalanx (IPV). We also measured the intermetatarsal angle, which was defined as the intersection of the longitudinal axes of the first and the second metatarsals (M1/2). The HVA angle was measured before surgery, after the Kirschner wires were removed 3 weeks after operation, 12 months after surgery, and at the last follow-up examination. The IPV, MTP-2 and M1/M2 angles were measured before surgery, 12 months after surgery, and at the latest follow-up examination. Changes in the angles were then evaluated.

Damage to the interphalangeal joint of the hallux

Two methods were used to evaluate the AP radiographs for the extent of joint damage in the IP joint of the hallux. The first method was a modified Larsen score, which assessed

Fig. 1 HVA: valgus angle between the first metatarsal and the proximal phalanx. MTP-2: valgus angle between the second metatarsal and the proximal phalanx. IPV: valgus angle between the first proximal phalanx and the distal phalanx. M1/2: intermetatarsal angle between the first and second metatarsals

the degree of joint destruction mainly determined using erosion changes [5]. The grading scale ranged from 0 to 5: 0= intact bony outlines and normal joint space; 1= erosion less than 1 mm in a diameter or joint space narrowing (JSN); 2= one or several small erosions (diameter more than 1 mm); 3= significant erosions; 4= severe erosions (usually no joint space left and the bony outlines were only partly preserved); 5= multiple changes (the original bony outlines were destroyed). The second method was a Sharp/van der Heijde score (SHS), which assessed both joint erosion and JSN [13]. A score of one corresponded to discrete erosions, and the score rose to two, three, four, or five depending on the amount of surface area affected (complete collapse of the bone was scored as a five). JSN was combined with a score for subluxation and scored as

follows: 0= normal; 1= focal or doubtful; 2= generalised, less than 50% of the original joint space; 3= generalised, more than 50% of the original joint space or subluxation; 4= bony ankylosis or complete luxation. Thus, the maximum score for a joint was 14. The grading and scoring were assessed before surgery, 12 months after the surgery and at the latest follow-up examination.

Statistical analysis

Paired *t* tests were used to assess the changes in the angles and scores that showed equal variance. When the data showed unequal variance, Wilcoxon signed-ranks tests were used. A *P*-value of less than 0.01 was considered to be statistically significant.

Results

Changes in the angles

Changes in the angles are shown in Table 1. Although the average HVA angle significantly decreased from a preoperative angle of 38.7° to a postoperative angle of 8.66° ($P<0.01$), the average HVA angle increased again to 23.0° during the first 12 months after the surgery ($P<0.01$). Significant deterioration of the angle from 12 months after the surgery to the last follow-up examination was not detected (25.3° at the last follow-up examination; $P=0.252$). There was still a significant difference between the preoperative angle and the angle at the last follow-up examination ($P<0.01$).

The average MTP-2 angle was 17.6° (range: −40 to 70°) before surgery, 16.3° (range: 0 to 30°) 12 months after the

Table 1 Average angles of measured at four times points

	Preoperative	Postoperative	Postoperative 12 mo	Last follow-up
HVA	38.7	8.66*	23.0**	25.3*##
MTP-2	17.6		16.3*	18.2*##
IPV	6.65		12.1*	13.3*##
M1/2	15.8		12.8#	13.4##

HVA: valgus angle between the first metatarsal and the proximal phalanx

MTP-2: valgus angle between the second metatarsal and the proximal phalanx

IPV: valgus angle between the first proximal and the distal phalanx

M1/2: intermetatarsal angle between the first and second metatarsals

* $P<0.01$, significantly different from preoperative angle

** $P<0.01$, significantly different from the postoperative angle

not significantly different from the preoperative angle

not different from the postoperative angle measured 12 months after the surgery

operation, and 18.2° (range: −15 to 55°) at the last follow-up examination. We found that the postoperative changes in the MTP-2 angle, including improvement in the angle and deterioration over time, were not consistent for the different patients.

The average IPV angle of the hallux significantly increased from a preoperative angle of 6.65° to 12.1° 12 months after the surgery ($P<0.01$). Thereafter, the angle slightly increased to 13.3° at the last follow-up examination, although the change was not significant ($P=0.433$).

The average M1/2 angle decreased from 15.8° to 12.8° 12 months after the surgery, but the change was not significant ($P=0.315$). Deterioration of the angle from 12 months after the surgery to the last follow-up examination was not detected (13.4° at the last follow-up examination; $P=0.373$). There was no significant difference between the preoperative angle and the angle at the last follow-up examination ($P=0.423$).

