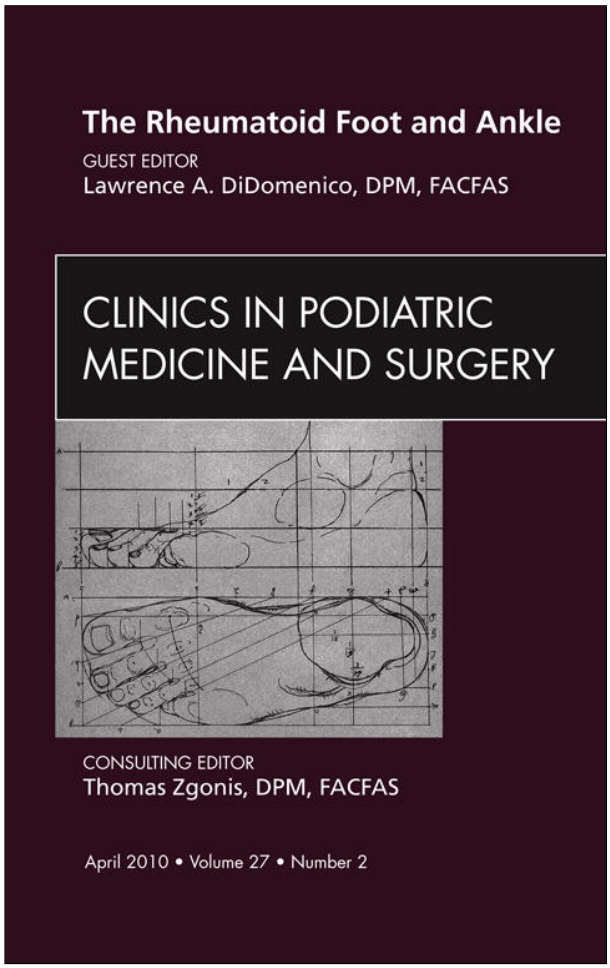

The Surgical Reconstruction of the Rheumatoid Forefoot

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KEYWORDS

• Rheumatoid arthritis • Rheumatoid foot • Forefoot surgery
• Forefoot deformity • Forefoot reconstruction

Rheumatoid arthritis (RA) is reported to affect 0.5% to 1% of the population.[1–7] This disease begins in the foot approximately 20% of the time,[8,9] and results in work disability in greater than 50% of patients[1–3] and foot deformity in approximately 100% of patients within 10 years of the onset of the disease.[4,10–13] The forefoot is more often affected than the rearfoot,[4,8,9] with 70% to 80% of the metatarsophalangeal (MTP) joints being involved early in the disease process,[14,15] resulting in the development of deformities in 90% of adults with chronic RA.[16,17] RA is an autoimmune disorder that presents in females more often than in males and may affect any age to include infants, but is primarily noted in the fourth and the fifth decades and provides no regional or ethnic preference.[18] Although genetic and environmental causes have been proposed, the definitive cause of immunologic susceptibility, as well as viral and bacterial infectious processes that may cause RA, have not been identified.[1,18]

PURPOSE

This article discusses reconstructive forefoot surgery for RA via soft-tissue procedures, joint-destructive procedures, and joint-sparing procedures, and highlights the combined approaches to reconstruction via forefoot joint-sparing techniques using soft-tissue rebalancing in conjunction with first ray forefoot joint-sparing procedures

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Clin Podiatr Med Surg 27 (2010) 243–259
doi:10.1016/j.cpm.2009.12.007 **podiatric.theclinics.com**
0891-8422/10/$ – see front matter

and midfoot joint-destructive procedures. This article also includes a discussion of the radiographic and magnetic resonance imaging (MRI) findings associated with RA and a discussion of perioperative care for the RA patient undergoing forefoot surgery.

CLINICAL PRESENTATION AND DIAGNOSIS

The various pathologies of RA of the forefoot that may be encountered include rheumatoid nodules; synovitis; pannus; capsulitis; bursitis; edema; metatarsalgia; fat pad migration and atrophy; calluses; ulceration; infection; hallux abducto valgus; hammertoe, claw toe, or mallet toe deformities; MTP joint soft tissue, cartilage, and bone erosion; and joint contractures, subluxations, or dislocations. The severity of the pathology may range from mild swelling and early joint pain with no or limited deformity to more pronounced swelling and severe joint pain, or absence of joint pain with mild to severe joint deformity with or without joint destruction. Pathologies of the lower extremity that may be found in the rheumatoid patient include osteoporosis, vasculitis and atherosclerosis, and cervical spine disease, as well as neuropathy that is secondary to entrapment, vasculitis, or drug toxicity.[18]

No single diagnostic test is provided to definitively diagnose RA. The American Rheumatism Association has provided 7 criteria and the corresponding definitions of each criterion for the classification of RA, and these may be used to assist in making the diagnosis. To be classified as having RA a person must exhibit 4 of the 7 qualifying criteria that include morning stiffness, arthritis of 3 or more joint areas, arthritis of hand joints, symmetric arthritis, rheumatoid nodules, and serum rheumatoid factor. Of these criteria the first 4 must be present for a minimum of 6 weeks.[1,19,20] Patients displaying 2 of the satisfying criteria are not excluded from the diagnosis of RA.[1] Also of note, arthritis of the hand joints is included as one of the first 4 qualifying criteria that is required to be present for at least 6 weeks, whereas arthritis of the foot joints is not specifically required despite the fact that foot has been reported to be the first affected site in up to 19% of patients, with 21% of patients developing pedal pathology within the first year of the disease process.[4]

