Hallux Rigidus: A Treatment Algorithm

Warren S. Taranow, DO and Judson R. Moore, PA-C, JD

Abstract: First metatarsophalangeal joint osteoarthritis, commonly known as hallux rigidus, is a progressive disabling condition. Several staging classification systems exist. We present a staging system incorporating radiographic findings, range of motion, and presence or absence of mid-motion pain and sesamoid pain. On the basis of these clinically significant variables, we present an algorithm for treatment of the various clinical manifestations of hallux rigidus. Finally, we describe these surgical techniques, with particular attention to cheilectomy, hemiarthroplasty, and arthrodesis.

Key Words: hallux rigidus, hallux rigidus classification, cheilectomy, proximal phalangeal hemiarthroplasty, hallux metatarsophalangeal arthrodesis

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Osteoarthrosis of the hallux metatarsophalangeal (MTP) joint leads to a syndrome of debility termed hallux rigidus. Typical findings include pain with first MTP motion, diminished dorsiflexion, and footwear discomfort.[1] Additional symptoms may include diminished propulsion, transfer metatarsalgia, habitual forefoot supination, and other gait abnormalities.[2]

CLASSIFICATION

Although none of the 14 described hallux rigidus classification systems are flawless[3] for surgical planning, 2 are widely referred in subsequent studies. Hattrup and Johnson[4] described a simple 3 grade radiographic classification in 1988. In grade I, the joint space is maintained and there are minimal osteophytes. Grade II demonstrates larger osteophytes and subchondral sclerosis. In grade III, there is a complete loss of visible joint space, subchondral cysts, osteophytes, and hypertrophy of sesamoids. This classification system relies on radiographic findings, regardless of subjective and clinical findings.

Coughlin and Shurnas[5] developed a 5-stage classification (stage 0 to 4) using symptoms and signs, radiographic findings, and range of motion. Stage 0 patients have 10% to 20% loss of motion but are otherwise asymptomatic, with normal radiographs. Stage 1 patients have 20% to 50% loss of motion, mild pain at extremes of motion, dorsal osteophytes, and minimal joint space narrowing. Stage 2 demonstrates 50% to 75% loss of motion, moderate pain at extremes of motion, and circumferential osteophytes. In stage 3, joint motion is decreased 75% to 100%. Pain can be nearly constant but minimal at mid-motion. Joint space is narrowed and accompanied by cystic degeneration. Stage 4 shows complete loss of motion at the MTP joint, pain regardless of motion, and complete loss of joint space.

We use a classification approach combining the simplicity of Hattrup and Johnson's system with the clinical utility of Coughlin and Shurnas. Our 3-stage, 3-type system includes information necessary for surgical decision-making: location of symptoms, motion, and radiographic changes including the presence or absence of sesamoid pathology. The amount of retained motion and presence of significant sesamoid pain can vary widely within stages of most other classifications.

Stage I, II, or III refers to the radiographic findings. Types A, B, or C refers to range of motion, mid-motion pain, and sesamoid pain, respectively, with type A maintaining at least 50% normal motion, type B having lost most (>50%) of dorsiflexion and/or having mid-motion pain or a significantly positive grind test, and type C exhibiting significant sesamoid-metatarsal head arthritic symptoms. The progressive stages and types correspond to the usual advancement of disease.

Stage I patients have mild radiographic arthritis. Radiographic findings include dorsal osteophytes and minimal dorsal joint space narrowing. Subjective complaints relate to dorsal impingement-type pain at the extreme of dorsiflexion. These are typically type A with >50% retained motion and no mid-motion or sesamoid pain.

Stage II patients have moderate radiographic arthritis. Radiographs show more diffuse joint space narrowing. In addition to dorsal impingement, some stage II patients will have mid-motion pain. Type A have retained motion, type B have diminished (>50%) motion and/or mid-motion joint pain. Stage II rarely involves significant sesamoid symptoms (type C).

Stage III patients have severe radiographic arthritis, with joint space obliteration on x-ray. They usually have mid-motion and dorsal pain. Some have surprisingly good range of motion (type A), whereas most have lost >50% of their motion and/or have mid-motion pain (type B) and/or have sesamoid pain (type C).

