Management of the foot in rheumatoid arthritis

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Rheumatoid arthritis is an autoimmune-mediated, systemic, inflammatory disease which is chronic and progressive in nature. It is the most common form of inflammatory arthritis and affects 1% of men and 3% of women. Diagnostic criteria, as defined by the American Rheumatism Association, are morning stiffness, swelling, nodules, positive laboratory tests, and radiological findings. The course of rheumatoid arthritis varies greatly from a mild, self-limiting disease to a severe destructive rapidly progressing variant. It can affect any synovial joint, but at onset it most often involves the small joints of the hand, with ulnar deviation and subluxation of the metacarpophalangeal joints, and the foot. The aetiology is unclear, but is probably related to a T-lymphocyte-mediated immune response to autoantigens produced by activation via the HLA-II locus. It is usually polyarticular and destroys the articular cartilage and surrounding soft tissues leading to severe deformities.

Ingrowth of pannus and cytokines destroy the cartilage and lead to death of chondrocytes. Subcutaneous nodules are strongly associated with a positive serum rheumatoid factor and are found in 20% of patients. Laboratory findings include an elevated ESR and C-reactive protein level and a positive rheumatoid factor in approximately 80% of patients. Systemic manifestations include rheumatoid vasculitis, pericarditis, and pulmonary disease with pleurisy, nodules and fibrosis. Popliteal cysts are common and may mimic venous disease. Still’s disease has an acute onset with splenomegaly, fever and rash, whereas Felty’s syndrome is combined with leucopaenia and splenomegaly.

The goals of treatment are the control of pain and the preservation of movement. A multidisciplinary approach is necessary which involves rheumatologists, physicians, occupational therapists and orthopaedic surgeons. The pyramid treatment approach starts with the use of non-steroidal anti-inflammatory agents, progresses to steroids and may include cytotoxic drugs, e.g. methotrexate, or ‘biologicals’ (drugs which modify the immune system by blocking cytokines or their receptors, such as interleukin-1 or tumour necrosis factor alpha). The inflammatory process is not only characterised by soft-tissue destruction, tenosynovitis, arthritis and muscular weakness, but also by radiological changes which are characteristic and include narrowing of the joint space, cysts and periarticular osteoporosis. Progressive destruction results in bony ankylosis. The severity is assessed by different scoring systems, such as the Lars classification which correlates with the degree of articular destruction.

Weight-bearing radiographs are necessary to evaluate any deformity. The lateral weight-bearing view of the foot should include the ankle and may show involvement of the subtalar, talonavicular and calcaneocuboid joints. Alignment of the forefoot to the hindfoot can readily be estimated, because a line drawn in the longitudinal axis of the first metatarsal should pass straight along the longitudinal axis of the talus. An anteroposterior (AP) weight-bearing view of the foot may show destruction of the forefoot and degeneration of the talonavicular and calcaneocuboid joints. Talar tilt, which indicates involvement of the ankle is best seen on the AP weight-bearing view of the ankle.

Surgical treatment includes preservation of joints by radioactive isotope synovectomy, surgical synovectomy or axial correction in Lars stage 1 or 2, and arthrodesis, resection arthroplasty or total joint arthroplasty in Lars stage 3 or higher. The forefoot is commonly the most painful area and it is usually the first to be operated upon, but if the forefoot and hindfoot are equally involved the hindfoot should be corrected first. If skin is ulcerated or infected, this should be managed by resection of a proximal interphalangeal joint or by treatment of an infected nail. Extensive bilateral surgery is not advised because the patient needs one foot to rely upon. Simultaneous surgery on the hindfoot...
and forefoot should also be avoided because of the risk of extensive swelling and delayed wound healing. Major hand or wrist surgery should not be combined with extensive reconstruction of the foot because the patient will not be able to use walking aids. The cervical spine should always be investigated because of instability of C1/2 and possible spinal compression and, similarly, interference with mobility due to lumbar disease should be excluded. Systemic issues related to rheumatoid arthritis must be taken into consideration before surgery; the skin is always thin, bruises easily and ulcers are common. A high incidence of post-operative complications can be avoided by discontinuing immunosuppressive drugs peri-operatively and using steroids.8,9

The systemic character of the disease needs a broad approach which should include assessment of the knees and hips, since changes in these joints can affect the whole lower limb. The main objective is a stable comfortable weight-bearing foot.