IMAGING FINDINGS OF RA IN THE FOREFOOT

RA involves the feet in up to 90% of patients, usually just lagging behind the hands in terms of frequency of involvement. Radiographic features of the involvement of the forefoot in RA are nonspecific; however, the constellation of findings together with clinical suspicion will often support the diagnosis. Early in the disease process, radiographs show periarticular osteopenia about the MTP joints. This finding reflects that synovitis and associated hyperemia occur about the joint, thus causing a washout of bone mineralization. Soft-tissue swelling about the MTP joints may also be appreciated. As the disease process progresses, marginal erosions become detectable. These erosions are first seen at the bare areas of the metatarsal heads, with the lateral aspect of the fifth metatarsal head usually being the first to be involved. **Fig. 1** shows periarticular osteopenia with small marginal erosions involving the fifth metatarsal head. Progressive erosive changes will usually be more extensive along the medial metatarsal heads as compared with the lateral aspects. No new bone production is seen about the erosive change. More progressive involvement of the forefoot will show a uniform and symmetric loss of the MTP joint space. As the MTP joint cartilage is destroyed, lateral subluxation of the proximal phalanges will be apparent. Hallux valgus and proximal interphalangeal joint dorsiflexion deformities may also be seen late in the disease process. Very late changes include severe periarticular erosions involving the MTP joints with associated lateral subluxations. Findings are symmetric

Fig. 1. Radiograph showing periarticular osteopenia with small marginal erosions involving the fifth metatarsal head.

with the contralateral forefoot. **Fig. 2** shows the late changes of RA in the forefoot, with extensive loss of MTP joint space of the second through fifth digits and marked erosive change about these joints.[21] MRI is being increasingly used to detect the first manifestations of RA in the forefoot, and it shows periarticular bone marrow edema and synovitis that affect the MTP joint before appreciable periarticular osteopenia or small marginal erosions are detectable on radiographs. Tenosynovitis is often associated and can easily be detected with MRI. Some researchers have advocated MRI as the gold standard for the detection and characterization of RA affecting the joints.[18] Although MRI is clearly more sensitive than radiographs, it is more costly and not as readily available. MRI certainly has an important role in problem solving.

In summary, radiographic manifestations of early RA in the forefoot include MTP joint periarticular osteopenia with associated small marginal erosions about the metatarsal heads, first along the lateral fifth metatarsal head. As the disease progresses, erosions become more extensive and lateral subluxation of the proximal phalanges develop. Uniform MTP joint space narrowing is evident. Findings are seen to be symmetric with the contralateral foot. Findings can usually be distinguished from psoriatic and reactive arthritis, as bone mineral density is preserved in psoriasis and there is bone production about the areas of erosive change in psoriasis and reactive arthritis. These arthropathies are also bilaterally asymmetric. Collagen vascular diseases are not usually a diagnostic dilemma, as these do not show erosive change or loss of joint space.

PRE- AND POSTOPERATIVE CONSIDERATIONS FOR THE MEDICAL MANAGEMENT OF THE PATIENT WITH PODIATRIC RA

RA is a common inflammatory joint disease that affects approximately 1% of the population and 3% of the population older than 65 years.[22] Irreversible structural damage

Fig. 2. Late changes of RA in the forefoot with extensive loss of MTP joint space of the second through fifth digits and marked erosive change about these joints. (*Data from* Brower AC. Arthritis in black and white. Philadelphia: WB Saunders; 1988.)

arising from synovitis frequently requires surgical intervention. The need for surgical intervention tends to occur later in the disease. Patients with RA have elective surgery for 2 primary reasons, namely to relieve pain and to improve functional status.

Patients with RA have a higher risk of postsurgical complications, including wound healing, because of their underlying systemic disease, immunosuppressive medications, malnutrition, and often severe deformities that need corrective surgery. Nonunion occurs in rheumatoid patients at a higher rate than the general population. This nonunion is thought to be caused by the same factors that cause postsurgical complications.[23,24]

Preoperative evaluation and medical management should focus on optimizing the patient's medical condition to reduce the risk of complications. Patients should be evaluated for skin ulcerations, vasculitis, carious teeth, periodontal disease, urinary tract infection, or prostatism, because these problems can increase the risk of postoperative infections.[25]

Cervical spine involvement merits careful attention in RA patients no matter what type of surgery is planned. Thirty to forty percent of patients with RA have cervical spine involvement, which is often asymptomatic.[26] An unstable cervical spine from atlantoaxial or subaxial subluxation places the patient at an increased risk for neurologic complications, especially with endotracheal intubation. Care should be taken during spinal anesthesia not to cause unnecessary prolonged flexion of the cervical spine. It is recommended that cervical radiography in lateral flexion and extension be conducted before surgery.[27]

Preoperative evaluation recommendations for patients with RA include electrocardiography, prothrombin time, partial thromboplastin time, complete blood count with platelets, electrolytes, creatinine, liver function tests, chest radiograph, cervical

spine radiograph, and skin evaluation to look for ulcerations, nodules, skin breakdown, or vasculitis. Lung involvement is common in RA and may not be apparent because of the patient's functional limitations. The rheumatoid patient is at an increased risk of developing pulmonary problems perioperatively if interstitial fibrosis is present; this affects gas exchange by decreasing the diffusion capacity.[28]

Blood loss is an inevitable consequence of surgery, and a hemoglobin level less than 13 predicts a 2-fold increase in the need for a transfusion in most orthopedic procedures.