OPERATIVE PROCEDURES

Although several operative interventions exist for treating hallux rigidus, the vast majority of cases can be treated with cheilectomy, arthrodesis, or interposition (soft tissue or implant) arthroplasty. Simple resection arthroplasty can also be considered in low demand and neuropathic patients.

Cheilectomy is the operative standard of care for mild to moderate hallux rigidus.[6] The procedure removes the offending dorsal osteophyte and 30% of the true dorsal metatarsal head. Yee and Lau[7] reported evidence supporting use of cheilectomy in Hattrup stage I and II but not in patients with stage III disease. Coughlin and Shurnas[5] noted that cheilectomy seems to decrease patient discomfort but does not alter the course of the disease process.

Although osteotomies have been described for treatment of hallux rigidus, they are used infrequently. Metatarsus elevatus can be seen in hallux rigidus, and osteotomies have been described to address the deformity. However, Coughlin and Shurnas[1] noted increased metatarsal elevatus corresponded to more severe hallux rigidus and thus felt it is a secondary change rather than a primary problem. Dorsiflexing proximal phalangeal osteotomies (ie, Moberg osteotomy) are infrequently performed, with few numbers of patients in published series.[7]

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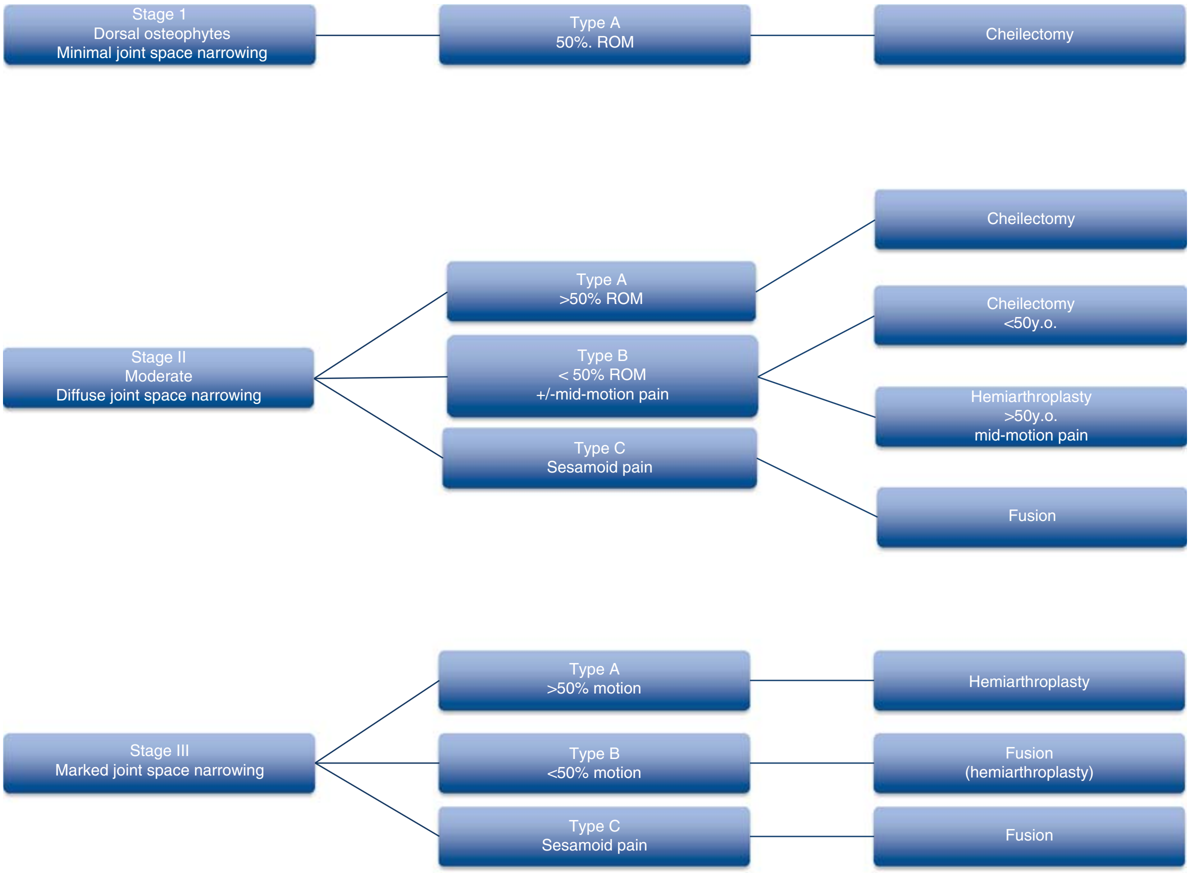

