

Metatarsophalangeal fusion for hallux valgus: indications and effect on the first metatarsal ray

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Arthrodesis of the metatarsophalangeal joint was performed in 31 cases of severe hallux valgus. With the surgical technique used, which is described in detail, internal fixation and plaster cast immobilization were not necessary. Analysis of the results suggested that the operation is indicated for severe deformities in elderly patients, preferably women. The basic metatarsal deformity was corrected by the procedure.

L'arthrodèse de l'articulation métatarsophalangienne a été pratiquée dans 31 cas d'hallux valgus sévère. Avec la technique chirurgicale utilisée, laquelle est décrite en détail, la fixation interne et l'immobilisation à l'aide d'un plâtre n'ont pas été nécessaires. L'analyse des résultats indique que l'opération est indiquée pour les difformités importantes chez les patients âgés, les femmes de préférence. La difformité métatarsienne essentielle a été corrigée par cette intervention.

There is understandable controversy concerning the indications for arthrodesis of the first metatarsophalangeal joint in the treatment of hallux valgus.¹ In a review of several operations for this condition Maschas² claimed that there is no place for fusion as a primary intervention and that it is rarely indicated as a salvage procedure. Tupman³ advocated fusion for hallux valgus if there is a splay foot or a short first metatarsus, or following unsuccessful Keller arthroplasty. Others have been more enthusiastic.⁴ Marin⁵ proposed fusion as a first operation in all middle-aged and elderly persons with moderate to severe deformities. Henry and Waugh⁶ and others^{2,5,7-14} claimed that arthrodesis is more effective than Keller arthro-

plasty because it increases weight-bearing on the first metatarsal ray and, as Kelikian¹⁰ noted, relieves metatarsalgia. In a study of 50 men with metatarsophalangeal fusion of the big toe Joseph⁹ showed that loss of metatarsophalangeal dorsiflexion did not impair the "take-off" position of the foot as long as motion at the interphalangeal joint was sufficient. Moynihan,¹² reviewing arthrodeses followed up for 10 years, found a greater success rate and more permanent results than have been reported for the Keller operation.

Arthrodesis v. arthroplasty

Arthrodesis of the first metatarsophalangeal joint is satisfying mainly because it avoids many of the pitfalls and complications sometimes noted following arthroplasty for hallux valgus.

With the McBride arthroplasty there is a distinct possibility of realigning the proximal phalanx onto a portion of the metatarsal head that is devoid of normal articular cartilage. Campbell¹ has attributed the not uncommon recurrence of hallux valgus following the McBride operation to a disruption between the bursal flap and the abductor hallucis tendon. He has also stressed that disfiguring iatrogenic hallux varus may occur as a result of the unopposed action of the abductor hallucis muscle; clawing of the great toe and a dorsal intraphalangeal bunion may also occur following unintentional section of the flexor hallucis brevis muscle.

The Mitchell arthroplasty corrects the metatarsus primus varus only in the distal part of the first ray, as Carr and Boyd¹⁵ noted. Campbell¹ referred to delayed healing at the osteotomy site with this procedure.

The deservedly popular Keller operation shortens the big toe and permanently impairs its control; if too much of the phalanx is resected

the toe may be completely nonfunctional. Other disadvantages are that the metatarsus varus remains unaltered and that the hallux valgus may persist if the metatarsus varus is severe. Indeed, severe metatarsus varus and metatarsalgia are relative contraindications to the Keller operation.

In the Mayo intervention, removal of the metatarsal head seriously alters the foot's weight-bearing pattern.⁸

Arthrodesis is free of most of these drawbacks. The main objection to arthrodesis is the loss of motion: however, while other procedures preserve mobility, the joint motion is not necessarily normal or painless. Since the principal function of the foot is painless weight-bearing and walking,¹⁰ joint stability may occasionally take precedence over abnormal or painful joint mobility.¹¹ None the less, patient selection is all important.