Steroids should be maintained at the lowest possible dose before surgery. Nonsteroidal anti-inflammatory drugs (NSAIDs) should be discontinued 5 or more days before the procedure. Aspirin needs to be held for 1 week before the procedure. NSAIDs inhibit thromboxane A_2 synthesis and can prolong bleeding time. Stress dose of the steroid hydrocortisone (100 mg) should be given intravenously (IV) before surgery. If the procedure is prolonged then hydrocortisone IV (100 mg) should be given intraoperatively. Hydrocortisone IV (100 mg) should be continued at an interval of 8 hours for 24 hours. If the patient is not allowed to take in food orally, then hydrocortisone (IV) (50 mg) should be given every 8 hours for 24 hours; however, if he can take food through the mouth, the usual oral dose of prednisone can be resumed. Recent studies suggest that patients who discontinued methotrexate before surgery had more postoperative infections and complications than patients who continued methotrexate.[29,30] Use of disease-modifying antirheumatic drugs (DMARDs), such as penicillamine, cyclosporine, and antimalarials, were associated with an increased risk of postoperative infections Agents that can cause leukopenia, namely cyclophosphamide (Cytoxan), azathioprine (Imuran), and sulfasalazine (Azulfidine), should be discontinued a few days preoperatively. At present there are no data on the use of leflunomide in the perioperative period, but it is currently recommended to hold the drug 2 weeks prior to elective surgery and resume its use when the patient is able to take oral medication.[31] The biologic DMARDs such as tumor necrosis factor (TNF) inhibitors and interleukin (IL)-1 have a significant impact on the treatment of RA. Proinflammatory cytokines, IL-1, and TNF-α play a central role in the pathophysiology of RA. These biologic therapies have a rapid onset and have been shown to prevent structural damage in RA. However, their main side effect is an increased risk of infection. It is recommended that these drugs should be administered for 1 dosing interval only, that is, etanercept for 1 week, adalimumab for 2 to 4 weeks, and infliximab for 6 to 8 weeks. Elective surgery is not advised when the drugs are at peak levels in the therapy. These TNFs can be reinstated 2 weeks after surgery as long as the wound is clean and healing well.

Rehabilitation is recommended after most surgeries, and follow-up radiographs are screened to document healing.

Rheumatoid flares that occur during the peri- or postoperative period can be managed with corticosteroids.

SURGICAL INTERVENTION

If conservative pressure reducing and offloading modalities, such as callous debridement, padding, accommodative or custom shoes, and custom orthotics, as well as pharmacologic management fail to alleviate symptomatic RA forefoot pathology, surgical intervention is indicated with the goal of reducing pain and recreation of a plantar grade foot that may be fitted with a shoe. Care must be taken to adequately assess the patient's vascular status, because vasculitis may be present and should be accounted for when selecting a surgical procedure that balances the desired deformity correction and wound-healing potential.

Removal of Soft Tissue Nodules or Masses

The literature indicates that 20% to 32% of patients with RA present with rheumatoid nodules, which are usually not painful.[18,32] Rheumatoid nodules result from a vasculitic process and have been reported to be a sign of an advanced stage of RA.[33–35] A study by Bibbo and colleagues[33] found that rheumatoid nodules were present in 43% of 104 patients. They reported that there was no statistically significant difference in the frequency of occurrence of rheumatoid nodules between groups of patients with postoperative complications and groups of patients without postoperative complications, and that there were fewer postoperative complications in the group of patients who had had rheumatoid nodules. Rheumatoid nodules located in weight-bearing regions may be symptomatic and predispose one to pain, ulceration, and infection. **Fig. 3** displays the rheumatoid nodules in plantar forefoot. Surgical removal of rheumatoid nodules or masses is performed by excising the identified soft-tissue nodule via the most direct approach, with the goal of producing the least soft-tissue damage and with consideration given to the surrounding anatomic structures, weight-bearing verses nonweight-bearing surfaces, relaxed skin tension lines, and the potential need for additional incision placement and reconstructive forefoot surgery. Postoperative care must be given to protect incisions from excessive tension, shear, and friction to provide maximum opportunity for skin healing and acceptable scar formation, especially in cases where a plantar approach is used. Three weeks of nonweight bearing on plantar incisions is recommended to assist in avoiding hypertrophic and painful scar formation. **Fig. 4** displays the plantar forefoot scar post resection of the rheumatoid nodules that had been identified previously.

