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## Arthrodesis in the treatment of hallux rigidus

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**Abstract** We reviewed 34 patients (38 joints) with hallux rigidus treated from 1989 to 1999 with arthrodesis of the first metatarsophalangeal joint. Average patient age at time of surgery was 52 (24–71) years, and the mean follow-up was 54 (18–116) months. There were six superficial infections, and all arthrodeses united. There was a good functional result with a significant pain reduction. The mean postoperative American Orthopaedic Foot and Ankle Society (AOFAS) score was 53 (5–84) points.

**Résumé** Nous avons examiné 34 malades (38 articulations) traités de 1989 à 1999 pour hallux rigidus par arthrodesse de la première métatarso-phalangienne. L'âge moyen des malades à la chirurgie était de 52 ans (24-71) et le suivi moyen était de 54 mois (18-116). Il y avait six infections superficielles et toutes les arthrodeses ont fusionné. Il y avait un bon résultat fonctionnel avec une réduction notable de la douleur. Le score AOFAS moyen post-opératoires était de 53 points (5-84).

### Introduction

Osteoarthritis of the first metatarsophalangeal (MTP) joint associated with a dorsal exostosis and restricted dorsiflexion of the great toe is generally named hallux rigidus. A forward-projecting big toe, a long or dorsally tilted first metatarsal (*metatarsus primus elevatus*), a pes plano-valgus and obesity have been reported as predisposing factors [11].

Clutton was the first to describe an arthrodesis of the first MTP joint in 1894 using an ivory peg for internal fixation [3] and reported satisfactory results. Since then various surgical procedures have been published, including osteotomies [2, 20], cheilectomy [7, 13], resection

arthroplasty [18], implant arthroplasty [5, 19] and arthrodesis [4, 8, 10, 22, 30, 31]. Also, various methods of fixation have been described, such as small tubular compression plating [14, 22, 23, 31], external fixation [17], compression screws [6, 8, 10, 22, 27], wire sutures [8, 9], absorbable sutures [1], Herbert screws [30], Steinmann pins [15], Rush pins [28], Kirschner wires [8, 10] and bone staples [21].

There are several different ways to prepare the bone surfaces of the MTP joint for the arthrodesis. Some authors use flat osteotomies of the articular surfaces because of the simplicity of the technique [15, 27], with a reported fusion rate of 90% [4]. Others prefer curved surfaces created by using reamers [4, 10, 16, 29] or a “hole-saw”, with a reported fusion rate of 92% [4]. Inadequate positioning of the arthrodesis with the great toe in extensive valgus or dorsiflexion may lead to walking difficulties and cause osteoarthritis of the interphalangeal joint [26].

### Materials and methods

We reviewed 34 patients (38 joints) treated for hallux rigidus with an arthrodesis of the first MTP joint between 1989 and 1999. Average patient age at time of surgery was 52 (24–71) years. The follow-up was performed after a mean of 54 (18–116) months. Seven patients were men; 27 women. Indication for surgery was a failed conservative treatment and grade III osteoarthritis of the first MTP joint (Fig. 1).

At follow-up all patients were evaluated by a thorough clinical investigation and plain radiography using a standard protocol. The clinical outcome was assessed using the hallux metatarsophalangeal-interphalangeal scale developed by the American Orthopaedic Foot and Ankle Society (AOFAS) [12]. The maximum Score is 100 points; 40 points are given for pain, 45 for function and 15 for alignment. No modification of this score was used despite the fact that an arthrodesis of the first MTP joint results in a maximum score of only 90, as 10 points are assigned for MTP joint motion.

A visual analogue scale (VAS) was used to assess patient pain pre-operatively and post-operatively, with 100 points indicating maximum pain and 0 points no pain. Radiographic evaluation involved plain standing radiographs of the forefoot in antero-posterior and lateral views. Patients suffering from hallux valgus were

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**Fig. 1** Forty-eight-year-old marathon runner with osteoarthritis of the first metatarsophalangeal joint



**Fig. 2** Three-year follow-up. The patient has resumed participation in marathon racing

excluded. We did not use the arthrodesis of the first MTP joint in patients with active infection or neurological or vascular diseases. Pre-operatively none of our patients suffered from degenerative arthritis of the interphalangeal joint.

#### Operative technique

The first MTP joint was approached dorsomedially. Resecting the articular cartilage, we formed a ball out of the first metatarsal head and a socket out of the base of the proximal phalanx using a "hole-saw". The desired position of the arthrodesis was at 10–15° [10] of valgus and 15–20° of dorsiflexion, individually adapted to the patient's functional requirements. Either crossed screws (Fig. 2) or K-wires with wire sutures were used for fixation. A below-knee cast was applied for 2 weeks post-operatively followed by full weightbearing using a surgical shoe for another 4–6 weeks. After radiographically controlled union of the arthrodesis, the patients were mobilised with full weightbearing in conventional shoes with a stiff insole guarding the first ray.

