Rheumatoid Forefoot Reconstruction

Amit Amin and Dishan Singh

Contents

Keywords

Arthroplasty • Fusion • Non-surgical treatment • Pathophysiology • Rheumatoid Foot • Surgical Treatment • Surgical Options • Surgical Techniques

Introduction

Rheumatoid arthritis (RA) commonly affects the foot and ankle. The forefoot is affected most frequently and the commonly encountered deformities include hallux valgus and dorsal subluxation or dislocation of the lesser metatarsophalangeal (MTP) joints, with or without fixed toe deformity. The combination of severe deformity and poor patient physiology, makes forefoot surgery challenging, yet extremely rewarding for both patient and surgeon. Fortunately, modern disease-modifying drugs have reduced the prevalence of severe forefoot deformities.

Pathophysiology of Forefoot Pathology

Rheumatoid arthritis is characterised by chronic synovial inflammation, which results in cartilage/bone loss and joint instability. Given the small contact area of the MTP joints, gradual attrition of the supporting soft tissue structures, results in typically valgus drift of the great toe and subluxation/dislocation of the lesser toe MTPJ's with

A. Amin
St George's Hospital, Tooting, London, UK

D. Singh (✉)
Royal National Orthopaedic Hospital, Stanmore, Middlesex, UK
e-mail: dishansingh@aol.com

G. Bentley (ed.), *European Surgical Orthopaedics and Traumatology*,
DOI 10.1007/978-3-642-34746-7_253, © EFORT 2014

Fig. 1 Dorsal and plantar view of a rheumatoid forefoot. Note the painful plantar callosities associated with dislocated lesser toe metatarso-phalangeal joints and the hallux valgus with the great toe under-riding the second toe. Callosities are present on the fixed interphalangeal joint deformities

distal displacement of the plantar fat pad and plantar displacement of the metatarsal heads (Figs. 1 and 2).

The interossei and the lumbricals are the primary plantar flexors of the MTP joints, and insert onto the proximal phalanges plantar to the axis of rotation. With dorsal subluxation of the proximal phalanx, the axis moves dorsally, de-functioning both muscles [1, 2]. The extensor digitorum brevis and longus function best with the toes in a neutral or slightly flexed position, however with chronic dorsiflexion at the MTP joints, they become inefficient in relation to the flexors [2]. The plantar plate is displaced distally, with failure said to be occurring at its weaker proximal attachment [1]. The thicker cartilaginous attachment to the proximal phalanx subluxes dorsally, along with the plantar fat pad, effectively uncovering the metatarsal head.

Clinically, patients develop corns and calluses over the dorsal proximal interphalangeal joint. and underneath the metatarsal heads as a result of rubbing and increased pressure during gait (Fig. 1). Rheumatoid nodules are sometimes seen and are more common in patients who have a positive rheumatoid factor (Fig. 3). Ulcers are occasionally seen.

Non-Surgical Management

Medical therapy with non-steroidal anti-inflammatory drugs (NSAIDs), corticosteroids, disease modifying anti-rheumatic drugs (DMARDs.) and newer biological agents, allows for long-term control of the disease process.

DMARDs. and newer biological agents alter the natural history of the disease process and should be instituted at the earliest opportunity. Increasing evidence supports the use of cytokine modulators targeting tumour necrosis factor-alpha [3].

Fig. 2 Narrowing of the joint space and peri-articular erosions are associated with a hallux valgus deformity and subluxation/dislocation of the lesser toe MTPJs. Arthritic changes are present in the mid-foot joints

Many patients find comfort with athletic training shoes, which have more cushioning soles and insoles than standard shoes. Custom-made cushioning orthoses are useful to provide an arch support and can also provide relief of pressure under the metatarsal heads by having a proximal raise under the metatarsal necks. When severe toe deformities are present, wide-fitting and deep toe box adapted shoes (Fig. 4) protect prominent areas and allow more comfortable ambulation [4, 5] but the shoes are not always aesthetically acceptable.