Classic incision approaches of interest in rheumatoid forefoot surgery include Hoffman's (1912) distal transverse plantar incision; Larmon's (1951) 3 dorsal longitudinal incisions; Fowler's (1959) distal transverse dorsal incision with first and fifth ray longitudinal extensions and a plantar skin ellipse; Clayton's (1960) distal transverse dorsal incision; and Kates' (1967) curved plantar incision with a plantar ellipse.[20] The surgical authors prefer the use of 2 dorsal foot incisions of which 1 dorsal forefoot incision is modeled after a single incision introduced by Hibbs in 1919 for the treatment of clawfoot.[36,37] The dorsal modified Hibbs incision extends from the distal medial second metatarsal head region to proximal lateral region; spanning the second, third, fourth, and fifth metatarsals and providing access to the corresponding MTP joints and digital

Fig. 3. Rheumatoid nodules in a patient with plantar forefoot.

Fig. 4. The plantar forefoot scar post resection of the previously identified rheumatoid nodules.

extensor tendons for soft-tissue rebalancing. It is combined with a second dorsal medial longitudinal first ray incision, which provides access to the joints of the medial column and first MTP joint as needed for stabilization. **Fig. 5** displays a healed modified Hibbs incision on the right foot and a healed dorsal medial longitudinal first ray incision on the left foot.

Correction of Digital Pathology

Correction of hammertoe, claw toe, and mallet toe may be achieved via independent procedures or by combinations of procedures, such as an arthroplasty,

Fig. 5. Healed modified Hibbs incision on the right foot and a healed dorsal medial longitudinal first ray incision on the left foot.

arthrodesis, osteoclasis, flexor digitorum tenotomy, flexor digitorum longus tendon transfer, flexor hallucis longus tendon transfer or capsulotomy of the distal interphalangeal joint, proximal interphalangeal joint, and hallux interphalangeal joints. The approach to hammertoe correction varies and is based on surgeon's preference, global surgical planning, and patient suitability. The planned approach to digital correction should take into account the desired goal, surgeon's experience, the digital pathology that is presented, the patient's vascular status, the patient's health, as well as the operative time that is required if additional surgical reconstructive procedures need to be performed. The surgical approach may be modified to address the presentation of reducible, semireducible, or fixed nonreducible hammertoes with or without additional MTP pathology, hallux abducto valgus, and first ray stability.

The digital joint-destructive procedures include arthroplasty, implant arthroplasty, and arthrodesis. Although the surgical authors prefer joint-sparing procedures, proximal interphalangeal joint arthroplasty when required is the digital joint-destructive procedure of choice in the RA population. Digital arthroplasty usually involves removal of the head of the proximal phalanx and less often the head of the distal phalanx via a dorsal curvilinear or longitudinal incision on the second, third, fourth, and/or fifth digits, followed by 3 to 4 weeks of temporary Kirschner fixation with either a 0.045-in or 0.062-in wire. Digital implant arthroplasty may be performed; however, it is rarely recommended by the surgical authors. Arthrodesis of the digits typically involves removal of the cartilaginous surfaces and bone from the adjacent sides of the proximal interphalangeal joint, followed by bony realignment and apposition of the surface of the base of the intermediate phalanx and remaining distal aspect of the proximal phalanx. Arthrodesis in the RA population may be accomplished via various techniques and is often performed via end-to-end bony apposition rather than peg and hole bony apposition, then followed by Kirschner wire fixation. Additional methods of digital fixation include the use of specialized digital screws placed from distal to proximal spanning the distal, intermediate, and proximal phalanx, or the use of specialized locking intramedullary digital implants placed within the proximal shaft of the intermediate phalanx and the distal shaft of the proximal phalanx. With the digital arthrodesis approach the surgical authors' preference is end-to-end arthrodesis with Kirschner wire fixation in the RA population, because of the quality of bone stock often encountered and the high frequency of Kirschner wire use for temporary fixation of proximal MTP joint pathology that is often corrected at the same surgical setting. **Fig. 6** displays the reduced digital and MTP pathology with Kirschner wire fixation in place. Clayton presented the forefoot resection arthroplasty to the American Rheumatism Association in 1958, and the technique was later printed in *Clinical Orthopaedics and Related Research* in 1960. The Clayton procedure included MTP joint resections and digital arthroplasties in which the base of the proximal phalanx of the digits 1, 2, 3, 4, and 5 were resected, in conjunction with the resection of metatarsal heads 1, 2, 3, 4, and 5.[38,39] Complications, such as recurring hallux abducto valgus, development of floppy toes, and cockup digital deformities are noted to have led to the transition from simple forefoot resection procedures to reconstructive surgery during the latter portion of the 1970s.[39] The surgical authors guard against the use of the original Clayton procedure because of its joint-destructive nature and the resulting destabilization of the MTP joints. On the contrary, they favor forefoot joint-sparing reconstructive techniques that use the release of joint contractures and tendon rebalancing techniques for the lesser digits and lesser MTP joints, combined with first ray stabilizing procedures.