This review deals with the conservative and operative treatment of the forefoot and hindfoot.

Conservative treatment
Some feet have areas which are painful because of prominent metatarsal heads, nodules or bony prominences due to exostoses or instability. Prescription footwear can minimise pain by relieving pressure. It should decrease the vertical pressure and reduce shear, the horizontal movement of the foot within the shoe. Shear and shock absorption are particularly important in patients with rheumatoid arthritis, because they have commonly lost fatty tissue, have a hypersensitive skin and inflamed, hypermobile joints.

A custom-made orthosis should be made from an impression of the patient’s foot for total contact. It should have two layers, the shell which is the top layer in contact with the foot and the posting which is the material between the shoe and the shell. Total contact distributes pressure evenly over the entire plantar surface, relieves pressure from painful areas and accommodates and supports deformities. Additional layers between the shell and the posting, such as a sponge rubber metatarsal pad or viscoelastic material under the heel can be added. Flexible deformities need a more rigid material in the posting, to control and limit movement of the joint whereas rigid deformities need soft materials in the shell to achieve comfort.10-13

Although many materials have been used in the last 30 years, there are three basic types: soft, semiflexible and rigid. Soft materials are made from cross-linked polyethylene foams and are used in the shell. Semiflexible total contact orthoses are made from cork or leather and provide more support. Maximum support is given by rigid orthoses made of thermoplastic polymers. A randomised study compared the treatment of metatarsalgia in rheumatoid patients with supportive shoes with or without semirigid orthoses. Pain was relieved in the group provided with orthoses.10 Another study reported a significant reduction in pain and disability by custom-designed orthoses and recommended early use.11

External modifications to the shoe are prescribed for a variety of deformities. A rocker sole restores lost movement. Wedges can be added to the heel medially for a pronated foot or laterally for varus deformity to redirect weight-bearing. Stabilisation can be achieved by medial or lateral flares to part of the heel. In the case of severe deformity or instability, a custom-made shoe from a model of the foot is necessary to achieve the best support.12 Shoes do not stop the inflammation and progressive axial deviation will limit the success of conservative treatment.

Operative treatment
The forefoot. The foot is commonly affected early with a prevalence of up to 90% for the metatarsophalangeal joints. In 15% of patients the forefoot shows the first manifestation of the disease. Usually, both feet are involved, although the resulting deformities may not be symmetrical because of differences in weight-bearing and inflammation.7 These result in severe disability. Painful deformities lead to decreased mobility which diminishes the quality of life. These are triggered by high levels of synovial proteinases and collagenases which weaken the integrity of capsular and collateral ligaments.

The typical rheumatoid forefoot has hallux valgus, plantar displacement of the metatarsal heads and a varus position of the little toe. Subluxation or dislocation of the proximal phalanges dorsally on the metatarsal heads is common (Fig. 1). Migration of the plantar fat pad distally to beneath the hyperextended toes leads to large bursae. The intrinsic-extrinsic muscle balance is lost and fixed clawing of the lesser toes develops. This causes pain in the toe box of the shoe and may lead the patient to seek medical advice. Lateral pressure on the foot, the so-called Gaensslen test, is very painful and the typical shape has been called
“pied rond” or “pied douloureux des rhumatisants” by Leliévre. Deformities of the forefoot are often caused by arthritis of the hindfoot which results in external rotation of the first metatarsal, instability of the tarsometatarsal joints and pronation of the great toe. These increase hallux valgus and its displacement under the second toe. Elevation of the first metatarsal and fixed supination of the forefoot produces a valgus position of the hindfoot. In the presence of a broadened forefoot, with deformity of the great toe and claw toes, symptoms will persist independent of inflammatory activity. Painful, thickened calluses develop beneath the prolapsed metatarsal heads, dorsally over the proximal interphalangeal joints and medially over the first metatarsal head (Fig. 2a). Correction of the forefoot should achieve stable realignment, improve the patient’s walking and allow easier fitting of a shoe. A number of procedures have been described for reconstruction of the forefoot. Unfortunately, the studies are limited by the duration of follow-up, the small number of patients, lack of comparison of pre- and post-operative radiographs and of objective post-operative findings. Few studies compare the outcome of different methods to assess mid- and long-term results. For the first ray, resection arthroplasty of the metatarsal head, the proximal phalanx or both, arthroplasty and arthrodesis have been described. Amputation of all toes has also been reported but is only regarded as of historical interest now. In addition to Hoffman’s original operation in 1912, numerous variations of resection arthroplasty of the metatarsal heads have been described, Hueter and Mayo favoured a partial resection of the metatarsal head, McGarvey and Johnson reported the Keller resection of the base of the proximal phalanx and Clayton combined resection of the metatarsal head and the proximal phalanx via a dorsal approach. Complete resection of the proximal phalanx in rheumatoid arthritis is no longer favoured by most authors because of a high rate of recurrent deformity, relative lengthening of the first ray when combined with resection of the lesser metatarsal heads, weakened strength during the push-off phase and less satisfaction and relief from pain.