FIGURE 1. Hallux rigidus treatment algorithm. ROM indicates range of motion.

Silicone joint replacements are not recommended.[2,7] Silicone does not possess the mechanical characteristics to withstand mechanical forces associated with ambulation.[8] Failures associated with wear, osteolysis, subchondral cysts, and foreign body reactions have been widely reported.[2]

Procedures that involve replacement of the metatarsal head with a variety of prosthetic materials have mixed results.[2,7] These include total joint arthroplasties and metatarsal head hemiarthroplasties.[9,10] The dorsally directed forces that pass through the metatarsal prosthesis during ambulatory push-off commonly result in osteolysis or loosening[11–13] and dorsal migration, regardless of the material used. In addition, any misalignment of the first ray will result in asymmetric forces on the base of the proximal phalanx with the potential for the metal to erode into the bone.

Despite conflicting reports and limited studies with high levels of evidence,[7] the lead author has noted long-term success with the use of a metallic proximal phalangeal hemiarthroplasty. The phalangeal hemiarthroplasty[8,14,15] avoids the structural failure and wear that are inherent in silicone arthroplasty as well as the mechanical failures that are associated with shear forces in arthroplasty procedures of the metatarsal

FIGURE 2. Dorsal approach. Capsulotomy will be 2 mm medial to extensor hallucis longus tendon.

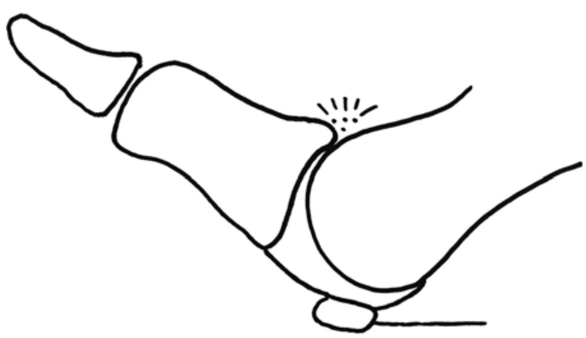

FIGURE 3. Plantar capsular tether leads to hinging motion and dorsal impingement.

FIGURE 4. A 15-mm McGlamry elevator.

head. The procedure preserves some motion while decreasing pain through joint decompression and resurfacing. Other advantages include rapid convalescence and ease of revision in rare cases of failure. The hemiarthroplasty gives patients an alternative when the pathology is too severe to warrant a cheilectomy, but clinical findings and/or patient preference make fusion less attractive.

Soft tissue interposition procedures have been developed to avoid the need for arthrodesis. The interposition spacers include capsule,[16] tendon,[17–19] combined tendon and capsule,[20] and regenerative tissue matrix.[21] Although presently there is insufficient evidence to recommend soft tissue interposition,[7] it can be considered for the same indications as described for hemiarthroplasty. The authors do not presently perform soft tissue interposition procedures.

The Keller resection arthroplasty procedure[22,23] is typically reserved for patients with low forefoot functional demands.[7] The technique unloads the arthritic joint. The amount of resection required can result in the release of stabilizing soft tissue attachments, leading to cock-up deformity,[22,24–29] transfer metatarsalgia,[22,24,26,28–32] and shortening.[24,27,33–35] An oblique modification of the ostectomy may lessen the occurrence of postoperative instability and deformity.[36] The Keller resection arthroplasty is also a viable option in neuropathic patients with hallux rigidus. These patients often present with interphalangeal (IP) neuropathic ulcers. The destabilization resulting from the Keller procedure unloads the IP joint.