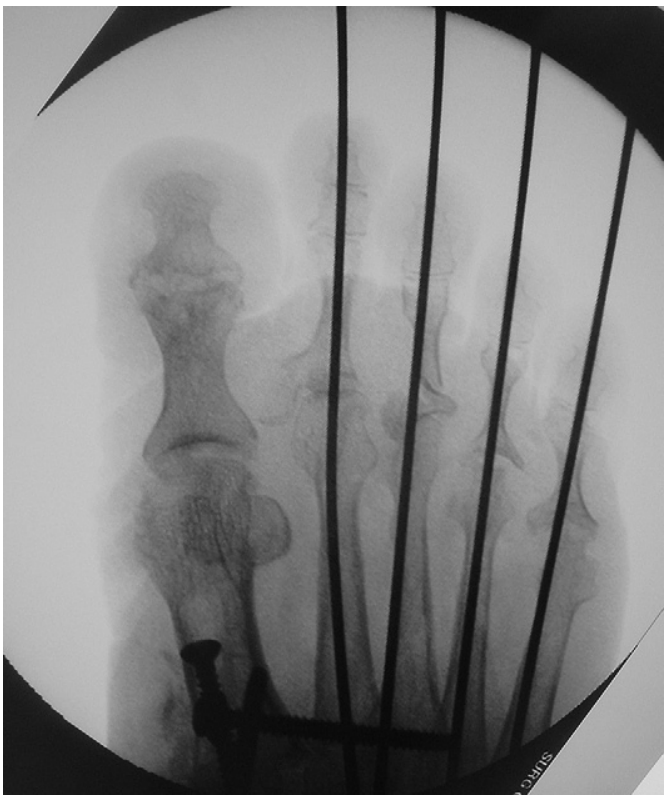

Fig. 6. The reduced digital and MTP pathology with Kirschner wire fixation in place.

Joint-Sparing Digital Procedures

Joint-sparing hammertoe correction is based on soft-tissue rebalancing and may be accomplished by performing open, percutaneous, or closed procedures that are aimed at releasing and reducing capsular and tendon contractures as well as reducing deforming soft-tissue influences by balancing tendon forces. Percutaneous plantar digital tenotomies, capsulotomies, and Kirschner wire fixation are often useful in reducing distal interphalangeal joint contractures and proximal interphalangeal joint contractures, and have been found to be useful in reducing operative time and soft-tissue trauma when combined with open MTP joint and proximal first ray procedures. Open distal interphalangeal joint and proximal interphalangeal joint capsulotomies, flexor digitorum longus tendon transfers, and percutaneous or open temporary Kirschner wire fixation are additional joint preserving approaches that are used to reduce hammertoes and claw toes. Flexor digitorum longus tendon transfers may be accomplished via various techniques such as a splint medial and lateral tendon transfer, complete medial or complete lateral tendon transfer, or dorsal tendon transfer through a bone tunnel. Of the 3 transfer options noted the surgical authors prefer an intact flexor digitorum longus tendon transfer, with the tendon being transferred to the proximal base of the proximal phalanx opposite the side of the primary deforming force. Therefore, if the deforming force is primarily plantar or plantarlateral, the flexor digitorum longus tendon is transferred to the proximal medial base of the proximal phalanx and the opposite is done if the deforming force is primarily plantarmedial. When harvesting the flexor digitorum longus for transfer the incision is performed on the plantar medial or lateral aspect of the digit according to the planned side of transfer, and is released from the distal phalanx distal to the distal interphalangeal joint, then transferred and reapproximated to the appropriate dorsal side of the proximal phalanx proximal to the proximal interphalangeal joint. After performing the flexor digitorum longus transfer a distal interphalangeal joint and proximal interphalangeal joint plantar

capsulotomy is performed, and the digit is temporarily fixated in a rectus position by a Kirschner wire before coapting the tendon to the new insertion location.

CORRECTION OF MTP JOINT PATHOLOGY

MTP Joint-Destructive Procedures

Resection of the metatarsals was initially described by Hoffman[40] in 1912 whereby the metatarsal heads 1, 2, 3, 4, and 5 are transected and removed.[41] As previously mentioned, Clayton expanded on the metatarsal head resections by removing the bases of the adjacent proximal phalanxes.[38] Additional modifications to the original Hoffman procedure allow for combination resection of the metatarsal heads 2, 3, 4, and 5 with various first ray procedures to include resection of the base of the proximal phalanx of the hallux, first MTP joint implant arthroplasty, and first MTP joint arthrodesis. **Fig. 7** displays 5 resected metatarsal heads along with the base of the proximal phalanx of the hallux. The Keller resection arthroplasty and the first MTP joint implant arthroplasty are joint-destructive options. However, the surgical authors prefer the first MTP joint arthrodesis, which if successfully accomplished provides an increased medial column stability, alleviates approximately 50% hallux abducto valgus recurrence rate noted with arthroplasty procedures, and allows the first ray to share a greater load of weight-bearing forces.[4,17] The key to forefoot reconstruction in the rheumatoid patient is the achievement of a stable realigned first ray.[8,17] MTP joint preparation may be completed by mechanical debridement of cartilage with hand instrumentation, such as curettes, rongeurs, osteotomes, and rasps, or with power instrumentation such as sagittal saw resection, conical reaming devices, and burrs. Various fixation techniques may be used for the first MTP joint arthrodesis including crossed Kirschner wire fixation, Steinmann pin fixation, crossed or stacked lag screw fixation, single lag or positional screw fixation with locking or nonlocking plate fixation, staples, and external fixation. **Fig. 8** displays a postoperative radiograph of the first MTP joint arthrodesis and hardware combined with metatarsal head resections. Pan-MTP joint arthrodesis has recently been described as an option for treating a painful severe rheumatoid forefoot deformity, and is performed through 5 dorsal incisions and is fixated with Steinmann pins.[4]

