CHAPTER **26**

FIRST METATARSOPHALANGEAL JOINT ARTHRODESIS: Practical Aspects of the Repair

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Arthrodesis of the first metatarsophalangeal joint (MTPJ) has gained in popularity in recent years. Refinements in technique and fixation have made the procedure more acceptable to the surgeon. Careful attention to great toe alignment and position has made the procedure more acceptable to the patient. First MTPJ arthrodesis has been primarily considered a salvage procedure. It is gaining acceptance as a primary reconstructive option. Little has been written on either the technique of joint resection or the manipulations of arthrodesis alignment to assure acceptable and consistent postoperative results.

Refinements in bone resection options at the first MTPJ and indications for application will be reviewed. The specific techniques for bone and cartilage resection that are proven and versatile will be emphasized. The position of first MTPJ fixation is critical. Basic universal angular assumptions are not always applicable. Individual foot functional and structural concerns will be identified that influence fixation choices and alignment concerns. Recognition of these factors will aid in acceptable functional results. These principles and concepts will be presented in a clinically illustrated format to aid in understanding and application.

OSSEOUS RESECTION

Two basic techniques for bone resection are possible for an effective first MTPJ arthrodesis. The differences in the two techniques lie primarily in the amount of bone removed from the first metatarsal. The first technique involves resection of all or most of the first metatarsal head. The remaining first metatarsal stump is contoured and rounded to a dome shape to accept the rounded phalangeal cup resection. This technique is utilized primarily in conjunction with pan metatarsal head resections. By removing the entire first metatarsal head a more even distal weight-bearing metatarsal and digital parabola is maintained in pan metatarsal head resections. Otherwise, an elongated and rigid first ray segment is created that is typically unacceptable to the patient.

The second technique for first metatarsal head resection involves leaving the first metatarsal head primarily intact. The osteocartilaginous surface is resected from the distal metatarsal head area. The rounded or dome shape of the metatarsal head is maintained to accept the rounded phalangeal cup resection. First ray length is not lost with this joint resection technique. The weight-bearing metatarsal and digital parabola is maintained when resection of the lesser metatarsal heads is not performed.

The phalangeal cup osteocartilaginous resection is similar in both first metatarsal resection techniques. The cartilage and subchondral bone of the proximal phalanx is resected to maintain a cup shape. A cup-in-dome arthrodesis site is created in both metatarsal head resection options. The cup-in-dome contouring technique allows for versatility in arthrodesis alignment intraoperatively, without constant refitting and remodeling concerns. Peg-in-hole or cone-in-cup type arthrodesis are not as versatile in fine tuning the critical position of fusion on the operating table.

ILLUSTRATIVE FIGURES

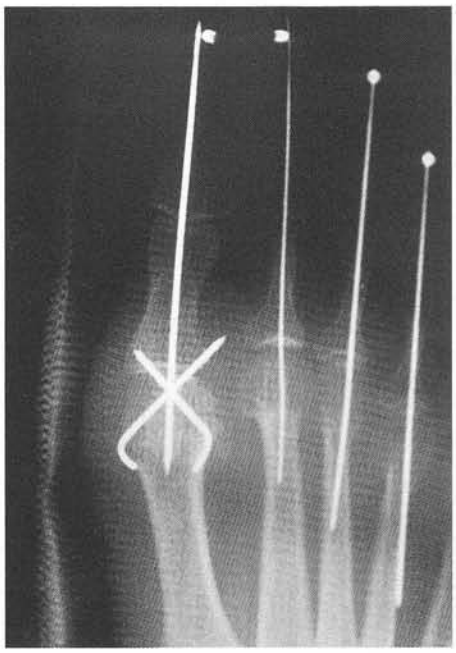

Figure 1. First MTPJ arthrodesis with primarily osteochondral resection of both joint surfaces and maintenance of first ray length relative to the lesser rays.

Figure 2. First MTPJ arthrodesis with first metatarsal head resection to establish metatarsal weight-bearing parabola with accompanying pan metatarsal head resection.