Surgical Management

The aims of surgery are to relieve pain, maintain function, prevent or minimise deformity and reduce risks of ulceration. The whole patient should be considered. Some rheumatoid patients have very thin skin (Fig. 5), severe vasculitis and/or ulcers and surgery carry significant risks of poor healing. Anti-TNF medication should be stopped but methotrexate can be continued. Patients on high dose steroids should have additional steroids in the pre-operative period. Antibiotic prophylaxis is recommended.

The First Metatarso-Phalangeal Joint

The options include arthrodesis, excision arthroplasty and joint replacement surgery. In a small minority of patients, the great toe is not affected as severely as the lesser toes but leaving a long great toe after shortening of the lesser rays is unaesthetic and may lead to a subsequent valgus drift (Fig. 6).

Arthrodesis

Many authors including Watson [5] concluded in their early studies that patients in whom an arthrodesis of the 1st MTP joint was performed, did better than with other treatments. This has withstood the test of time, and the gold standard treatment for correction of the 1st MTP joint is an arthrodesis. Coughlin [6] reported his long-term follow-up of forefoot arthroplasty in 58 feet,

Fig. 3 Rheumatoid nodules may cause pain on ambulation

using 1st MTP joint arthrodesis and lesser metatarsal head resection. An excellent or good result (AOFAS score) was obtained in 90 % of patients. He recommended stable re-alignment of the first ray, to allow permanent correction of the hallux deformity.

Resection Arthroplasty

It is generally well accepted that resection of the 1st MTP joint (such as a Keller's arthroplasty) has little or no role to play in any forefoot arthroplasty. Poor long-term results are attributed to de-functioning of the first ray, with recurrent hallux valgus and transfer metatarsalgia, plantar keratoses, and weakened push-off [7–12]. Henry and Waugh's [13] studies evaluated pre- and post-operative weight-bearing in two groups of patients treated for hallux valgus with either excision arthroplasty or arthrodesis: increased 1st MTP joint weight-bearing was reported in 80 % of the arthrodesis group compared to only 40 % of the excision group. More recent pedobarographic studies support these early findings [6, 14–16].

Replacement Arthtoplasty

Another option, replacement arthroplasty, in theory maintains flexibility as compared to arthrodesis, and provides more stability than resection.

Fig. 4 Custom- made insoles and wide-fitting shoes with a deep toe box may enable more comfortable walking

Fig. 5 Very thin skin and vasculitis in a patient with a rheumatoid foot

Fig. 6 Failure to address the great toe at the time of addressing the lesser toe MTPJ's has led to a relatively long great toe and hallux valgus

However, significant complication rates have been reported [17, 18], notably implant failure (as a result of wear and osteolysis), cock-up toe deformity and transfer metatarsalgia. Whilst a successful outcome may be achievable in the older rheumatoid patient, the complications reported and the complexity of salvage surgery, suggest caution should be exercised when treating the rheumatoid 1st MTP joint deformity. Fracture and/or fragmentation however does not necessarily dictate a poor result or necessitate revision surgery [19, 20]. The implant acts as a spacer in

this scenario and a fibrous reaction provides joint stability (mimicking a fusion), imparting pain relief [21].

Correction of hallux deformity will be discussed later in the chapter.

The Lesser Metatarso-Phalangeal Joints

There are many options with little difference in patient satisfaction. Dorsal transverse, dorsal longitudinal, plantar transverse or combined incisions may be used to resect the metatarsal heads or the bases of the proximal phalanges or both.

Resection of Lesser Toe Metatarsal Heads

Based upon Coughlin's long-term follow-up study, resection of the lesser MTP joints has been considered the standard of care in rheumatoid forefoot reconstruction (6). Reconstitution of the metatarsal parabola into a smooth arc redistributes forefoot stresses, and protects against recurrence of pain and deformity.