Differences between pre-operative and post-operative scores were interpreted with the *t*-test. The Pearson correlation was calculated to identify relationships between different items within the test; *p* values of 0.05 or less were considered significant.

#### Results

The mean post-operative AOFAS score was 53 (5–84) points. Using VAS score we noted a statistically significant reduction of pain from 80 pre-operatively to 27 postoperatively ( $p < 0.05$ ). The mean post-operative MTP joint angle (hallux valgus angle) was 14° (2°–32°) in the AP view. In the lateral view the MTP mean joint angle was 23° (12°–40°). We saw no symptomatic interphalangeal (IP) osteoarthritis of the great toe at follow-up, and all arthrodeses united (Fig. 2).

There were no re-operations; however, there were six superficial post-operative infections, which all healed without complications using oral antibiotics. Three patients complained of numbness on the dorsum of the great toe. A persistent mild swelling was seen in eight patients.

Body weight, body-mass-index (BMI) and patient age had no influence on the outcome. We noted a correlation between pre-operative pain score and delayed wound healing. There was a negative correlation between IP motion and pre-operative pain score. The MTP joint angle in both views did not correlate with post-operative problems. The Pearson correlation revealed an influence of the alignment on the post-operative outcome.

#### Discussion

Using a dorsal small fragment plate with interfragmentary screw fixation in 250 patients, Salis-Soglio [23] reported eight pseudarthroses (3%). There was no occurrence of degenerative arthritis of the interphalangeal joint for 3 years after the operation, and he saw good and excellent results in 80% of his patients.

In a post-operative interval of at least 10 years, Fitzgerald [9] reported a non-union rate of only 3% (100

cases) using different ways of fixation. Complete satisfaction was reported in 77% of his patients. In his opinion the two leading factors of poor results were arthrodesis malpositioning and interphalangeal osteoarthritis, which he found in 25% of his patients. However, the osteoarthritis of the interphalangeal joint was symptomatic in only 10%.

Turan and Lindgren [27] reported an injury to the dorsal digital nerve in 5% of their patients after using a dorso-medial approach to the first MTP joint. This complication is seen especially after previous surgery. In our patients 8% complained about numbness on the dorsum of the great toe at follow-up. This corresponds with the findings of Turan and Lindgren and is caused by injury to the dorso-medial cutaneous branch of the saphenus nerve.

Coughlin [4] reviewed the literature and reported an arthrodesis failure rate of 10% (range 0–23%). One year postoperatively Turan [27] reported a fusion rate of 100% in his 20 patients, 13 of who were completely asymptomatic.

Gregory and co-workers [10] reviewed 25 patients with 32 arthrodeses of the first MTP joint. Using this procedure they treated a variety of diagnoses, i.e. hallux valgus, hallux rigidus, failed previous surgery and rheumatoid patients. They reported a success rate of 81% and found the procedure to be a reliable, effective treatment. In patients with rheumatoid arthritis they reported a success rate of 100%. In contrast patients with hallux rigidus only achieved a success rate of 70% due to their increased functional requirements. This corresponds well with our own results of a mean AOFAS score of 53 points at follow-up.

Salis-Soglio [24] reported prolonged swelling of the first ray especially after early mobilisation. In 21% of our patients we saw a persistent, mild swelling of the first ray, but no patient had any serious complaints or problems with footwear.

Using Herbert screws for fixation of the arthrodesis Wu [23] reported 92.6% satisfactory results with bony union in all of his 27 cases. Unsatisfactory results were caused by technical errors with malpositioning of the great toe.

Sage and co-workers [22] reviewed 12 patients and reported a fusion in all of their patients with no major post-operative complications. They used conical reamers to prepare the joint surfaces, and they describe their technique as effective and reliable in achieving first MTP joint fusion.

DeFrino and co-workers [6] prospectively evaluated nine patients with ten cases of arthrodeses and a mean follow-up of 34 months. Using a modified AOFAS score with the 10 points for MTP joint motion excluded, they found an improvement from 38 pre-operatively to 90 post-operatively. Using pedobarographic measurements and gait analysis, they showed that MTP arthrodesis establishes a more normal plantar pressure pattern of the foot. This corresponds well with the findings of previous studies that this arthrodesis re-establishes the weight-bearing role of the first ray [17, 25].

The significant variability in our post-operative angular measurements results from individual functional requirements of the patients. There was no correlation between the MTP joint angle (dorsiflexion and degree of valgus) and potential post-operative problems like pain and swelling.

The arthrodesis of the first MTP joint is a reliable and reproducible way of treating hallux rigidus. All patients showed bony healing, and no complications concerning internal fixation of the arthrodesis could be observed. We saw a significant reduction of pain and good functional results with our patients. Pre-operatively the patient has to be informed about the post-operative restrictions, i.e. special footwear necessary to meet possible dissatisfaction due to exaggerated expectations or functional requirements.

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