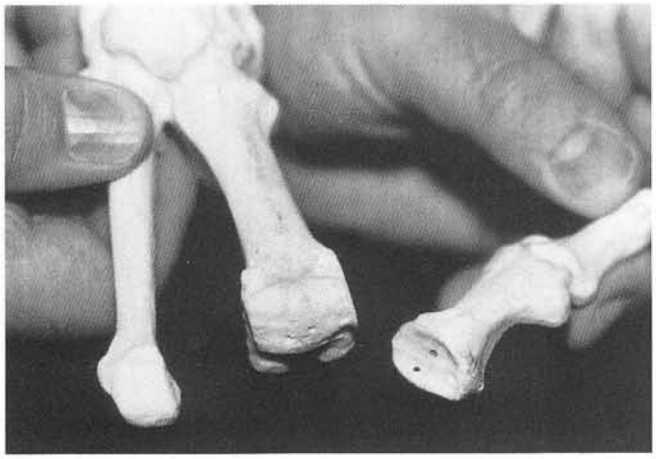

Figure 3. Bone model representation of maintenance of rounded contours of first MTPJ arthrodesis with osteochondral resection.

Figure 4. Bone model representation of maintenance of rounded contours at first MTPJ arthrodesis site with first metatarsal head resection.

FIXATION OPTIONS

Many possibilities of internal and external fixation and combinations of fixation are available, and have been described for the first MTPJ arthrodesis. Clinical factors such as osteopenia, bone graft needs, and type of metatarsal head and phalangeal base resection contours may warrant special fixation needs. Percutaneous and buried pins, plates, and various screw types and sizes have all been described.

A combination of buried crossed pins and a linear percutaneous pin provide very adequate stability in most cases. This pin fixation option is quick and generally easy to perform. Once the critical alignment of the arthrodesis has been established intraoperatively, pin fixation does not tend to pull or misalign the arthrodesis site from the desired position. Screws and plates can misalign the arthrodesis position as they are applied and tightened. The critical arthrodesis alignment must be constantly monitored and checked regardless of the type of fixation utilized. Additional surgical time and experience is needed for application of the screw or plate option. The pins provide an adequate degree of stability both in osteopenic and normal bone density states. The crossing arrangement of pins prevents movement in all body planes at the arthrodesis site. The pins are easily removable. They may be left percutaneous or buried. Generally, a 0.062-inch Steinmann pin or larger is preferred. Smaller pin diameters have not proven stiff enough for the rigidity necessary to maintain the alignment.

ILLUSTRATIVE FIGURES

Figure 5. First MTPJ arthrodesis with buried pin fixation alone.

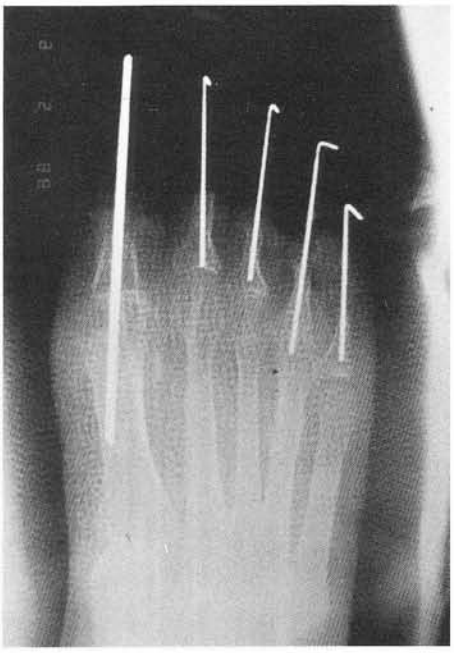

Figure 6. First MTPJ arthrodesis with single linear percutaneous pin fixation.

Figure 7. First MTPJ arthrodesis with cross screw fixation.

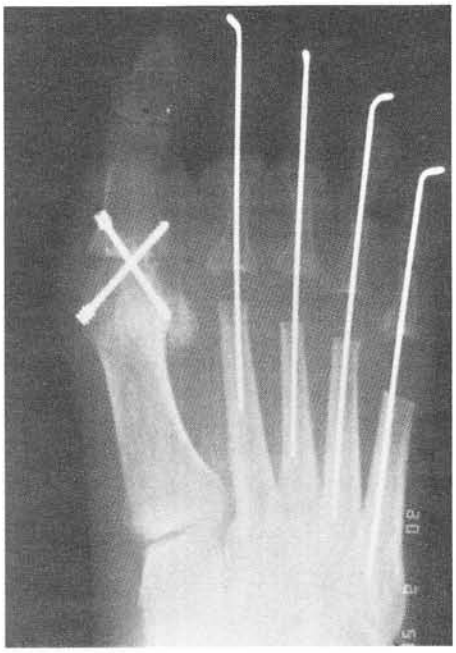

Figure 8. First MTPJ arthrodesis with crossed Herbert screw fixation.