Resection of the Base of the Proximal Phalanges

Operations such as the Stainsby procedure [22] took this concept one step further by suggesting preservation of the metatarsal head with joint arthroplasty (excision of proximal half of proximal phalanx and interpositional tenodesis of the extensor to the flexor tendon, with relocation of the plantar plate and fat pad). Few long-term outcome studies have been published, and Stainsby reported an 88 % excellent or good result, in a study of 20 ft followed for an average of 20 months.

Dorsal, plantar or combined approaches to the lesser MTP joints using either transverse or longitudinal incisions have been described. The combined approach originally described by Fowler [23] is now historical. The Kates, Kessel and Kay plantar approach [24] provides excellent direct visualisation of the metatarsal heads, and the ability to directly re-locate the plantar fat pad. There is however an increased risk of keratotic scar formation and wound-healing complications: Barton reported a 46 % rate of wound healing complications with the plantar wound when performed as part of Fowler's original reconstruction [25].

Preservation of Metatarsal Heads

When the metatarsal head is intact, joint-preserving surgery can be performed using the double-cut shortening Weil osteotomy. Bolland et al. [26] reported their results of 1st MTP joint arthrodesis and lesser metartarsal Weil osteotomies in 26 ft followed for an average of 26.2 months. Twenty-three feet were reported as having an excellent or good result, although a 12 % rate of recurrent metatarsalgia was noted, requiring revision shortening or resection [27]. Metatarsal head preservation offers greater revision options if faced with recurrent deformity in the future.

Pan-Metatarsal Head-Preserving Surgery

Barouk and Barouk [28] proposed pan-metatarsal head-preserving surgery. In a series of 60 patients, 55 underwent a SCARF corrective osteotomy and 5 had an arthrodesis. The lesser metatarsals were treated with double-cut Weil Osteotomies when the quality of the metatarsal head allowed.

Their principles include shortening of all metatarsals respecting the MS (metatarsal shortening) point as described by Maestro et al. [29]. This represents the most proximal aspect of the proximal phalanx of the most deformed ray. The 1st ray and 2nd ray are shortened to the MS point, followed by shortening of the 3rd ray (3 mm), 4th ray (6 mm) and 5th ray (12 mm). Little support exists for this approach in the literature, and further publications are awaited.

Lesser Toe Deformity

Once the MTP joints have been reduced and decompressed, lesser toe deformity should be addressed. Flexible deformities can be corrected with soft-tissue re-balancing, such as a