Arthrodesis is the mainstay of treatment for advanced hallux rigidus. It predictably relieves pain, although it permanently alters gait and transfers dorsiflexion forces to the IP joint. Achieving optimal alignment can be difficult. Despite these drawbacks, patient satisfaction is generally high and the procedure is considered the gold standard to which other procedures are compared.

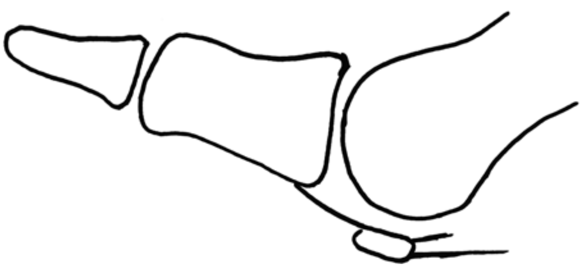

FIGURE 5. Plantar tether after release with McGlamry elevator, restoring concentric ball-and-socket motion and lessening dorsal impingement.

FIGURE 6. Stage I hallux rigidus. Dorsal 1/3 of metatarsal head is devoid of cartilage. Dorsal osteophytes noted on metatarsal head and proximal phalanx.

RECOMMENDATIONS

The recommended procedures in this algorithm maintain motion when present, respect the significance of mid-motion pain, and address plantar pain when the sesamoids are severely involved (Fig. 1). Surgical options with difficult salvage are best avoided. Failed cheilectomy or hemiarthroplasty can easily be salvaged with fusion and would not require intercalary grafting.

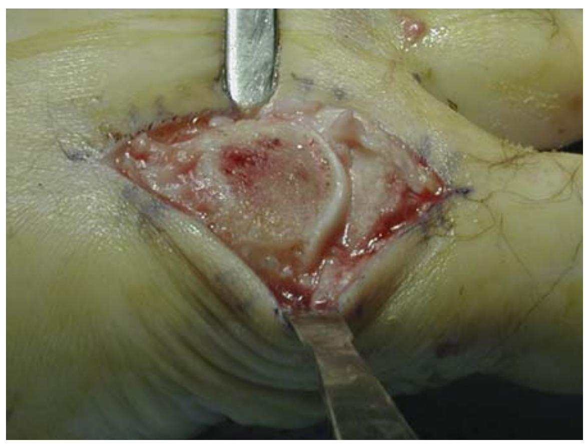

FIGURE 7. Cheilectomy. Osteophytes removed from metatarsal head and proximal phalanx; 1/3 of dorsal metatarsal head excised.

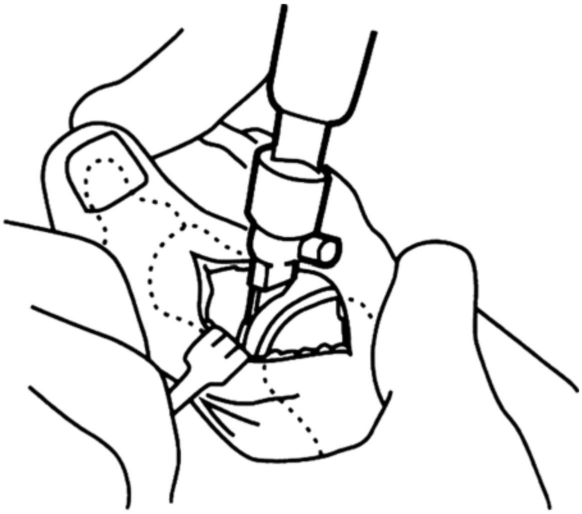

FIGURE 8. Resection of metatarsal head with oscillating saw during hemiarthroplasty.

Cheilectomy remains the procedure of choice for stage I patients (mild hallux rigidus). Counseling is provided regarding the continued natural progression of the disease.

Stage IIA and IIB patients typically present with dorsal degenerative articular cartilage defects of <50% of the metatarsal head. These can be treated with cheilectomy or hemiarthroplasty (or soft tissue interpositional arthroplasty). In younger (<50) patients, we typically proceed with cheilectomy, reserving the hemiarthroplasty for patients over 50. If more significant articular cartilage loss is noted intraoperatively, a planned cheilectomy can easily be converted to a hemiarthroplasty with identical postoperative protocols.