Review of a series of arthrodeses

We undertook the following review in an attempt to answer four basic questions about fusion for hallux valgus. First, does the operation permanently correct the deformity and provide normal function? Second, is a special, more demanding, postoperative regimen necessary? Third, is the metatarsus primus varus corrected? This is the critical question in view of the etiologic importance of metatarsus varus in the disability and deformity of hallux valgus, as Nicod stressed.¹³ Fourth, when there is severe metatarsus varus will arthrodesis of the metatarsophalangeal joint lead to hallux varus? This serious iatrogenic complication could theoretically occur since the fusion is performed with no attempt to compensate at the site of fusion for the varus deformity of the first metatarsus.

Patients

Of 31 persons who underwent metatarsophalangeal fusion for excessive

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hallux valgus without modification of the operative technique 8 are not considered in this review because of a follow-up period of less than 2 years, and 5 were lost to follow-up or had inadequate preoperative roentgenograms. Of the others, 16 were interviewed and reassessed clinically and radiologically, and 2 were reassessed from the answers to an elaborate questionnaire mailed to them.

The 5 men and 13 women had a mean age of 54.8 years (range 38 to 77 years), and the average follow-up period was 42 months (range 24 to 74 months). Since 16 underwent bilateral arthrodesis the total number of procedures was 34.

Surgical technique

Litigation is not uncommon following operations on the foot, probably because the surgical challenge is often underestimated. Careful dissection and attention to detail are as vital for the foot as they are for the hand. It is obviously wrong to dissect a hand but to attack a foot.

Although the "tongue-and-trough" method of fusion (Fig. 1) is not original, certain technical details warrant special attention. The metatarsophalangeal joint is exposed through a single dorsal midline incision medial to the bowstringing long extensor tendon. It is important to leave the lax lateral capsule and conjoint tendon intact. The medial capsule is incised vertically 0.5 cm from its phalangeal attachment; the capsule and periosteum are reflected proximally in continuity with the abductor hallucis muscle; this muscle is inevitably noted to have migrated laterally and under the metatarsophalangeal joint and has long lost its ability to abduct the joint. The bursal and capsular flap is dissected in continuity with the abductor hallucis muscle, which must be freed from the medial sesamoid bone to facilitate medial and dorsal mobilization of the flap and prevent medial and dorsal displacement of the bone at the time of capsular closure.

A trough is then prepared precisely in the middle of the proximal end of the proximal phalanx; an ordinary rongeur is used to excise the dorsal

cortex at the point of attachment of the extensor hallucis brevis muscle, a very useful landmark. Since the angle of the trough and the plantar surface of the foot must be precisely 90° to avoid fusion in any degree of rotation, a pituitary rongeur is used to complete the trough. The plantar phalangeal attachment of the metatarsophalangeal capsule is incised to facilitate the introduction of the tip of the pituitary rongeur under the proximal phalanx. The phalangeal trough is then deepened to 1 cm in line with the axis of the phalanx. When the articular cartilage is excised from the proximal phalanx on either side of the trough the medial and lateral capsules must remain attached to the phalanx to permit eventual stable closure.

The head of the first metatarsus is then shaped like a tongue, or lug,

with such depth and width as to provide a snug fit within the phalangeal trough. The axis of the tongue corresponds to the long axis of the first metacarpus. Care is taken to protect the relatively fragile base of the tongue. It is preferable to prepare the phalangeal trough first since the metatarsal tongue could be accidentally fractured at its base during creation of the phalangeal trough. The remaining articular cartilage on the tip of the metatarsal tongue is then excised.

The metatarsal tongue is then inserted in the phalangeal trough, with complete correction of the angular deformity between the metatarsus and the proximal phalanx. Because the bony shortening is fully compensated by the correction of the angular deformity at the metatarsophalangeal joint, the soft tissues on the lateral