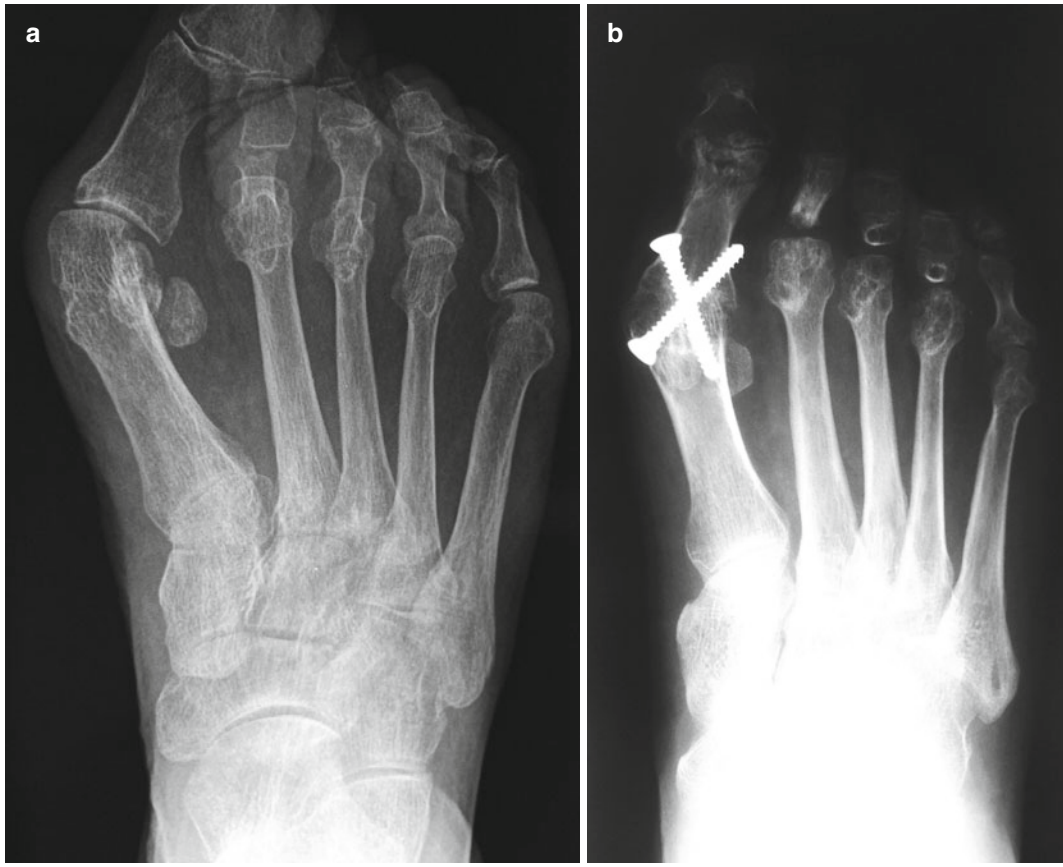

Fig. 7 Pre-operative (**a**) and 4 month post-operative (**b**) radiographs after great toe MTPJ fusion and Stainsby procedures of the 2nd, 3rd and 4th toes

Girdlestone flexor to extensor transfer. Joint arthroplasty or arthrodesis is usually required for rigid deformities. Some advocate reserving arthrodesis for revision surgery and instead performing a joint resection with interpositional extensor to flexor tenodesis (9).

Authors' Preferred Method

We perform a 1st MTP joint fusion on all patients undergoing rheumatoid forefoot reconstruction. The procedure reliably and permanently eliminates forefoot deformity, and is well supported in the literature as the gold standard of treatment. We typically use a trans-articular screw and either a second screw or a dorsal plate for fixation, depending on the bone quality. For the lesser MTP joints we individualise treatment based on the severity of the disease. Our philosophy is to try and preserve the metatarsal head if possible, and therefore we perform Weil's osteotomies for patients with early disease. As the disease progresses, we opt to perform the Stainsby procedure (Fig. 7a, b), on the premise that preservation of the metatarsal head may improve function. Additionally, an excisional arthroplasty, can be performed should the index procedure fail to relieve forefoot metatarsalgia.

Surgical Technique

A medial or dorsal approach to the 1st MTP joint can be utilised. A dorsal approach allows direct access to the joint for preparation and ease of

application of a dorsal plate. We prefer the medial approach, as it gives excellent exposure of the hallux deformity, allows one to plicate or excise medial capsule as necessary and allows the plantar trans-articular screw to be placed comfortably. Any pressure areas/ulcers can be debrided and excised at the same time, incorporating them into the exposure. A medial approach also allows for a wider skin bridge when performing dorsal longitudinal incisions over the lesser MTPJs. Both the surgical approach and the resection need to be flexible; Fig. 3 illustrates a case where a plantar incision was preferred to excise the plantar rheumatoid nodule as well as the lesser metatarsal heads.

The procedure described here is similar to the procedure described for hallux rigidus in chapter ▶ "Organisational Aspects of Trauma Care". Through a medial mid-central approach, the dorsal cutaneous nerve to the great toe is protected, and full-thickness flaps are developed down to the capsule of the 1st MTP joint. A longitudinal capsulotomy is performed and the joint exposed. Any remaining cartilage is debrided. We prefer to avoid the use of custom-made reamers in patients with rheumatoid arthritis due to the poor bone quality, and debride the joint carefully with rongeurs and osteotomes to expose the subchondral bone. An amount of shortening is incorporated in the arthodesis as excision arthroplasty of the lesser toes will lead to an inappropriately long great toe if length is preserved (see Fig. 6). Thereafter, the subchondral bone is petallised to increase the surface area exposed and promote the egress of blood and its associated factors and cells and encourages healing of the arthrodesis. The toe is then positioned in the appropriate position for fusion using a flat surface to simulate weight-bearing as described in chapter ▶ "Organisational Aspects of Trauma Care". The toe is aligned appropriately and stabilised temporarily with a Kwire. Formal fixation is not applied at this stage, as the bone quality is usually poor and correcting the lesser rays may compromise this fixation.