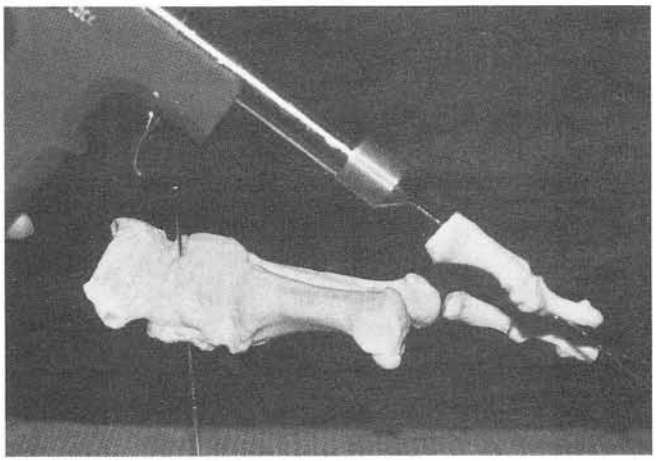

Figure 9. Pin fixation technique: The linear percutaneous pin is driven first. It is directed through the base of the proximal phalanx, out the distal aspect of the digit

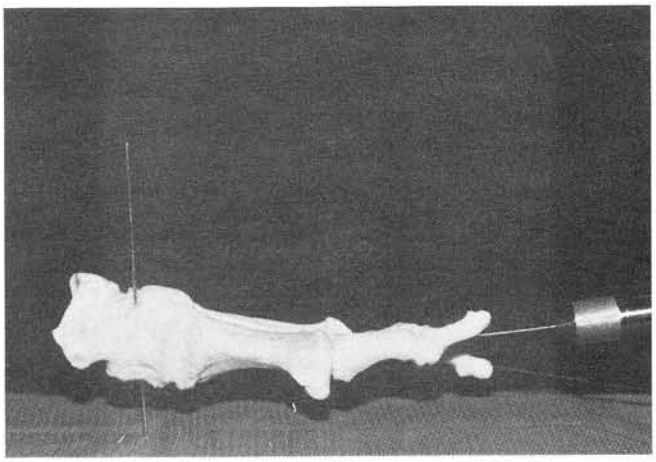

Figure 10. With the arthrodesis site held in the desired position, the linear percutaneous pin is then driven proximally into the first metatarsal.

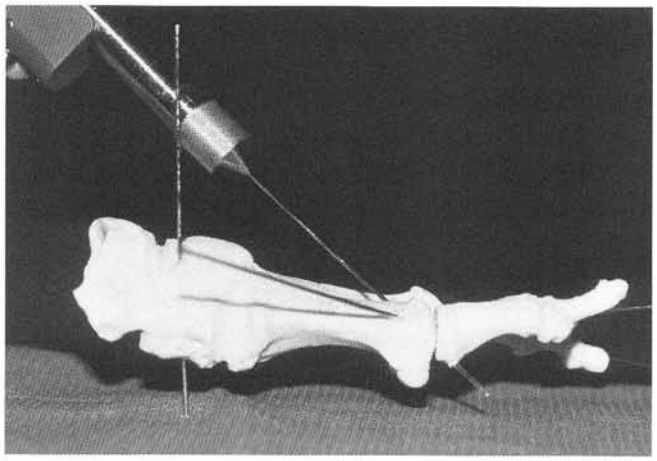

Figure 11. The buried crossing pins are then introduced from proximal to distal across the arthrodesis site.

POSITION OF ARTHRODESIS

The ideal position of fusion of the first MTPJ arthrodesis is similar in all cases. Some variations have been suggested such as to position the great toe for a particular shoe or activity need. The positional alignment of the great toe is in actuality varied minimally from case to case in application. The variations in position are primarily sagittal plane with greater or lesser degrees of dorsiflexion of the proximal phalanx on the metatarsal. Dorsiflexion to accommodate higher-heeled shoes or specific activity needs generally results in difficulties postoperatively. Hallux hammertoe contracture can be expected at the interphalangeal joint over time. Barefoot walking or sandals can be difficult and unsightly to the patient. These concerns should be reviewed with the patient preoperatively. The patient will be confined to those shoes that accommodate the hallux dorsiflexed position only. The frontal and transverse planes vary little from case to case and minimal manipulation of position is possible. No specific angular alignment of the first MTPJ arthrodesis applicable to all cases is possible to establish. General principles of alignment, however, are universal in application.