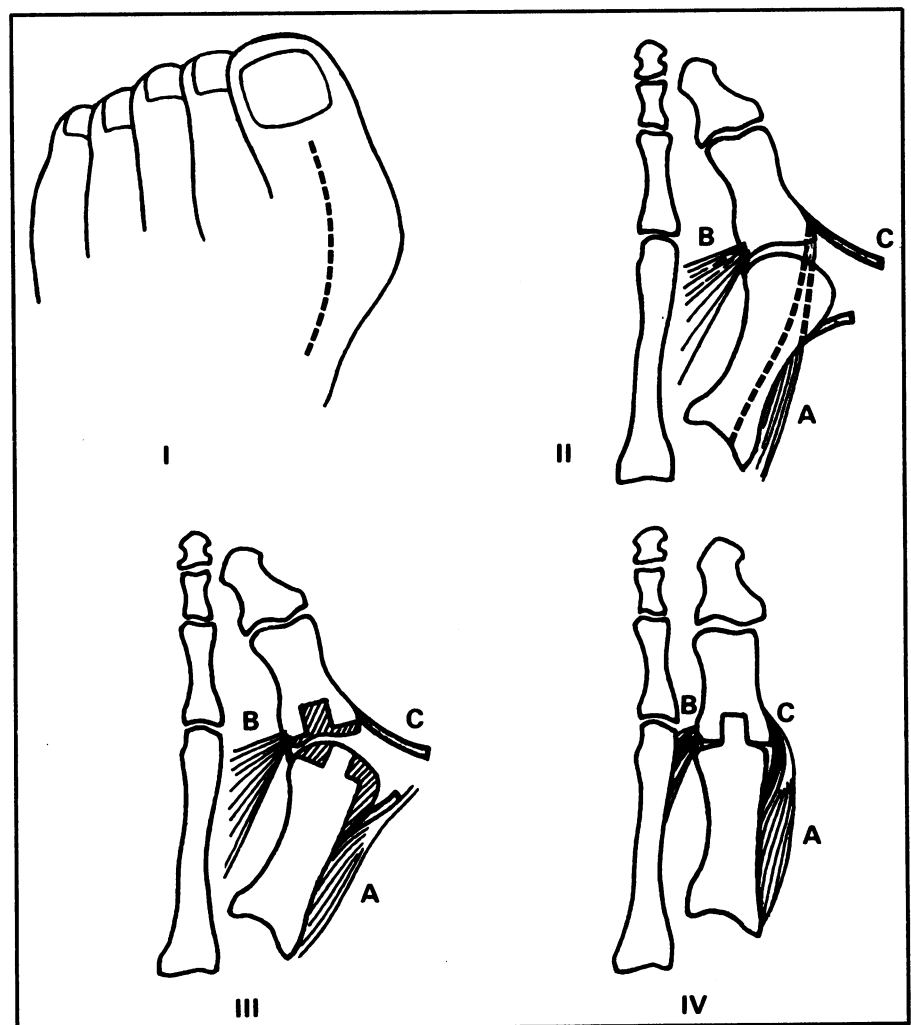


FIG. 1—Surgical technique of "tongue-and-trough" arthrodesis for hallux valgus: **A** = abductor hallucis muscle; **B** = conjoint tendon; **C** = medial metatarsophalangeal capsule.

side of the joint are under immediate tension; the intact lateral metatarsophalangeal capsule and conjoint tendon thus provide immediate stability. Similar soft tissue tension must then be achieved on the medial side of the arthrodesis. Since the angular deformity has been completely corrected, the medial bursal and capsular flap is too long; therefore, a sufficient amount of the flap is excised to permit its reattachment to the distal portion of the capsule under tension. When the medial metatarsophalangeal capsule has been closed, there should be immediate stability at the arthrodesis site. Metallic internal fixation and plaster cast immobilization are not necessary.

Progressive weight-bearing is permitted as tolerated, and the sutures are removed on the 10th postoperative day. The postoperative regimen is identical to that of a Keller operation.