For lesser ray correction, two dorsal longitudinal intermetatarsal incisions are used, one between the 2nd and 3rd toes, and one between the 4th and 5th toes. Generous incisions are made 4–5 cm. in length to avoid over-retraction of the delicate soft tissues, and to allow adequate exposure of the MTP joints. The extensor digitorum longus and brevis tendons are exposed and cleared of soft tissue. Thereafter a longitudinal capsulotomy of the MTP joints is made, releasing the capsule from both the proximal phalanx and metatarsal head. At this stage the metatarsal head is inspected and a decision made regarding whether to perform a shortening procedure, or proceed to a Stainsby reconstruction or a metatarsal head resection.

With preservation of the metatarsal head, we use a double-cut Weil osteotomy. The first cut into the metatarsal head is made parallel to the plantar surface of the foot. Prior to exiting the osteotomy proximally, a second cut is made and completed inferior to the first cut to create a double resection. The first osteotomy is then completed and the wedge of bone removed. Whilst we try to shorten the metatarsals according to the Maestro line, we often find that the metatarsal head decompresses to its preferred position on completion of the osteotomy. Barouk et al. [28] have emphasised that significant shortening is preferred in order to prevent stiffness and/or recurrence of MTPJ subluxation. The double cut ensures that with shortening the metatarsal head does not assume a plantarised position. The MTP joint reduces as the metatarsal head shortens, and the osteotomy is fixed with a small headless compression screw. This is repeated across all the MTP joints, although the 5th MTP joint rarely requires shortening.

If we decide to perform the Stainsby procedure, the metatarsal head is preserved. Full plantarflexion of the lesser MTPJ allows for sharp dissection of the plantar capsule from the base of the proximal phalanx and this sharp dissection is continued circumferentially to expose at least the proximal half of the proximal phalanx (Fig. 8a–d) and the bone is then removed by use of a bone cutter. If a fixed flexion deformity of the PIPJ is present, we excise two third of the proximal phalanx. Care should be taken not to divide the long flexor which is situated close to the plantar aspect of the proximal phalanx.

The displaced fat pad and plantar tissues are then released from the dorsum of the neck of the

