



Rheumatoid forefoot reconstruction : 1st metatarsophalangeal fusion and excision arthroplasty of lesser metatarsal heads

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This is a retrospective review of 66 feet (mean follow-up of 3 years) in 43 patients with painful severe rheumatoid forefoot deformities. All were treated by arthrodesis of the first metatarsophalangeal (MTP) joint through a dorsomedial incision and excision of the lesser metatarsal heads through a separate plantar approach.

The mean post-operative AOFAS scores were 65.94 (range : 32 to 82). The mean post-operative Foot Function Index (FFI) was 0.47 (range : 0.23 to 0.63). Eighty five percent (57/67 feet) reported excellent or good pain relief, improved cosmetic appearance, and improved footwear comfort. The mean hallux valgus angles improved from 39° to 16° and the inter-metatarsal angle from 16° to 8°. Five feet had non-union of the 1st MTP joint arthrodesis. There were five re-operations for non-union of the 1st MTP joint arthrodesis.

The success of the operation as evidenced by this study depends upon attention to metatarsal length harmonisation, stabilisation of the 1st MTP joint and thereby even distribution of loading of the forefoot. The poor results in this study were as a result of a failure to secure the stability of the 1st MTP joint.

Keywords : rheumatoid foot ; metatarsal realignment ; metatarsophalangeal fusion.

INTRODUCTION

Painful foot deformities are prevalent in 80-90% of patients with chronic rheumatoid arthritis (1).

The understanding of the pathomechanics of these deformities over the past fifty years has led to the development of reconstruction surgery (5, 23).

The destruction of the ligaments, capsule and other periarticular structures leads to metatarsophalangeal instability, destruction of collateral integrity, pannus, destruction of the articular surface and finally dislocation of the lesser metatarsophalangeal joints. Destruction of plantar structures such as the plantar fascia, plantar plate, plantar condyles and the flexor tendons may precede these events. Occasionally there is plantar ulceration.

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The deformity in the forefoot includes severe hallux valgus, plantar declination of the lesser metatarsal heads with painful plantar callosities. There is loss of the third rocker with poor propulsion, and severe metatarsalgia contributes to deteriorating mobility. There is characteristically absent or inappropriate loading of the first metatarsal. Weight bearing and ambulation add to the insult. The plantar fat pad is drawn distally with the proximal phalangeal subluxation. Painful plantar keratoses and deformities necessitate the use of customised shoes. Most attention has been given to the treatment of the first ray although lesser metatarsal excision is a well-known option for the treatment of the complications of rheumatoid disease of the forefoot (2, 7, 8, 11, 15, 22, 27).

We present our clinical and radiological outcome following 1st MTP fusion and excision arthroplasty of lesser metatarsal heads in 66 deformed feet with chronic rheumatoid arthritis.

MATERIALS AND METHODS

A retrospective cohort of 59 patients (88 feet) with severe rheumatoid deformities of the forefeet, with a mean age of 56 years (range 25 to 84 years), was operated upon by the senior author between 1997 and 2004. Sixteen died and were excluded from the study. We therefore followed up 66 feet in 43 patients with a mean follow-up of 3 years (range: 2 to 9). There were 38 female and 5 males patients. Twenty-three patients had bilateral procedures. Most patients had rheumatoid disease of their hips and knees. Eighty percent of patients were using prednisolone or methotrexate or both on a long-term basis at the time of procedure.

The indication for surgery was forefoot pain, footwear problems, poor mobility and failed conservative treatment. Pain was mainly due to significant plantar callosities and severe foot deformities. All patients completed a preoperative questionnaire based on foot pain (Visual Analogue Scale), mobility, footwear tolerance and cosmetic appearance of the foot. This was subjectively rated using the criteria described by Mann and Thompson (15).

All patients gave informed consent before participating and returned for clinico-radiological review. AOFAS and FFI scores were recorded (4, 13, 20).