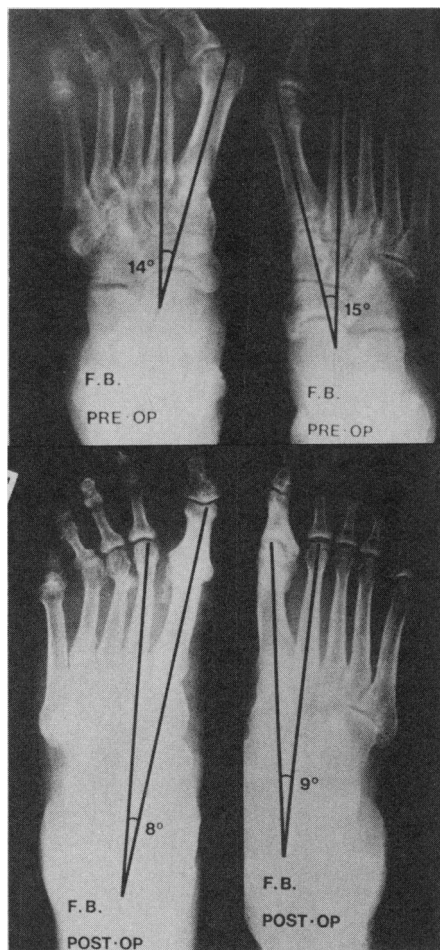


FIG. 2—Appearance before and after arthrodesis: lower left, excellent result; lower right, good result, with stable fibrous ankylosis at 4 months.

Results

Postoperative results were grouped as excellent, good or poor. For an excellent result all of the following criteria were met: the patient was completely satisfied and would accept the operation again; the fusion was clinically solid and painless, and no deformity was noted; and roentgenograms showed sound bony union and



FIG. 3—Poor results of arthrodesis: dorsiflexion of both metatarsophalangeal joints and external rotation of right big toe. Left, failure attributed to fusion in malrotation; mild valgus deformity at interphalangeal joint. Right, increased web space because of valgus deformity at metatarsophalangeal joint of second toe.

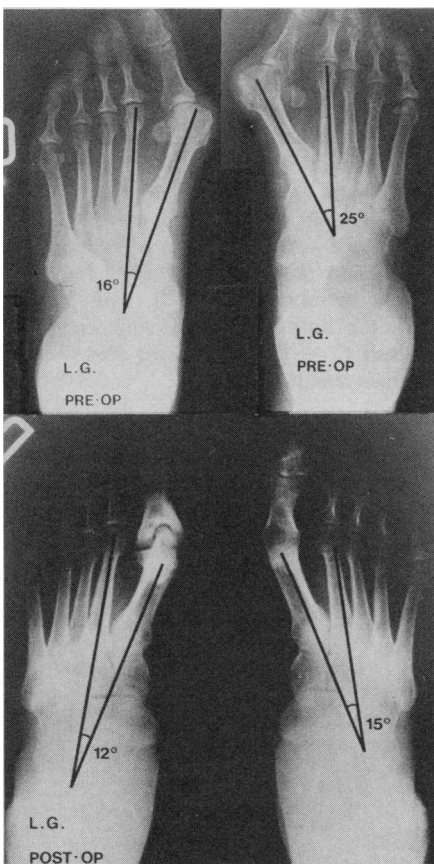


FIG. 4—Poor result of arthrodesis on left: painless pseudoarthrosis.

no deformity (Fig. 2). A good result met all of the following criteria: the patient was partially satisfied with the operation and would unequivocally accept it again; the pain was lessened, but local discomfort or mild metatarsalgia persisted; and the fusion was clinically sound and in good position, but roentgenograms revealed fibrous ankylosis (Fig. 2). For the result to be considered poor, or the operation a failure, only one of the following criteria had to be met: the patient was dissatisfied or would refuse the procedure if it were offered again; the pain was unchanged or aggravated; a varus or valgus deformity or excessive dorsiflexion was noted; or there was clinical motion at the fusion site.

The result was considered excellent in 16 of the 34 procedures and good in 13, for a success rate of 85%. The other five procedures were considered to have failed, but only two of the three patients would not have accepted the operation again: a 44-year-old man had a painful pseudoarthrosis on one side and excessive dorsiflexion of the fused joint on the other, and a 77-year-old man with sound bony fusion and good reduction of the intermetacarpal angle in both feet (to 9° and 11°) was dissatisfied with the dorsiflexion of both the fused joints and the external rotation of the big toe on one side (Fig. 3). The third patient, a 57-year-old woman, was satisfied with the functional and esthetic results in both feet but had a painless pseudoarthrosis on one side (Fig. 4); indeed, she had no pain in either foot. Her case illustrates well the occasional discrepancy between clinical and radiologic assessments.