In the transverse plane the great toe should be aligned close, but not touching the second toe. This transverse plane position avoids interdigital pressures laterally on the great toe and medially on the second toe. Alignment in the transverse plane also helps avoid shoe pressure and fit problems medially on the great toe. The position of arthrodesis of the first MTPJ in the transverse plane requires

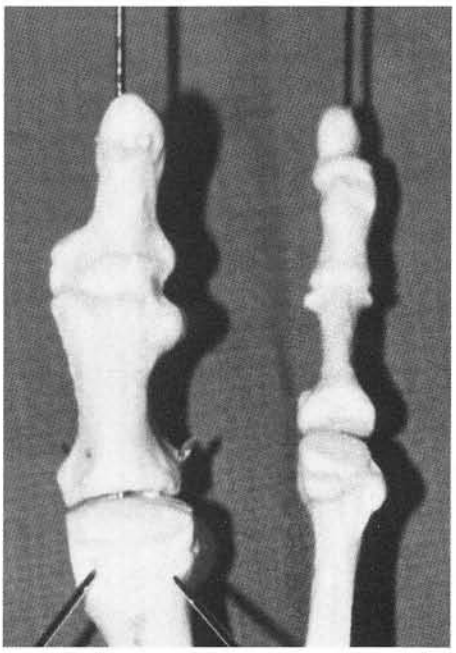

Figure 12. Final position of fixation of all pins. Refer to Figures 1 and 2 for comparison of radiographic evaluation.

establishing the second toe position first, if concomitant second digital deformity exists. It is impossible to appreciate the alignment of the great toe in the transverse plane until the second toe position has been established. If correction of lesser digital deformities is performed with arthrodesis of the first MTPJ, their correction and alignment must be established before any transverse plane alignment of the great toe can be determined.

In the frontal plane, the hallux nail should be positioned upwards or dorsally. The alignment of the hallux nail reflects the position of the medial and lateral condyles of the interphalangeal joint. The hallux nail and interphalangeal joint condyles alignment is parallel. The hallux interphalangeal condyles are parallel to the floor if the hallux nail is positioned upwards or dorsally. Positioning the hallux nail upwards ensures that the medial and lateral condyles of the interphalangeal joint are not rotated downward toward the weight-bearing surface. Frontal plane rotation of the interphalangeal joint of the hallux will result in pressure, pain, and lesions overlying the condyles plantarly. The tuft or pulp of the great toe following first MTPJ arthrodesis should contact the floor through the toe-off phase of gait and provide padding for weight bearing. If the unpadded and

unprotected interphalangeal condyles are rotated in the frontal plane, significant discomfort following arthrodesis of the great toe could result.

Frontal plane rotational problems of hallux positioning may easily be confused with inadequate dorsiflexion of the hallux in the sagittal plane. Both frontal and sagittal plane malpositioning can present clinically, with plantar interphalangeal hallux pressure and lesion complaints postoperatively. The frontal plane position of the hallux may not seem important. Patient complaints due to frontal plane malalignment can be as painful as sagittal plane malalignment problems.

The sagittal plane angulation of the great toe is of critical importance. The angular relationship of the proximal phalanx to the first metatarsal is not the critical alignment for assessment. It is more important to appreciate the angular alignment of the proximal phalanx to the floor. Variations exist in alignment of the first metatarsal to the floor whether a pes cavus or pes valgus foot type is present. Reliance on an angular relationship between the proximal phalanx and first metatarsal can be misleading. The alignment of the great toe to the floor is a more constant alignment and more reliable. The tuft of the hallux should be just off the weight-bearing surface at the mid-stance phase of gait following first MTPJ arthrodesis. The hallux can then rock onto the padded tuft area of the toe through the toe-off phase of gait. This alignment of the hallux to the floor is established regardless of foot type.

