

THERE'S HOPE WITH THE HOKE

Matrona Giakoumis, DPM

John A. Ruch, DPM

HISTORICAL REVIEW

Michael Hoke originally presented an operation for what he called “extremely relaxed flat feet” in Memphis, Tennessee on April 17, 1931 at the meeting of the American Orthopaedic Association (1). He reported on the use of the naviculocuneiform (NC) arthrodesis on lengthened, abducted, severely pronated feet with increased motion in the mid-tarsal and metatarsotarsal joints. An Achilles tendon lengthening was performed along with the arthrodesis that included a rectangular receptacle within the navicular and cuneiform into which a rectangular shaped graft from the tibia was placed. Several years earlier, in 1927, Miller had published on the use of the NC arthrodesis on the adolescent or pre-adolescent relaxed foot in conjunction with arthrodesis of the first metatarsocuneiform joint (2).

After personal communication with Hoke, Butte (3) repeated the procedure in a total of 72 patients comprising of 138 feet. The average age of the patient population was 14 years. Butte found that the ideal time for the operation ranged from 10-15 years of age. At the conclusion of the study, the following conditions were considered ideal for the NC arthrodesis: nonobese, early adolescent child, non-severely pronated foot type, primary medial column sag at the NC joint, absence of any significant deformity at other tarsal bones, and a nonarthritic ankle joint.

In 1951, Jack (4) read his paper on the NC fusion at the annual meeting of the British Orthopaedic Association in Edinburgh. He analyzed lateral radiographs of 46 feet and determined that 3 anatomical types of flat foot existed. The type could be determined by drawing a line through the axis of the navicular. That line indicated the location of the break in the arch and it occurred either at the talonavicular joint, naviculocuneiform joint, or at both the talonavicular joint and naviculocuneiform joint. Jack reported that when the break occurred at the NC joint, fusion at this level would correct the deformity with an 82% satisfactory rate.

Similar to the earlier proponents of the procedure, the senior author has found the naviculocuneiform arthrodesis to be an ideal procedure in a certain pediatric pes planovalgus population where there is a loss of sagittal plane structural integrity along the medial column, specifically at the naviculocuneiform joint.

ANATOMY

It has often been said the 5 midfoot bones, the navicular, medial cuneiform, intermediate cuneiform, lateral cuneiform, and cuboid bone, form the keystone of the medial arch of the foot. The medial longitudinal arch of the foot is maintained by a complex interconnection of bones, ligaments and tendons. Among these is the articulation cuneonavicularis of the great tarsal joint or the NC joint. The NC joint is composed of the navicular proximally, also known as the scaphoid, and the 3 cuneiforms distally; interposed between the talus and the first 3 metatarsals respectively. The navicular is pyriform in shape with an obliquely oriented long axis, directed downward and medially. The enlarged apex serves as a main insertion point of the posterior tibial tendon (5). The cuneiforms are wedge-shaped with the narrower portion pointing plantarly, creating a keystone arch in the coronal plane. The main motion between these planar-shaped surfaces is gliding with some rotational movements that take place primarily during pronation and supination of the foot (6). Due to this minimal motion, Hansen has defined this joint as nonessential (7).

In the normal weightbearing foot, the longitudinal axis of the first metatarsal and talus, defined as Meary's angle, forms a straight line on a lateral radiograph. In the collapsing pes planovalgus foot that is amenable to surgical correction by the NC arthrodesis, there will be a break in Meary's angle on a lateral radiograph at the NC joint (Figure 1). Typically, this is seen as a sag superiorly or as a gap inferiorly at the articulation between the navicular and medial cuneiform.



Figure 1. Lateral radiograph demonstrating breach of the naviculocuneiform joint.

SURGICAL TECHNIQUE

The NC arthrodesis is typically performed under general anesthesia with the patient in the normal supine position on the operating table. A mid-calf or thigh tourniquet is applied to the surgical limb and a bump can be placed under the contralateral hip to help facilitate external rotation of the surgical limb. Of note, collapsing pes planovalgus feet typically have some degree of equinus that must be addressed either through a gastrocnemius recession or Achilles tendon lengthening before dissection of the NC joint.