Frequency and position of fusion: Bony fusion (Fig. 5) was achieved in 24 instances, for a rate of 71%. Stable fibrous ankylosis resulted in nine instances and usually progressed to bony fusion; only two patients reported discomfort. There were two instances of pseudoarthrosis, but only one patient complained of pain.

The acceptable rate of fusion was achieved without metallic internal fixation or plaster cast immobilization for two reasons: the tongue-and-

trough design provides maximal contact between spongy bone interfaces and a certain degree of immediate stability; and once the angular deformity has been corrected, dynamic compression is achieved by muscles on all four sides of the fusion site — medially by the relocated abductor hallucis muscle, laterally by the conjoint tendon, and above and below by the long flexor and extensor muscles (Fig. 6).

Although the valgus deformity was always corrected, 85% of the joints were dorsiflexed, the angle varying from 5° to 30°.

Function and comfort: Two of the five men complained about the dorsiflexed position of fusion, and their operations were considered to have failed. Women willingly adjusted their heel height postoperatively and reported no dissatisfaction with the dorsiflexion. All but the two men with poor operative results reported an improved gait, and all the patients with bony or fibrous ankylosis resumed their former activities. Plantar callosities persisted in 8 of the 18 patients, and 3 reported mild meta-

tarsalgia that was well controlled with the use of a metatarsal pad.

Radiologic evidence of correction of angular deformity: One of the main objects of the radiologic evaluation was to determine the orientation of the first metatarsal ray before and after the operation, since fusion could conceivably produce hallux varus. The intermetatarsal angle was therefore measured at both times with the aid of lines drawn parallel to the long axis of the shaft of the first and second metatarsal bones. The angle between the two lines was decreased postoperatively in every foot; the average correction was 5.7° and the

range 1° to 11°. Indeed, the correction was frequently noted on roentgenograms taken in the recovery room (Fig. 7), when such were available. No loss of correction was noted in 10 patients in whom postoperative roentgenograms were taken on more than one occasion.

Discussion

The main object of the review was to answer four questions:

1. *Does metatarsophalangeal fusion permanently correct hallux valgus and provide normal function?*

An 85% success rate suggests that it does, although the selection of patients is important. Sound bony fusion is not synonymous with success. The operation is best reserved for elderly patients with severe metatarsus varus; a Keller operation for such patients is not uncommonly associated with recurrence of symptoms and metatarsalgia.

2. *Is a special, more demanding post-operative regimen necessary?*

The described technique requires no plaster cast immobilization, and progressive weight-bearing is permitted as tolerated. Possibly for this reason the degree of dorsiflexion at the fusion site is not accurately predictable. Dorsiflexion was not a serious concern of the women in this series, and there were no instances of a significant difference in the degree of dorsiflexion between the two feet of any of them. Men were more frequently dissatisfied with the dorsiflexion. This problem can be con-

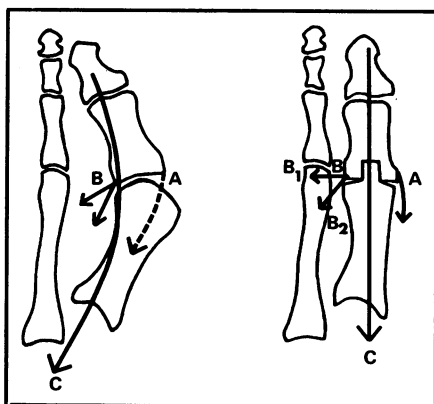


FIG. 6—Mechanical forces at metatarsophalangeal joint: before arthrodesis (left), mechanical vicious circle (A = medially displaced [under metatarsal head] abductor hallucis muscle; B = conjoint tendon; C = bowstringing long flexor and extensor tendons); afterwards (right), dynamic correction of metatarsus varus (A = relocated abductor hallucis muscle; B₁ and B₂ = adductor hallucis muscle and conjoint tendon; C = relocated long flexor and extensor tendons).