Stage IIIA patients have well-retained motion, despite significant arthrosis. We typically recommend hemiarthroplasty in these patients to preserve some motion.

Stage IIIB patients already have stiffness, so fusion is typically performed. A hemiarthroplasty can be considered for those opposed to fusion.

Stage IIC or IIIC patients are best treated with a fusion. Motion-sparing procedures are less desirable in the face of significant pain in the sesamoid articulation. Fusion limits the motion of the damaged sesamoids on the metatarsal head and lessens the chance of failure due to plantar pain.

Special Cases: Deformity and Neuropathy

Patients with MTP arthritis and deformities (hallux valgus or varus or sagittal plane deformities) are best treated with fusion.

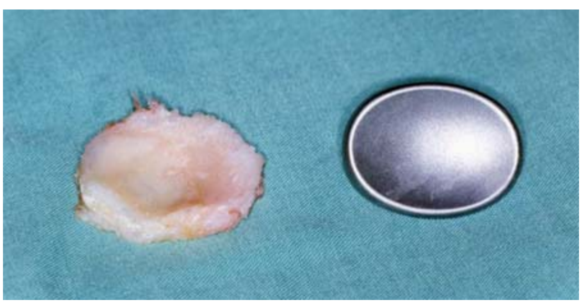

FIGURE 9. Resected bone matched to trial for sizing during hemiarthroplasty.

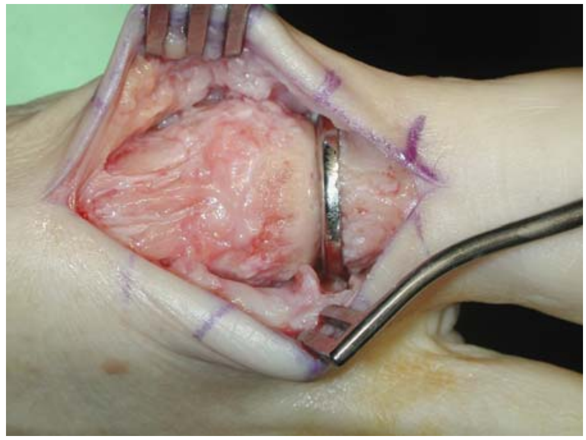

FIGURE 10. Implanted hemiarthroplasty.

The procedure predictably addresses both the arthrosis and deformity.

In cases of significant neuropathy, great toe arthrodesis should typically be avoided. Increased ambulatory forces on the IP joint can lead to recurrent ulceration. Neuropathic patients with symptomatic hallux rigidus are treated with cheilectomy if the pathology is mild. When hallux rigidus is severe or IP ulcers are present, a Modified Keller resection arthroplasty is recommended.

Surgical Techniques

Cheilectomy, hemiarthroplasty, and fusion are all approached through an identical dorsal approach. The skin is incised longitudinally in line with the extensor hallucis longus tendon (Fig. 2). An arthrotomy is performed 1 or 2 mm medial to the tendon, leaving a capsular cuff to allow later watertight capsular closure. Subperiosteal dissection is carried out circumferentially around the metatarsal head. All dorsal, medial, and lateral osteophytes are removed from the metatarsal head and proximal phalanx.

It is essential in a motion-sparing procedure to eliminate any plantar tethers blocking dorsiflexion. In patients with prolonged stiffness, the plantar capsule is often contracted and adherent to the metatarsal neck. Failure to address this pathology will result in a hinging motion rather than the normal ball-and-socket gliding (Fig. 3). In the plantar-restricted hinge,

FIGURE 11. Lateral radiograph 8 years after hemiarthroplasty.

FIGURE 12. Anteroposterior radiograph 8 years after hemiarthroplasty.

dorsiflexion forces are directed to the dorsal joint, resulting in painful localized compression. A 15-mm McGlamry elevator (Fig. 4) facilitates atraumatic release of these adhesions during cheilectomies, hemiarthroplasties, and interpositional arthroplasties (Fig. 5). Care must be taken to avoid damaging the metatarsal-sesamoid articulation.