In this subjective relevant outcome measure (SROM), the patients were graded as excellent, good, fair and

poor after scoring for pain, mobility, footwear tolerance and cosmetic appearance of the foot. An excellent grade was recorded, if the patient was able to wear any shoes that he or she liked with minimal pain on walking (< 1 on the visual analogue scale of 0 to 10). A good outcome was recorded when the patient was restricted with regard to the types of shoes that could be worn and had minimal pain. The result was recorded to be fair when the patient had improvement compared with the preoperative state, regardless of which shoes could be worn and had moderate pain (1 to 8 on the visual analogue scale). The outcome was considered to be poor when the patient had severe pain (> 8), regardless of shoe wear.

Pre and postoperative radiographs (Standard AP and Lateral weight bearing, medial oblique) of each foot were evaluated. Measurements on the radiographs were made for the hallux valgus angle, the first-second intermetatarsal angle and the dorsi-flexion angle of fusion.

Operative technique

Two-curved incisions (fig 1) were made on the plantar aspect of the forefeet to create a generous fish mouth incision (fig 2). The plantar callosities and the subcutaneous bursae were excised. The capsules of the lesser MTP joints were split longitudinally, followed by excision of the MT (II to V) heads. The resections were made serially, maintaining the transverse arch of the distal metatarsals. Synovectomy of the lesser metatarsal joints was also performed. The fish mouth incision was closed after making sure that the skin edges were bleeding and of normal appearance (fig 1). Closure of the fish mouth incision facilitated in pulling the lesser toe plantarwards to correct the claw deformity. If clawing deformity of the lesser toes persisted, extensor tenotomy with or without arthroclasis of the interphalangeal joints were performed. The 1st MTPJ was fused using a separate dorso-medial incision. Fixation of the 1st MTPJ arthrodesis was achieved using compression screws. The metatarsal lengths were assessed after the fusion and any discrepancies were addressed with adjustments of the lesser metatarsal lengths. All spikes and plantar condylar prominences were carefully excised.

Wounds were then closed using monofilament non-absorbable sutures. Post operatively, wool and crepe dressings were used. For the first forty-eight hours all patients had foot elevation and ice pack application to reduce post-operative oedema. They were mobilised subsequently using heel weight bearing shoes for six weeks to protect the 1st MTP joint arthrodesis. Full weight bearing was encouraged six weeks after surgery.



Fig. 1. — Fish-mouth incision to excise the plantar callosities



Fig. 2. — Prominent metatarsal heads lying under the skin. Healthy skin edges after excision of the ellipse.

Thereafter, it was recommended that ordinary shoes with or without supports or custom made shoes be used depending on the patient's requirement.

RESULTS

Patient assessment

Pain

Pain relief was a consistent feature in 38 patients (88%). Excellent pain relief was achieved in forty feet. Five patients remained painful and could localise the site of their pain (1st MTP fusion site). Non-union appeared to be the cause of their continued discomfort and dissatisfaction. The non-union was addressed and a revision fusion was performed using plates and bone graft substitutes. Though four patients had solid arthrodesis of the 1st MTP following their revision surgery, they continued to complain of moderate pain with recurrent callosities when ambulant. Further surgery to redress the metatarsal lengths was offered but refused by these patients.

Function and mobility

Improvement in mobility was difficult to assess because most patients had diseased hips or knees in addition to foot problems. Ninety percent needed

no walking aid or support. Twenty-one patients (24 feet) discarded their pre-operative orthosis and wore normal shoes. Fourteen feet in eight patients required custom made shoes (orthotic shoes with a wide toe-box). The remaining fourteen patients required minor shoe modification. Four patients who underwent re-operation for the 1st MTP fusion required walking sticks. Most patients required a smaller shoe size. Subjective improvement in mobility was only marginal due to involvement of other joints of the lower extremities.

Clinical assessment

Subjective relevant outcome measure (SROM) improved significantly at the latest follow-up (table I). Out of the 43 patients, excellent results were documented in 7, good in 27, fair in 4 and poor in 5. Poor outcomes were mainly due to non-union of the 1st MTP arthrodesis (fig 3). The average post-operative AOFAS score was 65.94 (range : 32 to 82) (table II). The mean post-operative Foot Function Index (FFI) was 0.47 (range : 0.23 to 0.63).