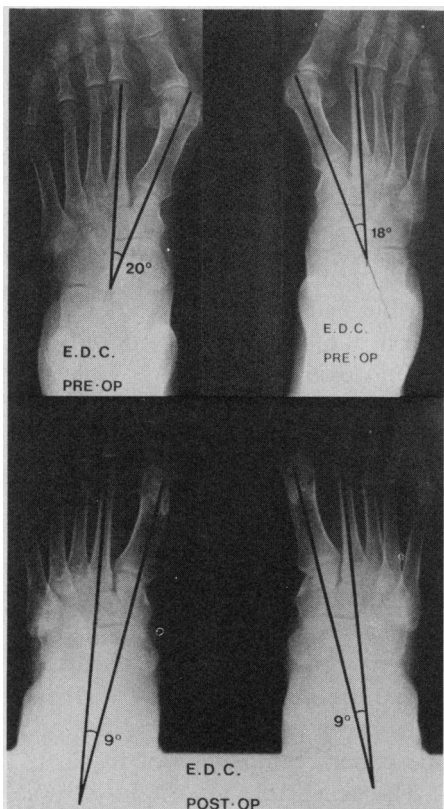


FIG. 5—Excellent result of arthrodesis, with bilateral bony fusion and diminution of intermetatarsal angle.

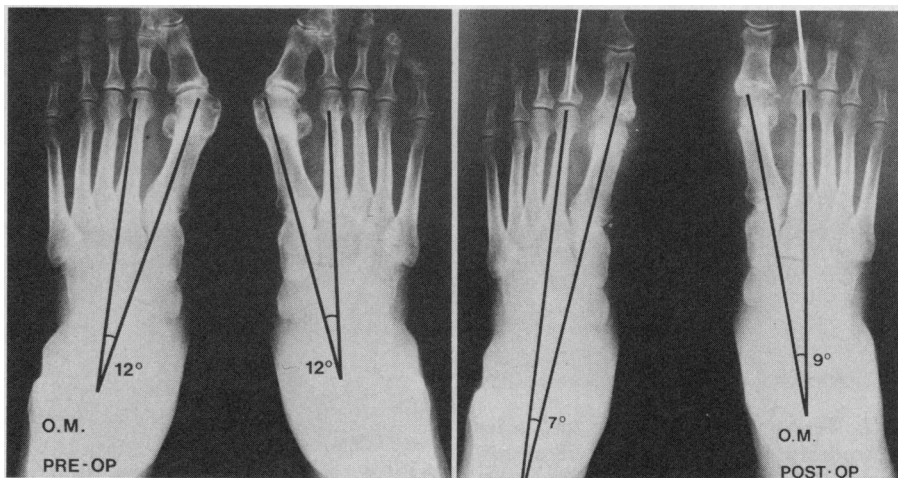


FIG. 7—Corrected intermetatarsal angle noted during stay in recovery room.

trolled by the placement of an intramedullary Kirschner wire if the individual is not willing to modify his or her heel height postoperatively.

3. Is the metatarsus primus varus corrected?

The intermetatarsal angle was decreased in all patients, by an average of 5.7°.

4. When there is severe metatarsus varus will fusion performed for hallux valgus ever produce iatrogenic hallux varus (Fig. 8)?

No such complication was encountered, although there were occasional instances of a widened web space between the first and second

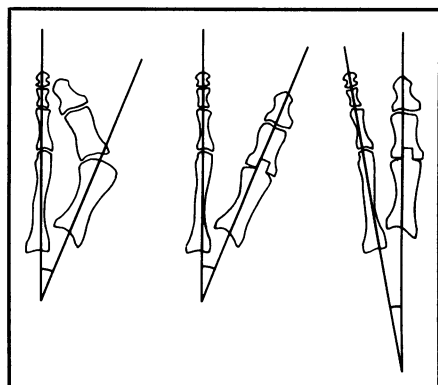


FIG. 8—Postoperative results: left, intermetatarsal angle preoperatively; middle, possible hallux varus due to fusion of metatarsophalangeal joint; right, correction of hallux valgus and metatarsus varus by metatarsophalangeal fusion.