If the angular alignment of the proximal phalanx on the first metatarsal is overly dorsiflexed, hallux hammertoe may result. Hallux hammertoe with an arthrodesis of the first MTPJ can result in pressure and pain at the tip of the great toe against the floor as well as the interphalangeal joint against the toebox of the shoe. If the angular alignment of the proximal phalanx on the first metatarsal is overly plantarflexed, the tuft of the great toe will contact the floor prematurely during the toe-off phase of gait. Again, pressure and pain at the distal aspect of the toe will be noted postoperatively. The patient will be observed to walk as if in a hallux rigidus type gait pattern. A varus forefoot positioning or rolling of the foot in a lateral direction once hallux contact occurs will be noted. Fifth metatarsal lesions may be evidenced as in hallux rigidus. The first MTPJ arthrodesis foot should not function like a hallux rigidus foot. There is a major difference between the hallux rigidus foot and the first MTPJ arthrodesis foot, even though the first MTPJ does not move in either condition. That major distinction is the position of the great toe. The great toe in hallux rigidus contacts the floor at the mid-stance phase of gait. The great toe in first MTPJ arthrodesis does not contact the floor until later in the toe-off phase of gait. This distinction is important to appreciate. Varus angulation or rolling out of the forefoot does not occur until the tuft of the hallux contacts the ground prematurely and forces the forefoot laterally through the toe-off phase of gait. Sagittal plane alignment of the first MTPJ after arthrodesis in a slightly dorsiflexed attitude at the mid-stance phase of gait prevents a hallux rigidus pathological gait pattern.

ILLUSTRATIVE FIGURES

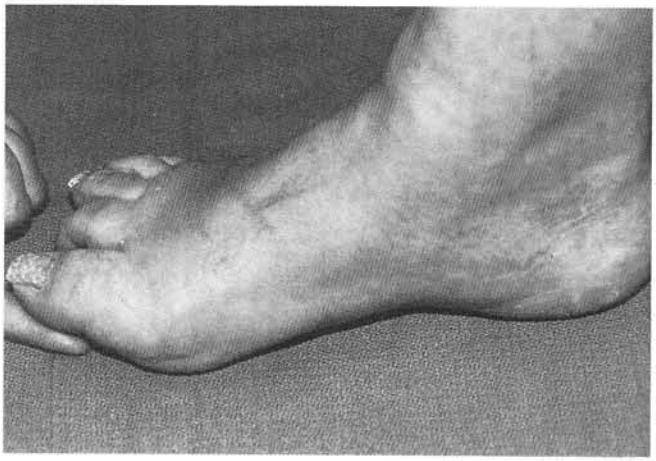

Figure 13. Preoperative relatively dorsiflexed attitude of the great toe. Non-purchase of the hallux is evident in a rheumatoid patient.

Figure 14. Postoperative alignment of the same patient showing slightly dorsiflexed attitude of the great toe with non-purchase of the hallux on mid-stance.

Figure 15. Position of fusion of the great toe with the hallux tuft just off the weight-bearing surface. This position is established regardless of first metatarsal angulation.

Figure 16. Toe-off phase of gait demonstrating contact of the tuft of the hallux to the floor, providing propulsion for weight bearing.

MANIPULATIONS OF ARTHRODESIS ALIGNMENT

Versatility for positioning of the first MTPJ arthrodesis intraoperatively is very helpful. Subtle angular changes must be possible on the operating table to fine tune positioning. The peg-in-hole or cone-in-cup type joint resections provide excellent bone-to-bone contact for arthrodesis. Subtle variations in positioning are extremely difficult. These arthrodesis techniques are very restrictive in terms of varying the position of the great toe if the alignment of the arthrodesis does not seem satisfactory upon completion of the resection technique itself. The dome-in-cup resection technique is easy to perform and provides broad angular alignment possibilities for the position of the great toe. It is in no way restrictive in its positioning. The dome-in-cup resection, as presented here, permits subtle adjustments and manipulations in alignment of the arthrodesis. A congruous fit and good contact of the resected joint surfaces is possible, and easy to establish in a variety of alignments. Two movements or manipulations of the first MTPJ arthrodesis are possible and should be appreciated with the dome-in-cup type arthrodesis technique. Appreciation of both of these maneuvers is critical to prevent misalignment, as well as aid in positioning of the great toe for the most optimal postoperative alignment.

The first movement possible through the dome-in-cup type arthrodesis arrangement is angular in nature. The cup type surface of the proximal phalanx can be located in a variety of angular positions on the dome surface of the first metatarsal in all body planes. This particular type of motion maintains the greatest degree of contact of the phalanx to the metatarsal. The movement represented here is an angular motion of the phalanx with respect to the metatarsal.

The second type of positioning maneuver possible at the arthrodesis site is a shifting or gliding type of motion. This type of motion can be effected in all body planes. A reduction of bone-to-bone contact at the arthrodesis site is possible that could impact healing and stability. It is primarily a secondary maneuver that can be helpful in fine-tuning and adjusting the position of fusion. It can also be utilized to eliminate bony prominences on the plantar phalangeal cup or dorsal metatarsal head area to maintain a smooth, even, outer bone surface. The actual movement represented here is not angular, but more of a shift in position. Both maneuvers will be reviewed in the clinically illustrated portion to follow.