The key topographical landmarks, the navicular tuberosity, talonavicular joint proximally, and first metatarsocuneiform joint distally, are palpated. A controlled depth linear incision is made commencing on the medial and central aspect of the talonavicular joint and ending at the medial and central aspect of the first metatarsocuneiform joint (Figure 2). Dissection is carried through the skin, subcutaneous layer and down to the level of the deep fascia with care taken to maintain surgical hemostasis. Tributaries

coming off of the medial marginal vein will be encountered deep to the pseudo fascial layer and will require ligation. The vein is then retracted dorsally for the remainder of the procedure (Figure 3). The medial dorsal cutaneous nerve is typically superior to the incision and avoided. A saline moistened 4x4 gauze is utilized to bluntly dissect the subcutaneous layer off of the deep fascia, dorsal medially and plantar medially.

The inferior extensor retinaculum is located over the dorsal medial aspect of the medial cuneiform. It is subsequently incised at this level where it overlies the tibialis anterior tendon as it inserts on the medial cuneiform (Figure 4). The tibialis anterior tendon, now visualized, is flat and fan-shaped at this level and is undermined to mobilize it dorsally and distally in order to adequately visualize the NC joint (Figure 5).

The NC joint is subsequently palpated and manipulated in the sagittal plane. Exposure is performed with a T-shaped periosteal and capsular incision while maintaining a subperiosteal layer (Figure 6). Strategically, the medial column capsular dissection helps preserve soft tissues



Figure 2. Topographical landmarks are key. Palpate the navicular tuberosity, the talonavicular joint and the first metatarsocuneiform joint.

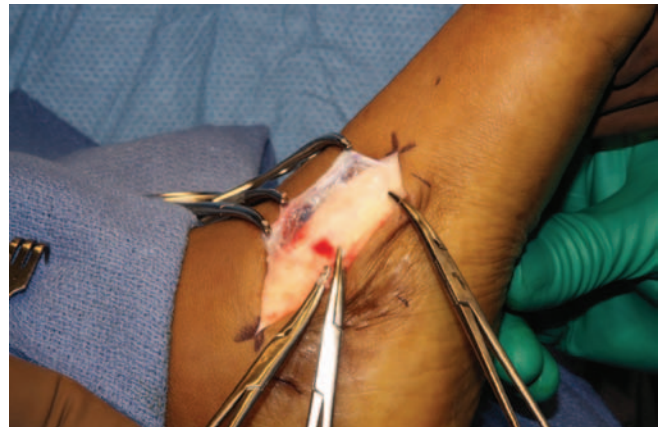


Figure 3. Hemostats are placed on the tributaries coming off of the medial marginal vein to be tied off. The vein can subsequently be taken dorsally.

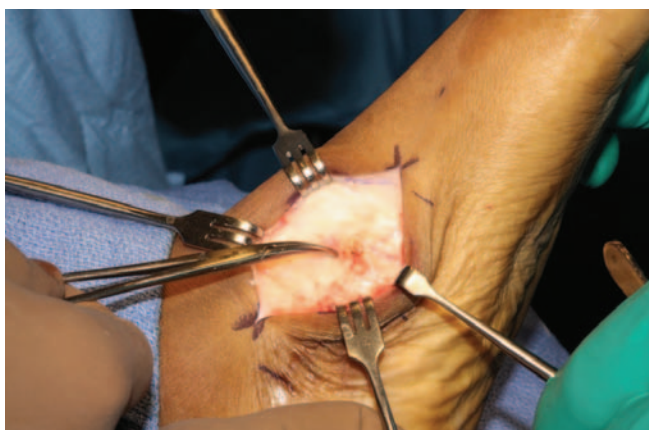


Figure 4. Inferior band of the extensor retinaculum overlying tibialis anterior is incised.



Figure 5. Tibialis anterior is undermined and mobilized dorsally and distally.

around the joint. Joint distraction is obtained with the use of an AO mini distractor. One pin is placed in the navicular from dorsal medial to plantar lateral and the other one in the medial cuneiform and intermediate cuneiform in a similar manner (Figure 7).

Preparation for arthrodesis is performed following Glissan's principles of arthrodesis (8). Utilizing contour joint resection with a 10 mm wide osteotome and a mallet, the articular cartilage and subchondral bone plate is completely denuded from the articular surfaces of the navicular, medial cuneiform, and intermediate cuneiform. If accessible, the lateral cuneiform is prepared as well, however, it is not necessary for the final success of fusion. Alternatively, a mix of hand and power instrumentation including curettes, saws and burrs can be used for joint preparation. The proper depth is reached when cancellous bleeding bone is visualized (Figures 8 and 9), known as the "paprika sign" (9).