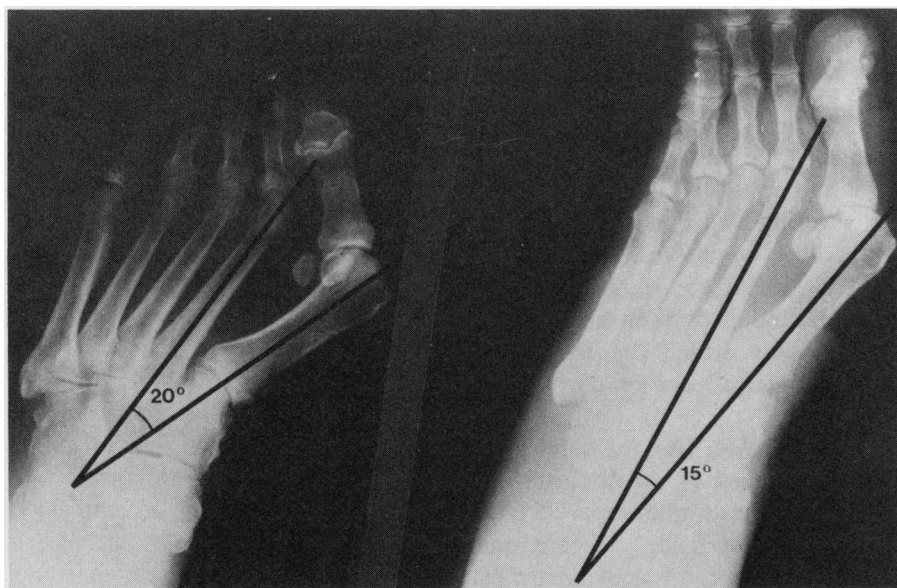


FIG. 9—Preoperative mobility of cuneometatarsal joint and passive correction of metatarsus varus with (right) and without (left) squeezing of foot by circular bandage.

toe. This was always attributable to persistent valgus deformity at the metatarsophalangeal joint of the second toe and not to varus deformity of the big toe (Fig. 3).

Severe hallux valgus associated with severe metatarsus varus is progressive and irreversible for two reasons⁸ (Fig. 6). Because of the excessive metatarsus primus varus the abductor hallucis muscle, which is in continuity with the plantar metatarsophalangeal capsule, eventually migrates plantar-ward and laterally to become functionless as an abductor of the metatarsophalangeal joint. The adductors of the metatarsophalangeal joint are then unopposed and mild hallux valgus is inevitable. The conjoint tendon and the bowstringing long flexor and extensor tendons then reinforce the action of the adductor hallucis muscle and push the first metatarsal head proximally and medially to further increase the metatarsus primus varus — the beginning and the end of a vicious circle.

The mobility of the first metatarsus at the cuneometatarsal joint can be easily noted preoperatively by simply squeezing the foot (Fig. 9) or comparing roentgenograms taken with the patient weight-bearing and not weight-bearing. The mobility is surprising, even in adults with long-standing severe hallux valgus.

Once the deforming forces have

been abolished by metatarsophalangeal fusion the metatarsus varus is immediately corrected, as can be noted on roentgenograms taken in the recovery room. With fusion the adductor force of the conjoint tendon acts on the first metatarsus to correct its varus malposition.⁷ Hence, diminution of the intermetatarsal angle is not only permanent, but also may decrease further with time, as we frequently noted.

Conclusions

Metatarsophalangeal arthrodesis is a reasonable and successful operation for correcting serious hallux valgus in elderly patients. It is best reserved for women since the site of fusion is usually dorsiflexed. It corrects the metatarsus primus varus and is never complicated by hallux varus. Gait is consistently improved and metatarsalgia is rare. A special postoperative regimen and plaster cast immobilization are not necessary.

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