MTP Joint-Sparing Procedures

The modified Hibbs procedure functions as a joint-sparing procedure via release of the MTP joint contractures by tenotomy and transfer of the proximal aspects of the

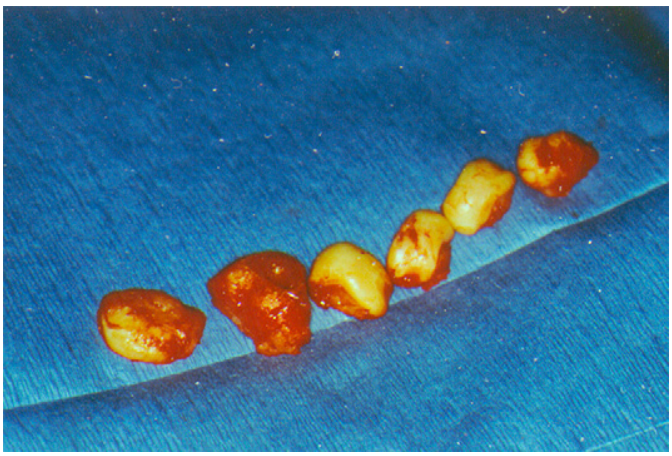

Fig. 7. Five resected metatarsal heads along with the base of the proximal phalanx of the hallux.

Fig. 8. Postoperative radiograph of first MTP joint arthrodesis and hardware combined with metatarsal head resections.

second, third, and fourth extensor digitorum longus tendons to the dorsolateral midfoot. This is accompanied by the tenotomy and transfer of the proximal aspects of the second, third and fourth extensor digitorum brevis tendons to the remaining distal portion of the extensor digitorum longus tendons of the second, third, and fourth digits, combined with a Z-plasty lengthening of the fifth extensor digitorum longus tendon or anastomosis of the fifth and fourth extensor digitorum longus tendons. **Fig. 9** displays the intraoperative Hibbs incision and the related exposed extensor tendons. Additional joint-sparing procedures that are used to rebalance soft tissues include percutaneous tendon lengthening of the extensor hallucis longus tendon,

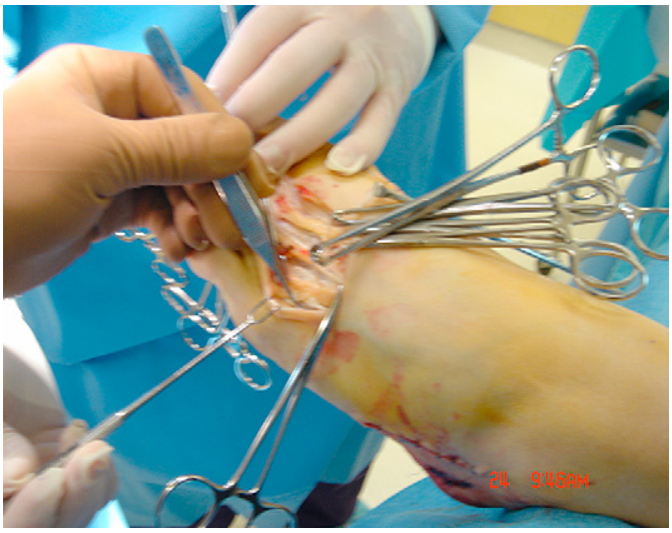

Fig. 9. The intraoperative Hibbs incision and the related exposed extensor tendons.

MTP joint release, extensor hood release, extensor tenotomy or Z-plasty tendon lengthening, capsulotomy, transection of the medial and lateral collateral ligaments, and plantar metatarsal head soft-tissue release via a McGlamry elevator followed by Kirschner wire fixation.[36] The soft-tissue joint-sparing MTP release procedures may be combined with hammertoe or claw toe correction via open, percutaneous, or closed reduction of the digital deformities, followed by Kirschner wire fixation spanning the distal interphalangeal joint, proximal interphalangeal joint and MTP joints. Metatarsal shortening osteotomies provide a joint-sparing bony reconstructive surgical option for the rheumatoid foot. The Weil metatarsal osteotomies with single dorsal to planter screw fixation have been presented as joint-sparing alternatives to the metatarsal head resections, arthroplasties, and first MTP joint arthrodesis procedures.[42] Shortening of the lesser metatarsals may also be combined with fusion or implant arthroplasty of the first MTP joint as well as with open, percutaneous, or closed reduction of digital contractures. Care should be taken to preserve the metatarsal parabola so that the length of the metatarsals reflects a 2, 1, 3, 4, 5 length pattern, with the second metatarsal extending most distally followed by the first and then descending medial to lateral approximately 2 mm from the proceeding metatarsal.[36] The metatarsal shortening point as described by Barouk and Barouk[42] may also be used as a template method for planning and providing the location of the metatarsal shorting osteotomies. Additional first metatarsal osteotomies, such as the Reverdin-Todd, Distal L, and Youngswick osteotomies, should be considered as they may be selectively used to reduce the hallux abducto valgus deformity by reducing the proximal articular set angle, reduce the hallux abductus angle, and reduce the first intermetatarsal angle as well as decompress the joint by shortening the first metatarsal. In the presence of the first intermetatarsal angle being greater than 14°, a proximal first ray procedure such as the Lapidus bunionectomy may be considered, in combination with first metatarsal cuneiform hypermobility and divergence of the dorsal cortex of the first and second metatarsals, to correct the sagittal and transverse plane deformities; or the scarf bunionectomy may be considered in the absence of hypermobility. **Fig. 10** displays a Lapidus procedure with plate and screw fixation as well as an oval to round lucency in the calcaneus depicting the site of a percutaneous calcaneal graft harvest.