Radiological assessment

Ninety percent of feet (60/66) had radiological evidence of fusion at the 1st MTP joint (table III).

Table I. — Subjective relevant outcome measure

	Pre-operative Mean score (1 to 10)	Post-operative Mean score (1 to 10)
Pain (VAS score)	8.7 (6 to 9)	2.6 (1 to 3)
Mobility	3.4 (3 to 5)	5.6 (5 to 7)
Footwear tolerance	3.4 (2 to 5)	7.2 (6 to 8)
Cosmetic appearance	1.8 (1 to 2)	8.4 (7 to 9)

Two feet had a painless non-union. At the time of most recent follow-up the hallux valgus angle was corrected from a mean of 39° (pre-operative) to 15° (post-operative) and the 1st-2nd inter-metatarsal angle was corrected from a mean of 15° (pre-operative) to 8° (post-operative). The dorsiflexion angle of the hallux with reference to the metatarsal averaged 24° .

Complications

Seven patients had superficial wound discharge that resolved completely by the time sutures were removed, after antibiotic treatment and regular

wound care. Two patients developed ulcerations over the plantar wound, which eventually healed with conservative treatment at four and six weeks respectively. There were no deep-seated or late infections. There were no systemic complications.

Assessment of the sagittal alignment on the most recent AP radiograph demonstrated that the five re-fusions had longer lesser metatarsals compared to the first (fig 3). Painful plantar callosities recurred in twelve feet. Two feet had painless callosity recurrence.

Re-operation was performed in five patients with non-union of the 1st MTP joint arthrodesis. Successful radiological fusion was achieved in four patients (fig 4).

DISCUSSION

Hoffmann in 1912 (11) first reported the resection of MT heads and necks to correct the toes and high arch, but his patient population was different from most contemporary patients with rheumatoid arthritis. He excised the MT heads through a plantar incision just proximal to the web spaces. He



Fig. 3. — Non-union of the 1st MTPJ : drifting of the lesser metatarsals into valgus.



Fig. 4. — Successful re-fusion of the non union using plate osteosynthesis.

Table II. — Follow-up AOFAS scores of 43 patients

AOFAS score (pain) Max. 40 points		AOFAS score (Function) Max. 35 points		AOFAS score (Alignment) Max. 15 points	
No of feet	Score	No of feet	Score	No of feet	Score
40	40	32	27	43	15
16	30	12	22	19	8
5	20	6	19	5	0
5	0	6	14	—	—
Total = 66	Mean = 33	Total = 66	Mean = 19.9	Total = 66	Mean = 12.1

Table III. — Radiographic assessment of the feet

Radiographic measurements (mean angles, in degrees)	Pre-operative	Post-operative
Hallux Valgus angle	39° (15° - 67°)	15° (9° - 20°)
Intermetatarsal angle	16° (10° - 25°)	8° (5° - 12°)
Dorsiflexion angle of fusion	—————	24° (15° - 30°)

encouraged a generous resection of the MT necks. The access to the MT necks is difficult through this incision. Clayton (5) introduced the concept of fore-foot resection arthroplasty in rheumatoid arthritis in 1963. He used the dorsal transverse incision to remove the MT heads and the bases of the proximal phalanx. The rationale was to decrease high foot pressures and thereby to relieve pain. Predictably, failures occur if surgery is not performed on all five MTP joints (1, 23) but poor results can also occur, without obvious cause, following an apparently comprehensive excision arthroplasty (1, 21, 23).