Once preparation is complete, distraction is reversed and the joint is placed in the anatomically corrected position with good bone-to-bone contact (Figure 10). Alignment

can be facilitated by activating the windlass mechanism or by plantarflexing the first ray. Subsequently, the AO mini distractor can be used to compress and maintain reduction while 3 guide wires are placed across the arthrodesis site. The first wire is inserted from slightly plantar central on the medial cuneiform to dorsal central on the navicular. The second wire is inserted from the navicular tuberosity to the distal lateral aspect of the intermediate cuneiform. The final wire is inserted from slightly dorsal central on the medial cuneiform to dorsal lateral on the navicular body. Intraoperative fluoroscopy is used to confirm placement and anatomic alignment with restoration of Meary's angle.

Permanent fixation is afforded with three 4.0 partially-threaded cancellous screws. Deep closure is performed in a layered manner with 3-0 Vicryl suture in an over-and-over fashion. The subcutaneous layer is subsequently reapproximated with 4-0 Vicryl suture in a running fashion and the skin is closed with 5-0 Vicryl suture in a running subcuticular fashion. A dry sterile dressing and below-knee Jones compression cast are applied.

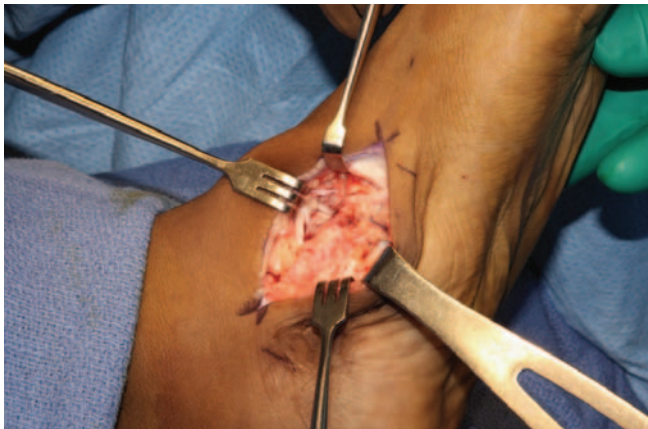


Figure 6. A T-shaped periosteal and capsular incision is created over the naviculocuneiform joint.

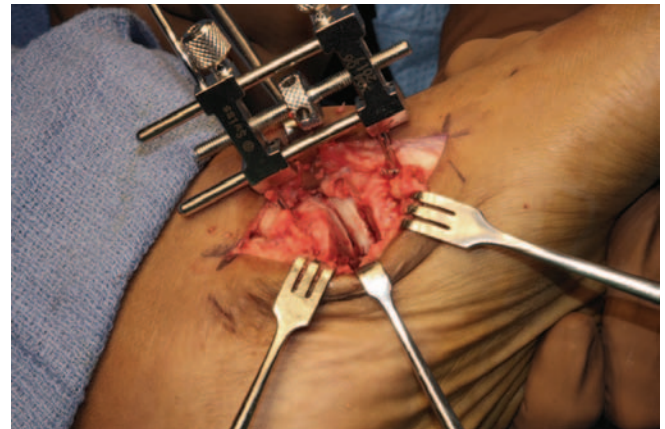


Figure 7. Distraction of the joint can be facilitated with various instruments such as the AO mini distractor.



Figure 8. Arthrodesis is prepared by contour joint resection utilizing a 10 mm osteotome and mallet.

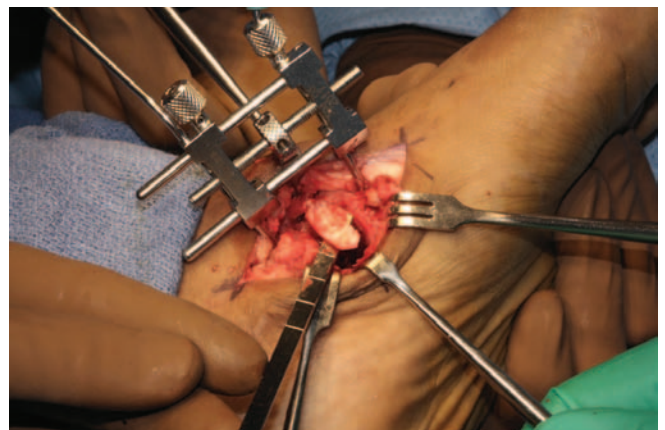


Figure 9. Contour joint resection is performed down to cancellous bleeding bone, taking care to remove all articular cartilage and subchondral bone plate.