ILLUSTRATIVE FIGURES

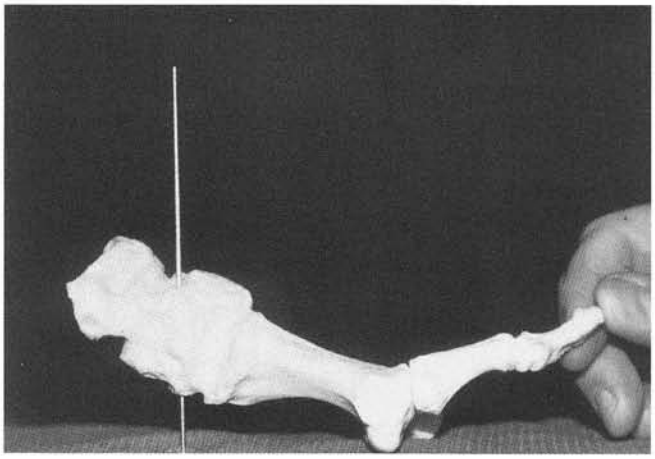

Figure 17. Bone model representation of angular dorsiflexion maneuver of the great toe.

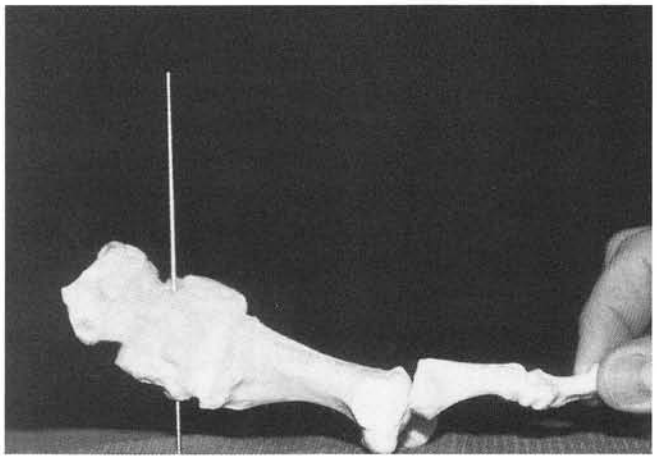

Figure 18. Bone model representation of shifting dorsiflexory maneuver of the great toe.

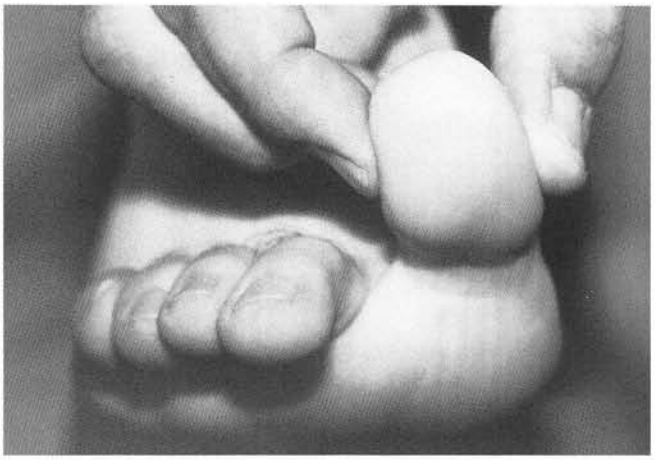

Figure 19. Clinical position of the great toe with angular dorsiflexion maneuver.

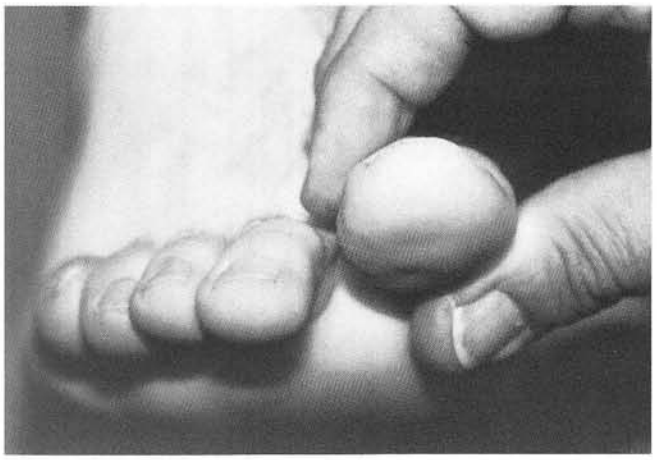

Figure 20. Clinical position of the great toe with shifting dorsiflexion maneuver.