Combination of Joint-Destructive and Joint-Sparing Procedures

Historical literature yields to joint-destructive procedures with the Hoffman procedure being favored over the Clayton procedure, probably because of the destabilization of

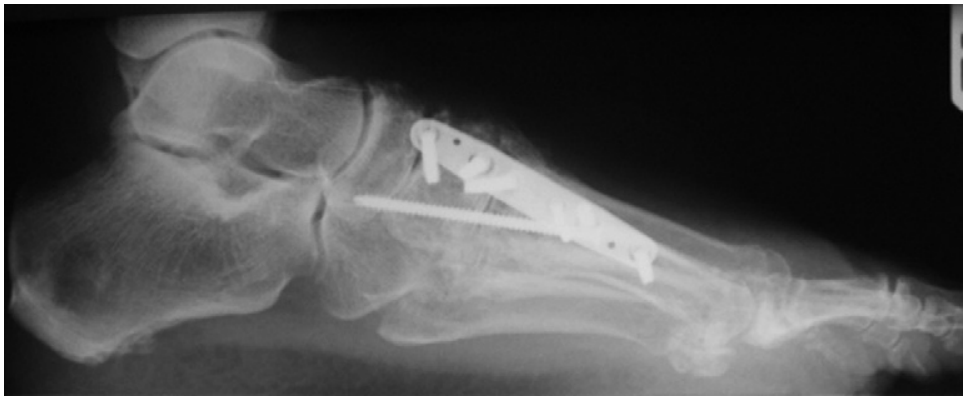

Fig. 10. Lapidus procedure involving plate and screw fixation as well as an oval to round lucency in the calcaneus along with the site of a percutaneous calcaneal graft harvest.

the MTP joint after resection of the base of the proximal phalanxes. Conventional thinking yields to the combination of a first MTP joint arthrodesis with resections of metatarsal heads 2, 3, 4, and 5. The first MTP joint arthrodesis is a viable option when presented with severe hallux abducto valgus, and it is preferred by the surgical authors over resection arthroplasty if the bone stock is adequate for fixation. However, recently the practice of using joint-sparing procedures for rheumatoid forefoot reconstruction is being recognized as a reliable option.[42] The modified Hoffman procedure may also be combined with joint-sparing first MTP joint procedures, such as the first metatarsal osteotomies aimed at correction of hallux abducto valgus and first metatarsal shortening osteotomies. When the emphasis is on surgical reconstruction there is a shift from forefoot joint-destructive procedures to the incorporation of joint-sparing procedures, and therefore a migration to combined procedures that provide the desired benefits of specific joint-destructive and joint-sparing procedures. The inclusion of forefoot joint preservation procedures yields options for combinations of MTP joint-sparing techniques, such as the pan-metatarsal shortening osteotomies, first metatarsal osteotomies, and the Lapidus procedure, with joint-sparing digital MTP joint contracture reduction via soft-tissue releases and tendon balancing procedures such as the modified Hibbs with or without open flexor digitorum longus tendon transfers, percutaneous flexor digital tendonotomies and capsulotomies, or closed digital reduction and Kirschner wire fixation of the distal interphalangeal joint, proximal interphalangeal joint, and MTP joints. **Fig. 11** displays an anteroposterior view of the modified Lapidus and modified Hibbs procedure with intact hardware. The forefoot joint-sparing surgical combination of the modified Lapidus with 3 point 4.0 fully threaded cortical screw fixation, modified Hibbs and digital joint-sparing percutaneous flexor digitorum longus tenotomies, and plantar digital capsulotomies with Kirschner wire fixation address the first ray pathology of hypermobility and hallux

Fig. 11. Anteroposterior view of the modified Lapidus and modified Hibbs procedure with intact hardware.