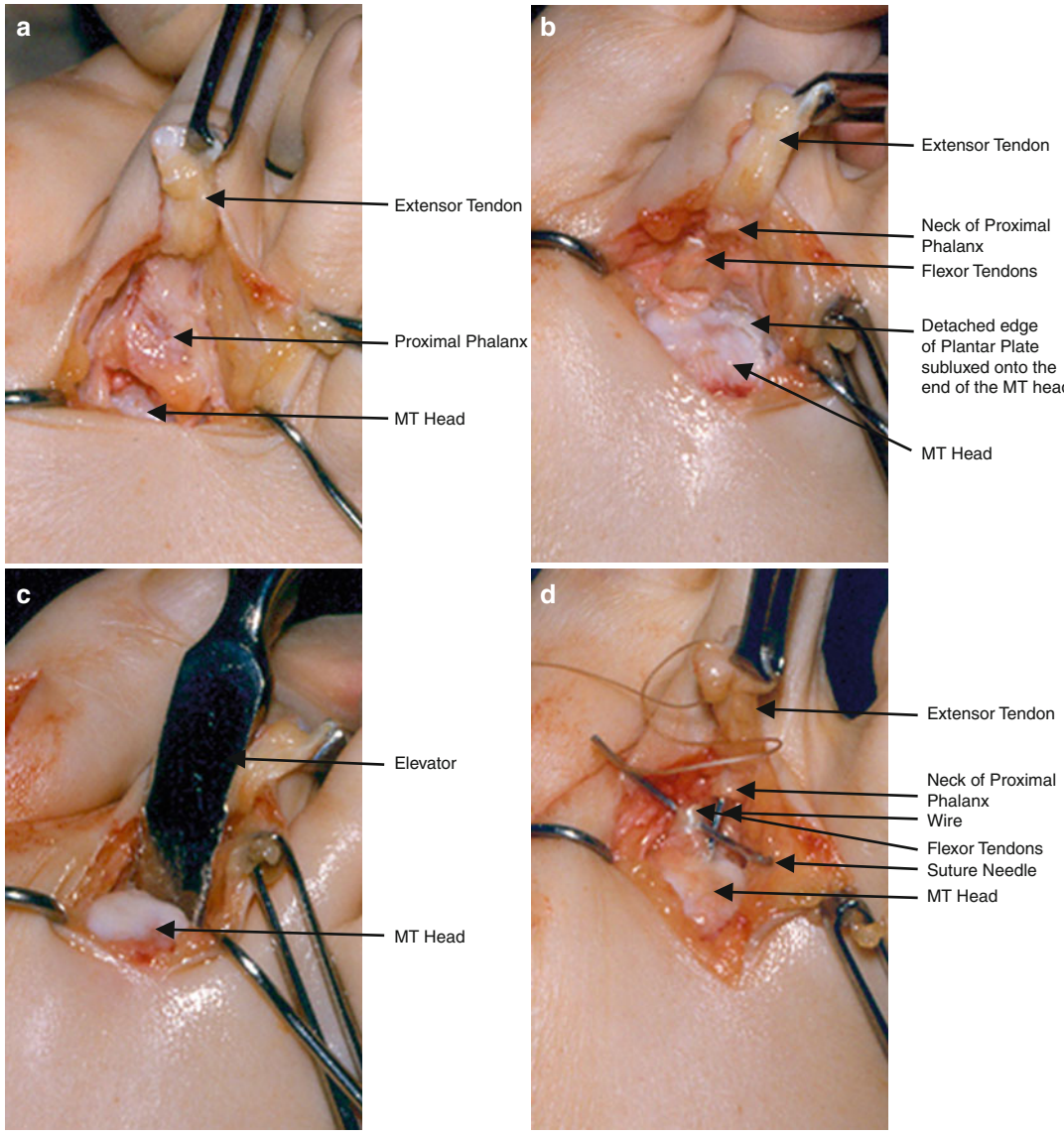

Fig. 8 Steps of the Stainsby procedure of the lesser toes. Courtesy of Mr Peter Briggs. (**a**) The extensor tendon to the lesser toe has been divided proximally and reflected distally to expose the proximal phalanx and the subluxed MTP Joint. (**b**) The proximal phalanx has been divided through its neck and the proximal part resected, exposing the dorsally subluxed plantar plate over the metatarsal head and the flexor tendon. (**c**) An elevator has been introduced between the plantar plate and the metatarsal head to free and re-position the plantar plate under the metatarsal head, thereby also relocating the plantar fat pad. (**d**) The toe is stabilized with an intramedullary K-wire advanced into the metatarsal head; a vicryl suture is passed through the long flexor tendon which is then sutured to the extensor tendon

lesser metatarsal and transferred back to the plantar aspect of the head of the metatarsal plate using a Macdonald retractor or McGlamry dissector. A K-wire is inserted from the tip of the toe into the metatarsal head with the toe in a straight position and the proximal limb of EDL is then tenodesed to the FDL at the MTP joint level. (Fig. 8c, d)

If severe erosions and bone loss are evident in one or more metatarsal heads, we perform a

Fig. 9 Three months after Stainsby procedures of the lesser toes and fusion of the great toe MTPJs. The toe swelling resolve but the lesser toes remain short

resection of all the lesser metatarsal heads, Exposure or each MTP joint is carried out as above and each metatarsal head is excised with a saw blade in turn. The saw blade is orientated parallel to the plantar aspect of the foot in order not to leave a sharp inferior bone spike and the bone is then smoothed with a rongeur and rasp to prevent later plantar callosities. Fowler [23] first recognised that patients in whom the metatarsal heads were irregularly trimmed often returned with pain. The EDL can be tenodesed to the FDL at the MTP joint level, or lengthened as desired. Care must be taken to preserve a parabola in the relative lengths of the metatarsals and use of an image intensifier to perform the saw cuts is advised as once again plantar callosities may develop if one metatarsal is left relatively long.