Damage to the interphalangeal joint of the hallux

The changes in the scores for IP joint damage of the hallux are shown in Table 2. Before the surgery, small degenerative changes of the IP joint (grade 0, 1, or 2) were observed in 18 of the 34 feet (53%), whereas severe changes (grade 4 or 5) were found in less than 30% of the feet (7 of 34 feet). At the last follow-up examination, severe degenerative changes were observed in more than 50% of the feet (19 of 34 feet).

The average SHS of the IP joint of the hallux significantly increased from a preoperative value of 5.71 to 8.58 during the first 12 months after the surgery ($P<0.01$). Thereafter, the SHS slightly increased to 9.65 at the last follow-up examination, although the change was not significant ($P=0.0155$); the highest scores from three of the feet were excluded.

Table 2 Damage to the interphalangeal joint of the hallux

	Preoperative	12 months postoperative	Last follow-up
Larsen grade			
Grade 0	4	0	0
Grade 1	8	5	3
Grade 2	6	3	3
Grade 3	9	12	9
Grade 4	3	9	10
Grade 5	4	5	9
SHS score	5.71	8.58*	9.65#

SHS score: Sharp/van der Heijde score

* $P<0.01$, significantly different from preoperative

not different from 12 months postoperatively

Discussion

In this study, we have shown that hallux deformities occurred soon after forefoot resection arthroplasties and that the radiographic progression of the deformities was most rapid during the first year following surgery. Moreover, the extent of the hallux deformity after surgery did not depend on the follow-up period. The prevalence of recurrent hallux valgus deformities after resection arthroplasties has been reported to be higher than 50%; the rate was 61% (109 of 179 feet) in the study by Vahvanen et al. [15] and was 68% (28 of 41 patients) in the study by van der Heijde et al. [12]. More recently, Fuhrmann and Anders found recurrent hallux valgus in 36.6% of the feet examined in their study (93 of 254 feet) [3]. Although in all of these studies, the hallux valgus deformities resulted in HVA angles of 20° or more, the mechanisms underlying the abnormal HVA angles in rheumatoid patients are not understood. In our study, none of the patients required a second operation because of recurrent hallux valgus, although 73.7% of the affected feet (28 of 38 feet) had an HVA angle of 20° or more.

To our knowledge, there are no reports about the effects of the hallux on the IP joint after resection arthroplasty, although the changes in the IP joint after arthrodesis of the first MTP joint have been discussed. The prevalence of arthritis in the IP joint following arthrodesis of the first MTP joint in a rheumatoid foot has been reported to be relatively high [2, 6, 7]. We postulated that the effects on the IP joint of the hallux after resection arthroplasty should be less severe than those following arthrodesis of the first MTP joint, because the mobility of the first MTP joint after resection arthroplasty is preserved. It is known that the joint adjacent to the fused joint is often damaged. In this study, however, deformities and degenerative changes in the IP joint of the hallux after resection arthroplasty were unexpectedly severe and rapidly progressed during the early stages following surgery.

Moreover, we could not predict the progression of the valgus deformity of the hallux IP joint after surgery. We predicted that a varus deformity of the IP joint would occur after the recurrence of a hallux valgus deformity due to direct contact between the hallux and the second toe. Moreover, the valgus deformity of the hallux IP joint did not relate to the course of a second valgus deformity in the MTP joint after surgery. We believe that these factors cause unnatural power to be applied to the IP joint of the hallux to support the instability of the forefoot and the decreased forefoot pain allows the great toe to contact the ground directly soon after surgery. Phillipson et al. used EMED F pressure to show that the total pressure and the pressure-time of the hallux significantly increased after forefoot resection arthroplasty, and the greatest area of change was

the region of the first metatarsal head remnant [10]; these results support our hypothesis.

This raises the possibility that deformity and degenerative changes of the IP joint of the hallux after surgery are affected not only by a mechanical factor, but also by rheumatoid arthritis. Deformity of the IP joint of the hallux, however, is relatively rare in rheumatoid patients. Kirkup et al. reported that in rheumatoid patients with hallux disorder, erosion changes in the IP joint were observed in 29% of the feet examined (57 of 194 feet), and IP valgus deformities were seen in only 6.7% of the affected feet (13 of 194 feet) [4]. Moreover, because the deformities and degenerative changes occur at an early postoperative stage, we believe that mechanical factors greatly contribute to the development of the deformities and degenerative changes in the IP joint of the hallux after the surgery.

In conclusion, our study shows that the deterioration and destruction of the hallux after resection arthroplasty occur at a relatively early stage and that the progression of the deformity is a temporary process. Therefore, forefoot resection arthroplasty is a stable procedure for the patient with RA over the long term.

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