In 1967, Kates *et al* (12) popularised the technique of excision of the skin ellipse proximal to the plantar fat pad for a better exposure of the MT necks. Stockley *et al* (1989) reporting on a series of 35 patients with dynamic pedobarography following Kates procedure, suggested that the maximum load bearing site is the first MT (15). The plantar approach allowed us to reposition the fat pad underneath the excised metatarsal ends. We observed that the plantar approach for excision of the metatarsal heads allows dermodesis thereby bringing the toes down to the ground for more even distribution of weight transfer when walking. As a result, the first MT may have reduced concentration of load. McGarvey and Johnson (16) found that 20% of their

patients who had Keller's arthroplasty of the great toe with resection arthroplasty of the lesser toe MTPs had continued pain on weight bearing and only 59% had an increase in their ambulatory function. Recurrence of hallux valgus was reported to be higher than 50% in large series (9, 16, 24). Thomas *et al* (22) observed hallux valgus deformities in 51% patients (19/37) and plantar callosities in 30% patients (11/37). Beauchamp *et al* (3) claimed that there was no difference in pain between thirty-four feet treated with arthrodesis and thirty treated with excision, although they noted better results in terms of appearance and function following the arthrodesis. These results gradually improved in the subsequently published literature when 1st MTP arthrodesis was undertaken along with the resection arthroplasty of the lesser toes (6, 8, 14, 15). Though twenty-five of our patients had more than five years follow-up, we have not had recurrences of the deformity in the lesser MTP joints. Mulcahy *et al* (17) compared the pedobarographic results of two groups of patients. One group had a stable 1st ray (either arthrodesis or no surgery) and the other group had resection of the 1st MTP joint. The results suggested significantly higher pressures and loading of the lesser metatarsal in the resection group. The higher load on the forefoot may lead to

recurrence of deformities, pain and less satisfied patients (17).

Fusion of the 1st MTP joint improves the weight bearing along the medial column of the foot, thus protecting the transverse arch from increased pressures during ambulation, thereby reducing the incidence of pain and plantar callosities (6, 15, 17). On toe-off, after a 1st MTP resection arthroplasty, the MTP joint is forced into dorsiflexion and lateral deviation, which frequently results in a recurrence of the hallux valgus deformity, loss of 1st metatarsal loading and as a consequence, transfer pain and recurrence of plantar callosities (6, 9, 16, 24, 25). In our series, only 18% had mild painful callosities with palpable bursae. The prevalence of recurrence of plantar callosities ranges from 12% to 66% (Amuso *et al* (1) 12%, Faithful and Savill (7) 12%, Barton (2) 29%, Newman and Fitton (18) 38%, Watson (27) 66%). The fusion rate of the 1st MTP joint was 90% in our series, which compares quite favourably with previously published results (6, 15, 17). It is emphasised again that a good strong fusion of the 1st MTP joint is essential in providing a stable weight-bearing strut for the foot. In the present series, the stable strut has prevented further progression or recurrence of the deformities of the lesser toes. It is thought that non-union of the first MTP joint resulted in the loss of this strut and patients continued to suffer from pain in the forefoot due to increased load transfer on the excised lesser MT heads. Henry and Waugh (10) demonstrated an increase in weight bearing of the hallux with a resultant decrease in metatarsalgia and plantar callosities after MTP joint arthrodesis when compared with Keller's arthroplasty.

The levels of lesser metatarsal neck resection should be measured meticulously during surgery. These vary from 0.5 to 1.0 cm. In many feet the extent of resection in the fifth MT has been slightly more than the rest (range : 1.0 to 1.5 cm). This maintains the normal cascade of the transverse arch. Vahvanen *et al* (24) observed that the lateral pressure from the hallux might cause lateral deviation or malalignment of the lesser MT joints. They also suggested that an overly long MT could produce recurrent plantar callosities. Thus, suitable shortening of the lateral metatarsals may reduce the

rates of recurrence (24). It is a matter of debate whether to or not to excise the 5th MT head since the current evidence suggests that there is increased pressure under the first and fourth MTP joints and the 5th MTP joint may be spared (26).