The development of a stiff first metatarsophalangeal joint after resection arthroplasty was observed in some patients. Long-term results report a deterioration of the primarily favourable good short-term results of resection arthroplasty with or without interposition over time. However, resection arthroplasty permanently disrupts toe function and gait with a high incidence of recurrent hallux valgus, metatarsalgia, plantar calluses and pain. The concepts and principles of reconstruction of the forefoot have been described by Clayton. These have been modified over time with regard to the incision, plantar or dorsal, the treatment of the first ray, the degree of resection and method of stabilisation. Each method has advantages and disadvantages. Pedobarographic studies of the distribution of plantar pressure after resection arthroplasty have reported reduced or absent pressure across the toes with the transmission of the weight-bearing load to the ‘pseudo-heads’ with nearly identical pressure under the lesser toes and the first ray. The result is an overload of the lesser metatarsal heads. Resection arthroplasty of the first ray has frequently been recommended in association with resection arthroplasty of the lateral part of the forefoot. Although high patient satisfaction was reported, there are some limitations. Resection arthroplasty of the lateral metatarsophalangeal joints weakens support for the hallux. In the long-term deterioration, recurrent deformity, pain and an unacceptable cosmetic appearance have been reported. One study described a higher incidence of loss of ground contact and plantar callus after a Keller’s procedure and deterioration after the Hueter-Mayo procedure. Comparison of arthrodesis and Keller’s procedure showed that better load-bearing of the first ray was achieved in
arthrodensis with no difference regarding satisfaction.\textsuperscript{39} In the largest studies of resection arthroplasty, a high rate of recurrence and loss of correction of more than 50\% were found. The unstable first ray resulted in a progressive malalignment of the lesser toes leading to metatarsalgia, recurrent plantar keratoses and lateral deviation.\textsuperscript{15,24,30-32,40,42} There have been two large retrospective long-term follow-up studies of arthrodesis of the first ray.\textsuperscript{37,42} Coughlin\textsuperscript{37} described 47 feet with a mean follow-up of 74 months. Fusion was obtained in all patients without a poor result. The angle of hallux valgus was corrected to a mean of 20\degree with a mean dorsiflexion angle of 22\degree. Arthritis of the interphalangeal joint was rated as severe at follow-up in eight patients, three required surgical treatment, and did not correlate with the post-operative angle of hallux valgus, but with an angle of arthrodesis with dorsiflexion of less than 20\degree. It was concluded that fusion of the first ray maintained alignment and protected the hallux and the lesser metatarsophalangeal joints from recurrent deformity and subsequent metatarsalgia. Mulcahy et al\textsuperscript{42} compared the results of two different forefoot procedures, presenting a stable first ray (52 feet) and resection arthroplasty (86 feet). The latter group had a significantly longer follow-up (102 vs 36 months) and was older, but no differences in the SF-36 and WOMAC scores were observed. The stable group had a significantly increased walking distance, higher satisfaction and less pain from the foot. Patients were followed pedobarographically with a more favourable outcome for the stable group with a physiologically greater distribution of weight-bearing forces through the first and lesser toes. Complications occurred in 11\% and a revision operation was required in 10.6\%, compared with 12.9\% and 30\% respectively, including removal of metal in Coughlin’s study.

For the lesser toes, the amount of resection is controversial. Resection of the metatarsal head and the base of the proximal phalanx has been advocated, but this abolished function.\textsuperscript{42-44} Some authors recommend resecting only that amount which is necessary to correct deformity, improve contact and increase the distribution of weight through the lesser toes. Transient stabilisation with Kirschner (K-) wires is recommended in order to decrease the risk of recurrent deformity and whatever method is used, it is important to achieve a smooth arc of resection of the lesser metatarsal heads with meticulous debridement of bone and synovium. This should prevent the development of metatarsal exostoses and recurrent plantar keratoses. Another integral part of realignment of the forefoot is the correction of fixed hammer-toe deformities so as to maintain the relationship of the metatarsophalangeal joints in an arc.