POSTOPERATIVE CARE

On the first postoperative visit, the Jones compression cast is removed and if everything looks good, a below-knee permanent cast is applied. On average, the patient remains

non-weightbearing for 6-8 weeks and is transitioned to a walking boot once evidence of arthrodesis is observed radiographically.

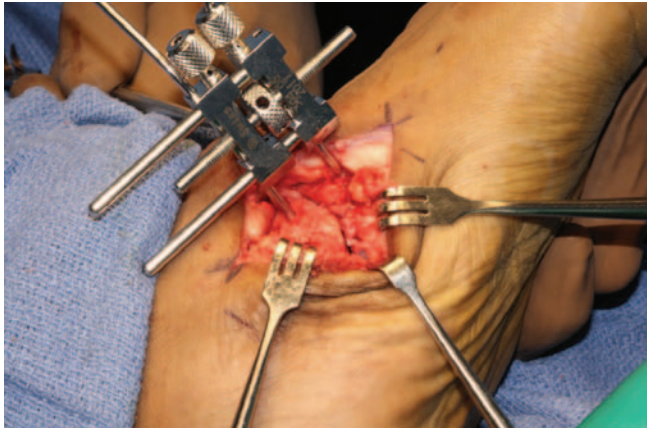


Figure 10. With release of the distraction, bone to bone apposition is noted as well as anatomic realignment.

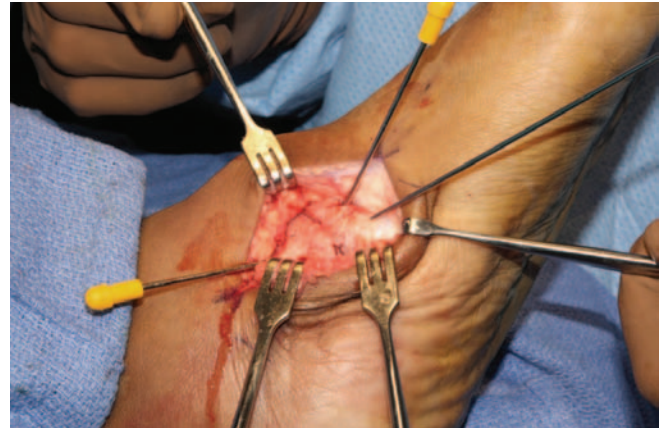


Figure 11. Placement of guidewires across the arthrodesis site.



Figure 12. Insertion of first screw



Figure 13. Insertion of second screw.



Figure 14. Insertion of last screw.



Figure 15. DP view of final construct.



Figure 16. Lateral view of final construct.

REFERENCES

1. Hoke M. An operation for the correction of extremely relaxed flat feet. *J Bone Joint Surg Am* 1931;13:773-83.
2. Miller O. A plastic foot operation. *J Bone Joint Surg* 1927;9:84-91.
3. Butte FL. Navicular-cuneiform arthrodesis for flat-foot. *J Bone Joint Surg Am* 1937;19:496-502.
4. Jack EA. Naviculo-cuneiform fusion in the treatment of flat foot. *J Bone Joint Surg Br* 1953;35:75-82.
5. Kelikian AS, Sarrafian, SK. Osteology. In: Sarrafian's *Anatomy of the Foot and Ankle: Descriptive, Topographic, Functional*. 3rd ed. Philadelphia, PA; Lippincott Williams & Wilkins; 2011.
6. Draves DJ. Arthrology of the ankle and foot. In: *Anatomy of the lower extremity*. Baltimore (MD): Williams & Wilkins; 1986. p. 146-81.
7. Hansen SV. Functional anatomy. In: *Functional reconstruction of the foot and ankle*. Philadelphia, PA; Lippincott Williams & Wilkins; 2000.
8. Glissan DJ. The indications for inducing fusion at the ankle joint by operation, with description of two successful techniques. *Aust N Z J Surg* 1949;19:64-71.
9. Cierny G, Mader JT, Pennick JJ. The classic: A clinical staging system for adult osteomyelitis. *Clin Orthop Relat Res* 2003;414:7-24.