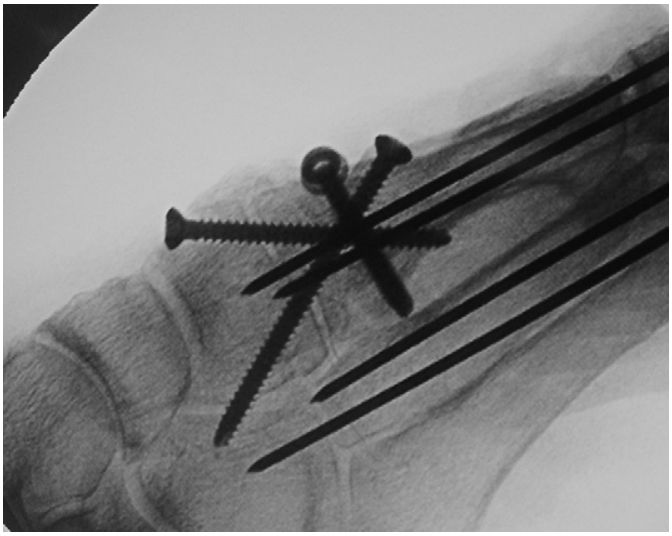

Fig. 12. Lateral view of a modifed Lapidus procedure and modified Hibbs procedure with intact fixation and the resulting sagittal plane correction of the first metatarsal.

abducto valgus while also addressing the lesser digital and MTP joint contracture pathologies. A percutaneous calcaneal bone graft harvest is often performed and used as a sheer-strain relief graft at the first metatarsalcuneiform arthrodesis site.[43] **Fig. 12** displays a lateral view of a modified Lapidus procedure and modified Hibbs procedure with intact fixation, and the resulting sagittal plane correction of the first metatarsal. Open flexor digitorum longus tendon transfers provide a joint-sparing option for reduction of severe hammertoes and aid in the reduction of plantar forefoot pressure and calluses by reducing the retrograde force placed on the metatarsal heads by contracted digits. A percutaneous tendo Achilles lengthening or gastrocnemius recession may also be required in cases where gastrocsoleus equinus or gastrocnemius equinus is present and noted to contribute to excessive plantar forefoot pressure, calluses, or ulceration.[44,45] The surgical authors' reasoning behind choosing a particular approach to reconstructive forefoot surgery in the rheumatoid patient includes avoiding forefoot joint-destructive procedures; stabilizing the first ray without sacrificing first metatarsal joint mobility; releasing joint contractures and providing soft tissue and tendon rebalancing; alleviating the need to entirely reproduce a near anatomic metatarsal parabola as required with resection of the metatarsal heads or shorting osteotomies of the metatarsals; avoiding the risk of delayed union, malunion, and nonunion of the metatarsal osteotomies and MTP arthrodesis procedures; avoiding the potential for development of synovitis associated with failed silicone implants as well as revision of failed implant arthroplasties; nullifiying the potential for distal heterotrophic bone growth post MTP head resection arthroplasties; reducing the expense associated with pan-metatarsal osteotomies and multiple screw fixation while reducing the number of potential screw fixation complications associated with osteoporotic bone; allowing for intramedullary Kirschner wire fixation and temporary stabilization post reduction of the digital and lesser MTP joint contractures without the potential interference of proximal screw fixation associated with lesser metatarsal shortening osteotomies, and because Kirschner wire fixation is less costly than digital screw and digital intramedullary locking fixation.

SUMMARY

Although no one specific test or finding provides a definitive diagnosis of RA, correlation of the clinical, laboratory, radiographic, and MRI findings if available assist in

making the diagnosis. Care must be taken to adequately work up a patient with RA before executing elective surgical intervention, and a multidisciplinary team approach including the patient's rheumatologist is recommended during the perioperative phase. Multiple surgical options exist to address the rheumatoid forefoot, such as joint-destructive resection arthroplasties, implant arthroplasties, and arthrodesis procedures; joint-sparing osteotomies, tenotomies, capsulotomies, and tendon transfers; as well as the combination of such joint-sparing and joint-destructive procedures. First metatarsal and lesser metatarsal joint-destructive and joint-sparing procedures with digital joint-destructive and joint-sparing procedures have been presented and opinions have been published regarding the level of evidence and grades of recommendations for several of the procedures.[18] It is the surgical authors' position that most joint-sparing and joint-destructive procedures presented are useful given the appropriate patient and pathology. However, in reviewing the different procedures the authors would highlight the reconstructive forefoot procedures that are joint-sparing and their combination with joint-destructive procedures that stabilize the first ray, as this has been reported to be the key to reconstruction of the rheumatoid forefoot.[8,17] The surgical authors have found the combination of a modified Lapidus bunionectomy with a modified Hibbs procedure and a percutaneous release of digital contractures or an open flexor digitorum longus tendon transfer to provide an effective means for reconstruction of the forefoot in the patient with RA that is both forefoot joint-sparing and first ray stabilizing. At present the surgical authors are not aware of prior publication combining the forefoot joint-sparing and midfoot joint-destructive Lapidus procedure with the forefoot joint-sparing modified Hibbs procedure with the additional digital joint-sparing percutaneous flexor digitorum longus tenotomies, proximal interphalangeal joint capsulotomies and, if needed, distal interphalangeal joint capsulotomies for the reconstruction of the rheumatoid foot, and hence present this combination procedure as another option for the foot and ankle surgeon to consider when surgically reconstructing the foot in the rheumatoid patient.

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