The distal ends of each metatarsal should be left slightly shorter than the adjacent one. The treatment of hammer-toe deformities depends on the deformity. For moderate deformities closed manipulation including osteoclasis has been described.\textsuperscript{18,33} Resection of the base of the proximal phalanx is only an indirect correction, which leaves the proximal interphalangeal joint in hyperextension. This may lead to recurrent hyperkeratoses and deformity in 20\% to 60\% of patients.\textsuperscript{24,43} Other methods include resection of the distal proximal phalanx or arthrodesis of the proximal interphalangeal joint. Stabilisation by K-wires is recommended for three to six weeks.

An alternative to resection of the metatarsal heads is preservation of the heads in combination with Weil’s shortening osteotomy, synovectomy and lengthening of the extensor tendon.\textsuperscript{45} The Weil osteotomy is an oblique division of the metatarsal head and neck with controlled shortening and screw fixation. A proximal osteotomy is not helpful because synovectomy is necessary. Preservation of the metatarsal heads is not a routine procedure for patients with rheumatoid arthritis, but has been used for transfer metatarsalgia. A study on 29 feet gave satisfactory mid-term results and no requirement for revision (Fig. 2b).\textsuperscript{46}

The aim of correction of the forefoot should be a well-aligned, stable, weight-bearing foot. In order to achieve this arthrodesis of the first ray in combination with correction of hammer toes and resection or shortening of the metatarsal heads is appropriate.

The hindfoot. The joints of the midfoot are involved in 40\% to 60\% of rheumatoid patients and the ankle and subtalar joints in 30\% to 60\%. Deformities of the hindfoot can be the most important barrier to walking. Successful reconstruction of the hip and knee has provided new standards in the rehabilitation of the lower limb. A painful, deformed foot limits walking and changes the mechanical axis and alignment of the limb so that correction is necessary.\textsuperscript{47} The midfoot is not commonly involved, but, if it is, the talonavicular and naviculo-cuneiform joints are most often affected causing pes planus and a valgus deformity of the hindfoot, which in turn causes abduction of the midfoot. In the hindfoot pes planovalgus is common. It is caused by involvement of the talonavicular joint, with resultant pronation and evasion of the foot. An insufficient or damaged tibialis posterior tendon, dysfunction of the capsule and weakening of collateral ligaments (deltoid, calcaneonavicular, talonavicular) increase the collapse of the longitudinal arch. With weight-bearing the talus is forced forwards and medially. This interplay between painful alteration of the joints of the medial column in both the hindfoot and forefoot is the key to understanding the problem. Persistent weight-bearing irreversibly stretches the supporting ligaments and tendons, resulting in a valgus hindfoot. If this is untreated it becomes fixed and requires correction by a triple arthrodesis. Early surgical intervention while the foot is still flexible should prevent this progression.

Instability of the ankle increases with progressive dislocation of the talus. Pain in the hindfoot may be localised to the lateral side of the ankle when associated with valgus and lateral impingement. Most patients with involvement of the hindfoot complain of ill-defined pain with restriction of walking on uneven ground. Although the pain is
mechanical in nature, paraesthesiae may result from entrapment of a peripheral nerve or peripheral neuropathy. The tarsal tunnel, with the posterior tibial nerve, is often compressed by synovitis. Although the incidence of tenosynovitis of the foot is relatively lower than that of the hand it may compromise the function of the tendons. Dysfunction of the tendon of tibialis posterior is shown by oedema and swelling with inability to perform a single heel-rise. Synovitis with swelling but little deformity is an early feature.

**Synovectomy.** At first synovitis should be treated conservatively by immobilisation and physical treatment. Early stages without involvement of articular cartilage can be treated by radioactive synovectomy so as to avoid recurrent effusions. If there is no resolution immobilisation with a cast may be necessary. If this fails operative synovectomy is necessary to avoid rupture and instability of the tendons. The proliferative synovium must be excised to decompress the tendons. A curved incision is made behind the medial malleolus for synovectomy of the tendons of tibialis posterior, hallux and digitorum longus and an additional lateral incision for the lateral peroneal tendons, if necessary. If there is synovitis of the ankle an arthroscopic or an open procedure may be done at the same session. A recent study has shown improvement over four years in 40% of patients and another suggests that a change in the natural history of rheumatoid arthritis may follow a synovectomy. Synovectomy of the ankle is a rewarding procedure with good results in patients with recurrent and painful effusions without advanced degeneration of articular cartilage.