Cheilectomy

Following the above surgical approach, the magnitude of the articular cartilage loss at the metatarsal head is evaluated (Fig. 6). An osteotome is used from proximal to distal, first removing dorsal osteophytes in line with the metatarsal shaft. Medial and

FIGURE 14. Checking sagittal plane alignment with a flat edge during arthrodesis.

lateral osteophytes are removed. In cases with a large medial or lateral eminence, more bone is excised to further decompress the capsule, but care is taken to preserve the sagittal sulcus. A second dorsal osteotomy is performed, resecting 25% to 30% of the dorsal metatarsal head, depending on articular involvement. A rongeur is used to round over sharp bone edges and corners. Similarly, the proximal phalanx (P1) is debrided of osteophytes. An angular ostectomy can be performed on the P1 removing 10% to 30% of the joint surface if articular cartilage is damaged (Fig. 7). The McGlamry elevator is used as described above if plantar tethering is noted. Once the ostectomies and soft tissue releases are complete, there should be at least 70 degrees of unimpinged dorsiflexion. Exposed bleeding bone can be sealed with bone wax. The joint is irrigated, and the capsulotomy repaired with 2.0 Vicryl. The subcutaneous tissue and skin are coapted sequentially. A sterile compression dressing is applied. Immediate weight bearing is allowed in a stiff rocker-bottomed postoperative shoe. The dressing can be removed 2 days postoperatively, and gentle passive motion is encouraged. Shoewear is permitted when swelling and comfort allow.

Hemiarthroplasty

A standard dorsal approach is used. The exposure is augmented by the preliminary resection of osteophytes on the metatarsal

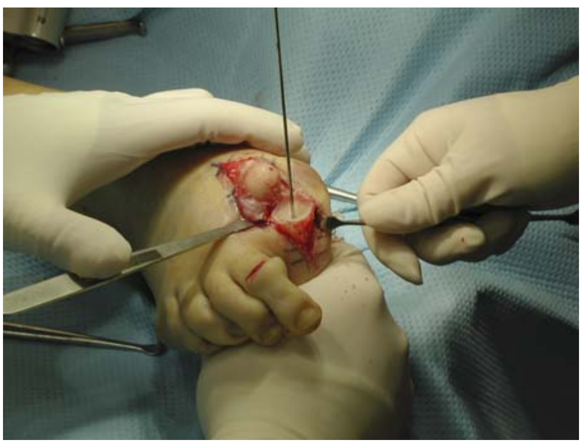

FIGURE 13. Reaming the proximal phalanx with plantar traction to protect the metatarsal head during arthrodesis.

FIGURE 15. A 3.5-mm stainless-steel cortical screw placed in lag manner across the metatarsophalangeal joint during arthrodesis.

FIGURE 16. A 1/3 tubular plate with 3.5 screws after lag screw fixation during arthrodesis.

head and base of the phalanx. The articular surface of the phalanx is osteotomized with an oscillating saw (Fig. 8), and sufficient bone is resected to accommodate the thickness of the articulating plate of the implant. As the resected fragment is removed, any remaining plantar capsular attachments are released carefully by subperiosteal dissection to avoid releasing the short flexor tendon insertion. The resected bone can be assessed to help determine the size of the prosthesis and to assure that the bone removed is slightly thicker than the implant (Fig. 9).

Any remaining marginal osteophytes are resected completely from the medial, dorsal, and lateral metatarsal head to allow normal, unimpinged motion of the joint. The McGlamry elevator is used to release plantar capsular adhesions. A slotted sizing template, which approximates the dimensions of the osteotomized phalanx, is used to assist creation of an intramedullary ingress for the implant stem. With the template slot maintained precisely in the transverse plane, a delineating mark is made on the bone surface with a punch or marking pen. A trial is inserted and checked for sizing and motion. Modest traction is applied to the toe. If the articulation cannot be separated by at least 3 mm, the implant is removed and more bone is resected. The trial is removed, and the bone aperture is enlarged with the diamond-shaped osteotome to accommodate the geometry of the stem and to allow flush seating of the implant. Insertion sometimes is difficult and may be facilitated by an assistant applying manual traction longitudinally and with the toe maximally plantarflexed. The implant is seated with compression against the metatarsal head or with the polyethylene-ended impactor (Figs. 10–12). Routine closure is performed as described above for cheilectomy, and active and passive motion is initiated within days. Formal physical therapy can be initiated within 2 weeks in cases of stiffness. Shoewear is advanced based on comfort.