Having corrected the deformity at the MTP level of the lesser toes, with any of the methods above, attention is directed to the PIP joint (except for the Stainsby procedure where the PIPJ deformity is addressed by preserving the PIPJ and resecting more of the proximal phalanx). For mild deformities an osteoclasis can be performed, however often the deformity is more severe and this requires an arthrodesis.

We utilise an elliptical incision over the dorsum of the PIP joint. This skin is excised and the dissection taken directly through the extensor hood and tendon. The capsule is excised and the PIP joint exposed. The collateral ligaments are incised and the joint surfaces resected. Special attention should be directed to the plantar aspect of the joint, which when adequately debrided should allow the PIP joint to reduce. A 1.6 mm K-wire is used to transfix the PIP joint. The Kwire is often driven into the metatarsal head to hold the toe in the correct position, as there may be a tendency for the toes to sit dorsiflexed despite the soft-tissue and bony decompression.

Finally, attention is drawn back to the 1st MTP joint, The position and length of the great toe are again checked with a flat surface to simulate weight-bearing and any adjustments made. A partially-threaded cannulated compression screw can be inserted in any direction but our preference is to direct it from distal to proximal utilising the shoulder/flare on the proximal phalanx to gain compression. The position is checked on the image intensifier and either a dorsal locking plate or another screw is then applied. Numerous products are available on the market; locking screws are preferred when the bone quality is poor.

Closure is performed in layers and we prefer to use interrupted nylon for skin closure in the thin skin of rheumatoid patients. A bulky dressing is

applied and the foot is elevated. Post-operatively, we use a heel-weight-bearing shoe for 6 weeks, as for hallux valgus surgery, as this off-loads the forefoot sufficiently to allow healing of the arthrodesis, usually within 6 weeks. Sutures are removed at 2 weeks and the K-wires in the lesser toes are removed in the outpatient clinic 6 weeks post-operatively. Radiological union is confirmed before allowing patients to start using wide-fitting athletic trainers from 6 weeks. However it is often 3–4 months before the swelling starts to settle (Fig. 9), and the overall recovery period is 6–12 months post-surgery.