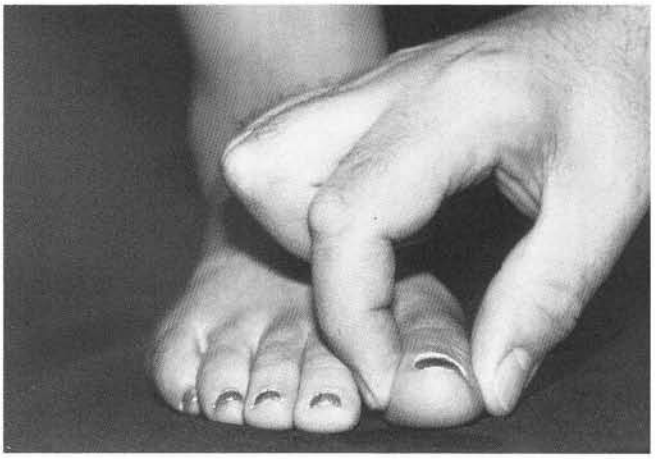

Figure 21. Neutral frontal plane position of interphalangeal joint condyles of the great toe.

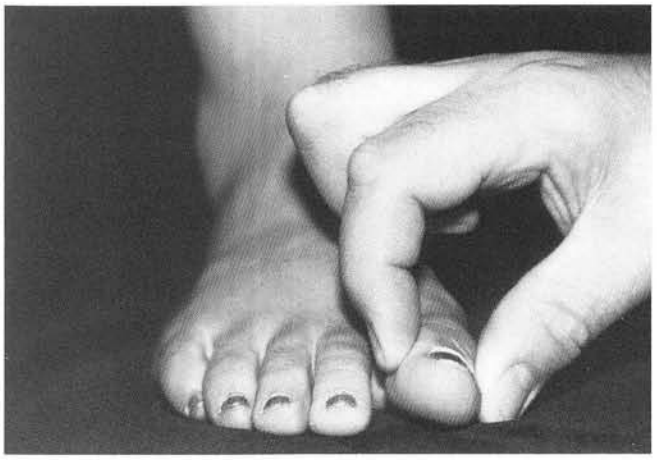

Figure 22. Unacceptable frontal plane varus angulation of interphalangeal joint condyles of the great toe.

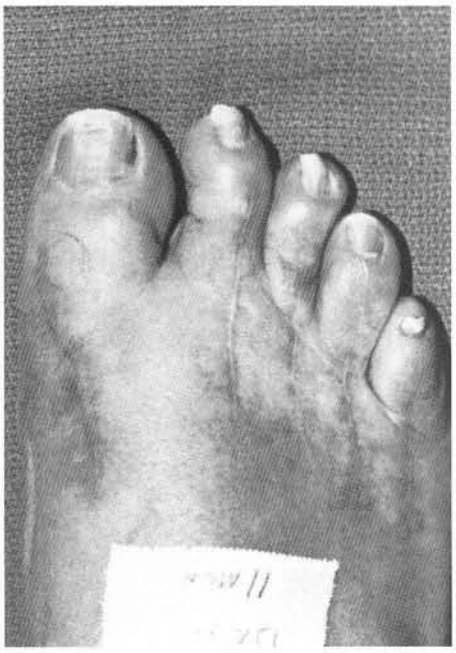

Figure 23. Dorsal view of neutral frontal plane positioning of the great toe with parallel plane alignment of the hallux nail to the weight-bearing surface.

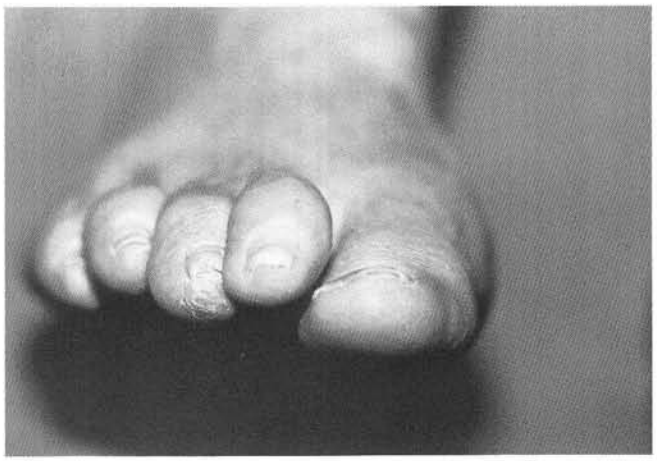

Figure 24. Frontal view of neutral frontal plane positioning of the great toe with parallel plane alignment of the hallux nail to the weight-bearing surface.