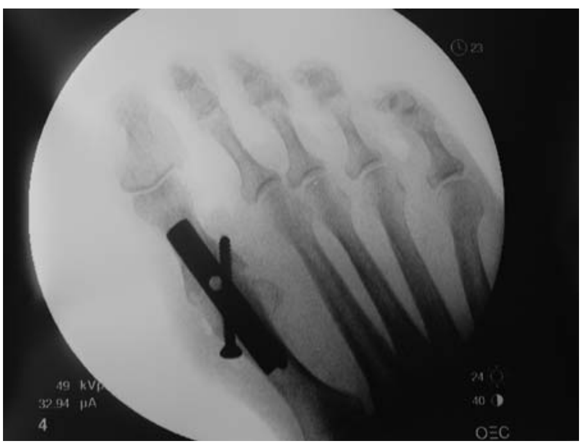

FIGURE 17. Anteroposterior radiograph of lag screw and plate fixation after fusion.

Keller Procedure (Modified Oblique)

This procedure is rarely used, outside of neuropathic patients and infirm patients with very low demands. The standard dorsal approach and marginal osteophyte resection are performed. A modified oblique proximal phalangeal osteotomy is performed as described by Mroczek and Miller,[36] removing 1 to 1.5 cm of bone from the dorsal base of the proximal phalanx but leaving the plantar cortex and soft tissue attachments intact. Routine closure is performed, with advancement of shoewear and activities as tolerated.

Arthrodesis

The standard dorsal approach, marginal osteophyte resection, and plantar release (McGlamry) are performed. The hallux is maximally plantar flexed to expose the metatarsal head. The proper-sized cannulated conical reamer is chosen and held manually against the metatarsal head and used as a drill guide for the intramedullary guide pin. This technique allows easy central pin placement. All articular and subchondral bone is carefully reamed using Homan retractors to protect the soft tissues.

Longitudinal-directed and plantar-directed manual traction is then applied to the plantarflexed proximal phalanx. This will typically provide sufficient clearance to allow reaming of the proximal phalangeal articular surface without damaging the metatarsal head with the reamers (Fig. 13). The site is irrigated. Multiple 1.5- to 2-mm drill holes are placed in the articular surfaces, leaving the resulting slurry as bone autograft.

The MTP joint should then be positioned in 5 to 10 degree of dorsiflexion (relative to the ground), 10 to 15 degree of valgus, and neutral in the axial plane (0 degree of pronation or supination).[37,38] Proper dorsiflexion is indicated by 2 to 5 mm of clearance between the great toe and a flat surface placed under the foot intraoperatively (Fig. 14). If associated surgery is required on the second toe, it should be performed first to use the second toe as a guide for proper hallux valgus positioning. When proper position is achieved, the joint is temporarily fixed with a Kirschner wire and position confirmed visually and radiographically.

Rigid compression fixation is mandatory. Biomechanically, single lag screw fixation with dorsal plate neutralization yields a strong construct.[39] The authors' preferred technique uses a 2.7- or 3.5-mm stainless-steel cortical screw inserted either proximal to distal or distal to proximal in a lag manner (Fig. 15). Alternately, a headless cannulated screw can be used. This is followed by screw fixation through a stainless-steel dorsal plate. A 3- to 5-hole one-third tubular or 2.7 low-contact dynamic compression plate can be contoured or a prefabricated dedicated fusion plate can be used (Fig. 16). A recent study suggests a higher nonunion rate with a locked construct.[40] We prefer to use a locking plate with nonlocking screws, which can be replaced by locking screws in cases of questionable purchase. Standard closure is performed. Postoperatively, the patient avoids weight bearing on the forefoot for 6 to 8 weeks or until radiographic union is noted (Fig. 17). Gait can be improved with rigid rocker-soled shoes.