**Arthrodesis of the hindfoot.** The talonavicular joint is the most commonly affected tarsal joint and isolated arthrodesis may be indicated if the hindfoot is flexible or neutral. Different techniques have been described, including the use of staples or screws with or without bone graft. One study has reported a high rate of nonunion, but the patients had mild or no pain, suggesting a fibrous fusion. Fixation of this joint reduces talocalcaneal movement and enhances stabilisation of the hindfoot. Disruption of the longitudinal arch most often occurs at the talonavicular joint. Fusion of the talonavicular joint may avoid the need to fuse the subtalar joint.

**Triple arthrodesis.** A fixed valgus hindfoot with the forefoot in supination and abduction, requires a triple arthrodesis for correction. This procedure was initially developed for the treatment of paralytic deformities of the hindfoot such as in poliomyelitis. With a decrease in neurological disorders it is often used in the treatment of rheumatoid and post-traumatic arthritis or decompensated hindfeet. Previously triple arthrodesis required the resection of much bone; it is now a relatively bone-sparing technique. The articular surfaces must be removed with preparation of the underlying subchondral bone and internal fixation, either with screws (preferably cannulated) or staples for compression, is undertaken in order to maintain correction and reduce the rate of nonunion. In patients with extensive loss of bone, bone graft may be used. Medial and lateral incisions are used. The latter may be difficult to close after a major correction and wound healing may be compromised. Care must be taken to avoid entering the ankle or damaging the anterior talofibular joint. It is necessary to loosen and remove the cartilage of all three joints. The subtalar joint is fixed first after which the forefoot and the remaining transverse tarsal movement can be corrected. The position of the hindfoot is critical because too much valgus will cause lateral impingement and overload of the medial part of the knee. On the other hand, a varus position results in a compensatory external rotation of the leg and stiffness of the forefoot. Percutaneous lengthening of tendo Achillis may occasionally be necessary. The talonavicular joint is fixed from the medial incision and finally the calcaneocuboidal joint (Fig. 3). Pell et al reported the results of triple arthrodesis with rigid internal fixation using cannulated screws without wedge resection of bone in a subgroup of 22 patients with rheumatoid arthritis. This subgroup needed the most correction in all planes and there was a significant correlation between post-operative alignment of the ankle and satisfaction, but not of the late development of arthritis of the ankle which is a long-term complication of triple arthrodesis. Smith et al described six patients with rheumatoid arthritis who had a triple arthrodesis through a lateral incision.

**The ankle.** The ankle is less frequently involved than other weight-bearing joints. If conservative treatment fails, tibiotalar arthrodesis has been the standard treatment for more than 40 years. Fusion of the ankle is more difficult to obtain than of the subtalar joint. In the ankle a small area of contact has to bear high stress forces over the lever arm of the whole foot. This may be the reason why so many different techniques regarding the mode of fixation, surgical
approach, and the use of bone grafts have been described in an attempt to avoid nonunion, which has been reported in more than 15% of patients. Although studies with smaller numbers have described a rate of union of 100%, in larger series the rate was between 60% and 95%. Techniques which include the use of compression, internal fixation and a transfibular approach have higher rates of union. The evaluation of the functional benefit after ankle arthrodesis is difficult because of multiple joint involvement. It is still a matter of debate whether the ankle should be fused or replaced. The first generation of ankle arthroplasties consisted of a cemented two-component system with a metal talar cup and a polyethylene tibial component, such as the Mayo ankle, or of multidirectional two-component systems such as the Newton arthroplasty. High rates of revision were reported. Second-generation ankle prostheses have a meniscal unconstrained polyethylene component which can be fixed without cement. There have been only a few studies by authors who are not connected with the innovators and these present merely the mid-term results. However, there remains a high rate of osteolysis and revision. The theoretical advantages of ankle arthroplasty over arthrodesis are clear and include a range of movement over arthrodesis are clear and include a range of movement which allows walking with reduced stress on the adjacent joints. At present a clear statement in favour of one or the other cannot be given and long-term results are required.

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