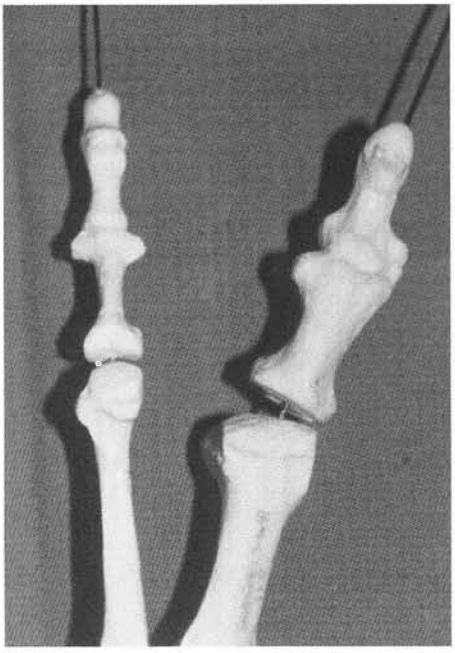

Figure 25. Bone model representation of adductory transverse plane angular alignment possibility of the first MTPJ arthrodesis site.

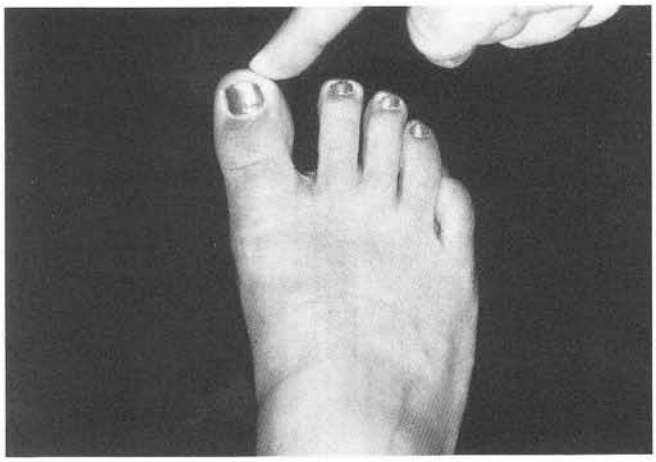

Figure 26. Clinical representation of adductory transverse plane angular alignment possibility of the first MTPJ arthrodesis site.

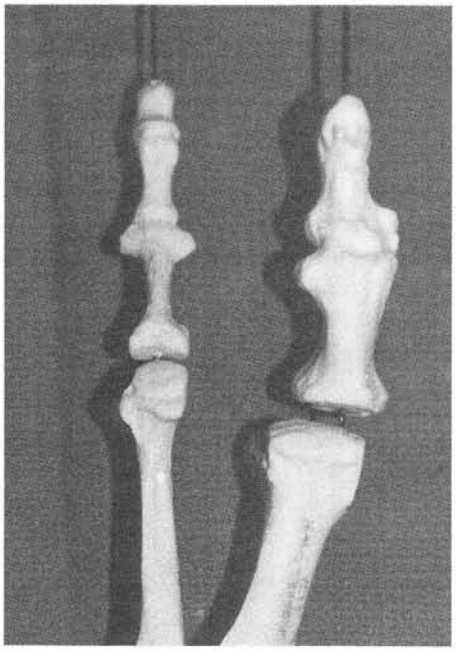

Figure 27. Bone model representation of adductory transverse plane gliding maneuver possibility of the first MTPJ arthrodesis site.

Figure 28. Clinical representation of adductory transverse plane gliding maneuver possibility of the first MTPJ arthrodesis site.

CONCLUSION

Arthrodesis of the first MTPJ as a primary reconstructive option is gaining in popularity. Understanding the function of the foot following first MTPJ arthrodesis is critical to appreciation of alignment needs postoperatively. Many manipulations are possible to help achieve that alignment. Versatility in arthrodesis site resection techniques, as well as adequate fixation to hold bony positioning until healing is critical. This review presented an update of these factors to help both the experienced and novice surgeon in application of first MTPJ arthrodesis.

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