CONCLUSIONS

We present a classification system and surgical algorithm for treatment of the varied manifestations of hallux rigidus. Classification includes radiographic findings, motion restriction, and location of pain to better guide appropriate surgical choices. Recommended procedures attempt to preserve motion when present and respect and address the significance of mid-motion and sesamoid pain.

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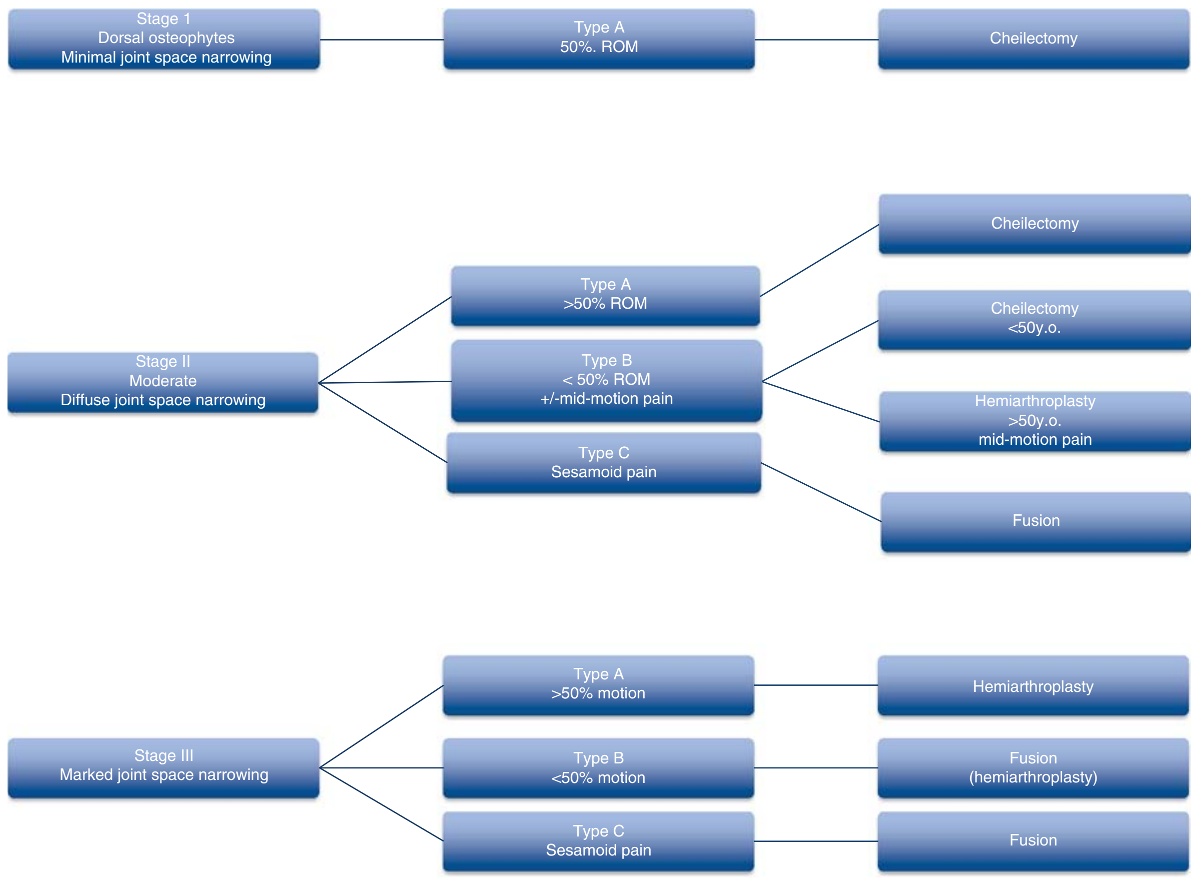
APPENDIX

Taranow WS, Moore JR. Hallux Rigidus: A Treatment Algorithm. *Tech Foot Ankle Surg*. 2012;11:65–73.



ALGORITHM. Hallux rigidus treatment algorithm. ROM indicates range of motion.