In our series, recurrent callosities were mainly due to 1st MTP non-union and reversal of the weight bearing characteristics to the preoperative status. This occurred because the first ray was defunctioned again as a consequence of non-union and eventual recurrence of the deformity. Re-operation to re-fuse the first MTP joint was not successful in relieving symptoms in the lesser metatarsals as the transverse metatarsal harmony was lost due to shortening of the first ray with re-fusion of the first MTP joint. In retrospect, we believe that the re-fusion should have been carried out with bone grafts to restore the length of the 1st ray along either with or without re-excision of the metatarsal stumps to recreate the transverse metatarsal harmony. The other factors that were taken into account during surgery were repositioning of the plantar fat pad under the resected metatarsal heads and plantar flexion of the toes by excision of an ellipse of skin. This shortened the longitudinal skin length in the sole creating a dermodesis effect and thus resulting in plantar direction of the lesser toes.

In our series, significant pain relief and improvement in the post-operative footwear requirement as evidenced by the functional outcome scores substantiates previous observations (3, 6, 8, 15, 17).

Correction of the hallux valgus improves the cosmetic appearance of the foot as well as allowing for comfortable shoe wear. A hallux valgus angle of 20° to 30° has been recommended (6, 8, 14, 15, 24). Although the hallux valgus angle did not correlate with the clinical results (14), it may be a major determinant of development of arthritis in the interphalangeal joint (8).

Fitzgerald (8) reported an association of osteoarthritis in the interphalangeal joint of the great toe if the hallux valgus angle is less than 20°. This result was further supported by Henry and Waugh (10), who observed osteoarthritic changes in 18 great toes (21%) after fusion. They preferred arthrodesis of the hallux in valgus angle of more

than 20°. Coughlin (6) failed to identify this association in his series of patients with forefoot reconstructions. Cosmetically, the alignment of the hallux (mean of 15°) and the forefoot dimension remain acceptable to the patients in our series.

The recommended angle of dorsiflexion has varied between 20° to 30° depending on the degree of pes planus, the presence of metatarso-cuneiform joint hypermobility, and the desire to wear an elevated heel. In the current series, with the 1st MT shaft as the point of reference, the average dorsiflexion angle of fusion was 24° (range : 15 to 30).

We had wound problems in 7/67 feet, most of them superficial. Wound breakdown has been reported to be 8% with the plantar approach in the study by van der Heiden *et al* (25), 13% by Faithful & Savill (7), and 39% by Barton (2). The low incidence of wound dehiscence in this series may be because we advised heel weight bearing for the first four to six weeks followed by full weight bearing. Delay in full weight bearing is a disadvantage of the plantar approach procedure (6), but it gives adequate time for the swelling to settle and reduces the risk of wound dehiscence. One may argue that rheumatoid foot surgery requires weight bearing as soon as possible to prevent further osteopenia in an already osteopenic foot. Despite this theory we delayed weight bearing. A study by O'Connell *et al* (19) revealed that rheumatoid subjects significantly delayed and reduced forefoot loading, which minimised use of the foot as a rigid lever for push off during gait. As a result, stride lengths were shorter and gait was slower compared to nonarthritic subjects (19). Thus, we believe that four to six weeks of reduced weight bearing in an already chronically compromised foot may not alter the ongoing osteopenic process and may give adequate protection for the 1st MTP arthrodesis for a successful union.

We owe the good outcome to the metatarsal length harmonisation, stabilisation of the 1st MTP joint with successful reloading of the first ray, maintaining the normal cascade of the transverse metatarsal arch, shaping the resected MT necks with no remnant bony spike, adequate closure of the plantar skin incision and delayed post operative weight bearing.

CONCLUSION

The operation combining fusion of the first MTP joint with lesser metatarsal head excision results in excellent pain relief, improved cosmesis, and more comfort with footwear. Fusion of the first MTPJ prevents further deformities of the toes by acting as a strut and loading in the correct axis. A plantar approach allows to perform the excision arthroplasty and dermodesis of plantar fascia, thereby improving function of the toes and even distribution of weight. The plantar fat pad can be repositioned under the distal extremity of the lateral metatarsals after resection of their heads. For an improved weight-bearing and successful re-fusion surgery of the first MTP joint for non-union, it is suggested that the 1st MT length be restored with bone grafts and re-excision of the lesser metatarsal to harmonise the transverse metatarsal arch.

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