References

1. Myerson MS. Arthroplasty of the second toe. Semin Arthroplasty. 1992;3:31–8.
2. Stainsby GD. Pathological anatomy and dynamic effect of the displaced plantar plate and the importance of the plantar plate-deep transverse metatarsal ligament tie-bar. Ann R Coll Surg Engl. 1997;79:58–68.
3. Pieringer H, Stuby U, Biesenbach G. Patients with rheumatoid arthritis undergoing surgery: how should we deal with antirheumatic treatment? Semin Arthritis Rheum. 2007;36:278–86.
4. Woodburn J, Barker S, Helliwell P. A randomized controlled trial of foot orthoses in rheumatoid arthritis. J Rheumatol. 2002;29:1377–83.
5. Watson MS. Long-term follow-up of forefoot arthroplasty. J Bone Joint Surg. 1974;56-B:527–33.
6. Coughlin MJ. Rheumatoid forefoot reconstruction. A long-term follow-up study. J Bone Joint Surg. 2000;82-A:322–41.
7. Fuhrmann RA, Anders JO. The long-term results of resection arthroplasties of the first metatarsophalangeal joint in rheumatoid arthritis. Int Orthop. 2001;25:312–6.
8. McGarvey SR, Johnson KA. Keller arthroplasty in combination with resection arthroplasty of the lesser metatarsophalangeal joints in rheumatoid arthritis. Foot Ankle. 1988;9:75–80.
9. Molloy AP, Myerson MS. Surgery for the lesser toes in rheumatoid arthritis: metatarsal head resection. Foot Ankle Clin North Am. 2007;12:417–33.
10. Patsalis T, Georgousis H, Gopfert S. Long-term results of forefoot arthroplasty in patients with rheumatoid arthritis. Orthopedics. 1996;19:439–47.
11. Trieb K. Management of the foot in rheumatoid arthritis. J Bone Joint Surg. 2005;87-B:1171–7.
12. van der Heijden KW, Rasker JJ, Jacobs JW, Dey K. Kates forefoot arthroplasty in rheumatoid arthritis. A 5-year follow-up study. J Rheumatol. 1992;19:1545–50.
13. Henry APJ, Waugh W. The use of footprints in assessing the results of operations for hallux valgus. A comparison of Keller's operation and arthrodesis. J Bone Joint Surg. 1975;57-B:478–81.
14. Beauchamp CG, Kirby T, Rudge SR, Worthington BS, Nelson J. Fusion of the first metatarsophalangeal joint in forefoot arthroplasty. Clin Orthop Relat Res. 1984;190:249–53.
15. Mann RA, Thompson FM. Arthrodesis of the first metatarsophalangeal joint for hallux valgus in rheumatoid arthritis. J Bone Joint Surg. 1984;66-A:687–92.
16. Mulcahy D, Daniels TR, Lau JT, Boyle E, Bogoch E. Rheumatoid forefoot deformity: a comparison of 2 functional methods of reconstruction. J Rheumatol. 2003;30:1440–50.
17. Granberry WM, Noble PC, Bishop JO, Tullos HS. Use of a hinged silicone prosthesis for replacement of the first metatarsophalangeal joint. J Bone Joint Surg. 1991;73-A:1453–9.
18. Rahmann H, Fagg PS. Silicone granulomatous reactions after first metatarsophalangeal joint hemiarthroplasty. J Bone Joint Surg. 1993;75-B:637–9.
19. Cracchiolo A, Weltmer J, Lian G. Arthroplasty of the first metatarsophalangeal joint with double-tem silicone implant. J Bone Joint Surg. 1992;74-A:552–6.
20. Hanyu T, Yamazaki H, Ishikawa H, et al. Flexible hinge toe implant arthroplasty for rheumatoid arthritis of the first metatarsophalangeal joint: long-term results. J Orthop Sci. 2001;6:141–7.
21. Senthil Kumar C, Holt G. Hallux metatarsophalangeal arthroplasty in the rheumatoid forefoot. Foot Ankle Clin North Am. 2007;12:405–16.
22. Briggs PJ, Stainsby GD. Metatarsal head preservation in forefoot arthroplasty and the correction of severe claw toe deformity. Foot Ankle. 2001;7:93–101.
23. Fowler AW. A method of forefoot reconstruction. J Bone Joint Surg. 1959;41-B:507–13.
24. Kates A, Kessel L, Kay A. Arthroplasty of the forefoot. J Bone Joint Surg. 1967;49-B:552–7.
25. Barton NJ. Arthroplasty of the forefoot in rheumatoidarthritis. J Bone Joint Surg. 1973;55-B:126–33.
26. Barouk LS. Weil's metatarsal osteotomy in the treatment of metatarsalgia (in German). Orthopade. 1996;25:338–43.
27. Bolland BJRF, Sauve PS, Taylor GR. Rheumatoid forefoot reconstruction: first metatarsophalangeal joint fusion combined with Weil's metatarsal osteotomies of the lesser rays. J Foot Ankle Surg. 2008;47:80–8.
28. Barouk LS, Barouk P. Joint-preserving surgery in rheumatoid forefoot: preliminary study with more than two year follow-up. Foot Ankle Clin North Am. 2007;12:435–54.
29. Maestro M, Besse JL, Ragusa M, Berthonnaud E. Forefoot morphotype study and planning method for forefoot osteotomy. Foot Ankle Clin. 2003;8:695–710.