

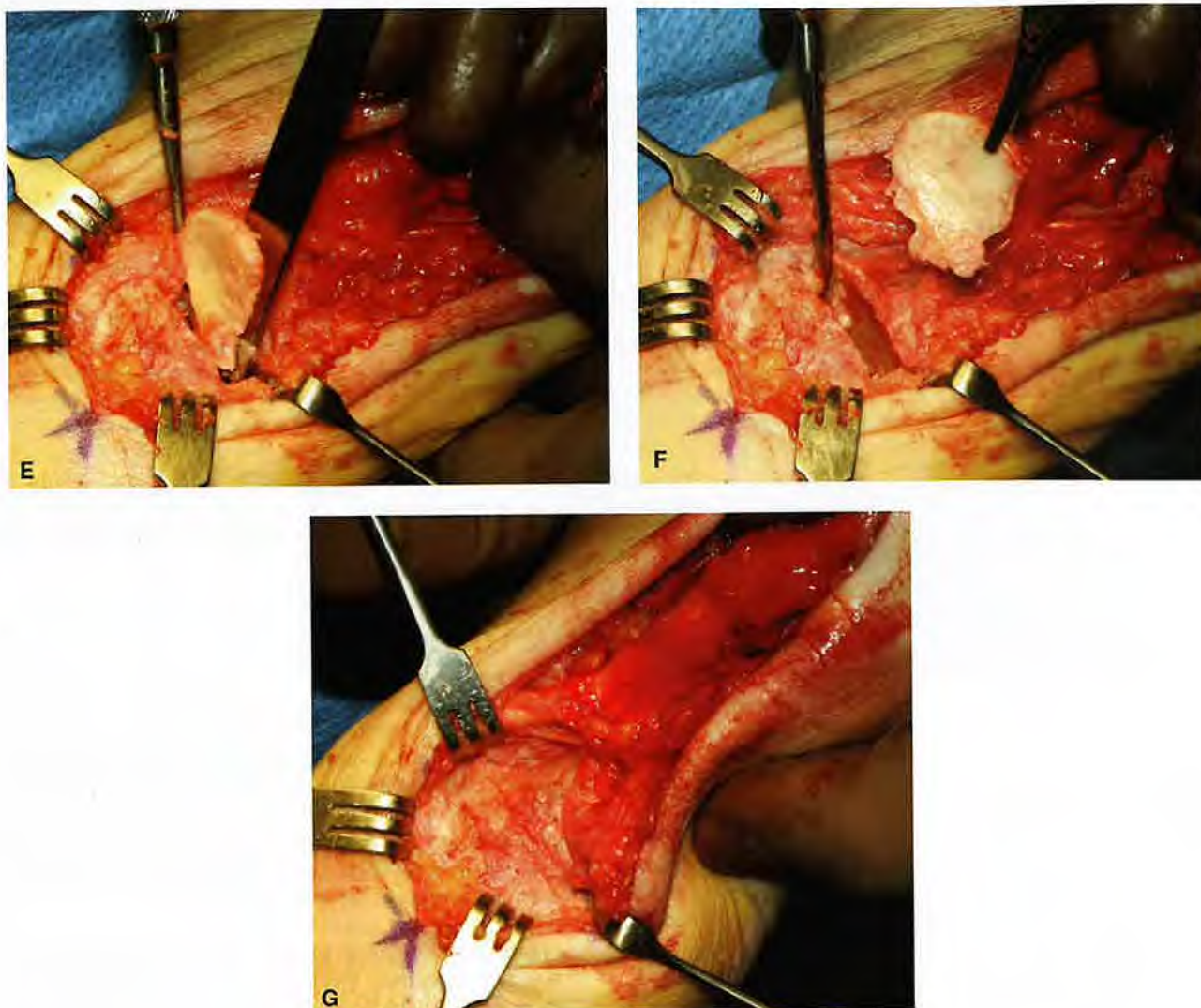


Figure 55.7 (Continued) **E:** An osteotome and/or Freer may be used to free the fragment after the saw cut is complete. **F:** The fusion surfaces are inspected, and any interposing soft tissue is removed. **G:** Final appearance of the first metatarsal cuneiform joint after planar resection. Note the close apposition of the fusion surfaces.

CLOSURE

Closure of the tissues in their respective layers is the final opportunity intraoperatively to maintain anatomic channels of nutrition to the arthrodesis site. This is accomplished by reapproximating each individual layer in close apposition and holding it in place until such time that the body has reestablished the tensile strength of the tissue to maintain the anatomical relationship. This may be facilitated by selecting a suture than will maintain its strength for the desired length of time (e.g., Vicryl or Monocryl). Another benefit to layered anatomic closure is the tamponade effect to control bleeding and limit postoperative edema.

CONCLUSION

The ability to reliably and accurately achieve fusion of joints is perhaps the podiatric surgeon's most valuable tool in the

treatment of a wide variety of foot and ankle pathology. If the principles of arthrodesis are stringently followed, many of the reported complications of foot and ankle fusions can be avoided.

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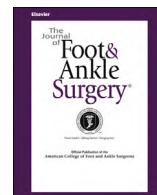
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Fixation of Lapidus Arthrodesis with a Plantar Interfragmentary Screw and Medial Locking Plate: A Report of 88 Cases

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ABSTRACT

Lapidus arthrodesis is a powerful procedure that can be used to correct pathologic features within the forefoot or midfoot. Many different methods of fixation for this procedure have been reported. The use of plating constructs has been shown to provide increased stability compared with screw-only constructs. The technique we have described consists of a plantar to dorsal retrograde lag screw across the arthrodesis site, coupled with a low-profile medial locking plate. A total of 88 consecutive patients were treated with this modification of the Lapidus procedure by 2 surgeons and were retrospectively evaluated. All patients followed an early postoperative weightbearing protocol. Patient age, gender, follow-up duration, interval to weightbearing and radiographic fusion, preoperative and postoperative intermetatarsal angle, hardware removal, preoperative and postoperative American Orthopaedic Foot and Ankle Society midfoot scores, and adjunct procedures were analyzed. The mean follow-up period was 16.76 ± 5.9 (range 12 to 36) months, and all healed fusions demonstrated radiographic union at a mean of 51 ± 19.1 (range 40 to 89) days. The patients were treated with weightbearing starting a mean of 10.90 ± 4.1 (range 5 to 28) days postoperatively. Complications included 15 patients (17%) requiring hardware removal, 2 cases (2%) of hallux varus, 6 cases (7%) of radiographic recurrent hallux valgus, and 2 patients (2%) with first metatarsocuneiform nonunion. The results of the present study have demonstrated that plantar lag screw fixation with medial locking plate augmentation for Lapidus arthrodesis allows for early weightbearing with satisfactory outcomes, improved clinical and radiographic alignment, and improved American Orthopaedic Foot and Ankle Society scores.

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More than 130 procedures have been described for the treatment of hallux abductovalgus (HAV) (1). Indications for the Lapidus procedure include the presence of hypermobility in the first ray, a large first intermetatarsal angle (IMA), arthrosis of the first metatarsocuneiform joint, recurrent HAV, instability of the medial column, and some cases of juvenile HAV. Many different internal fixation options have been described for the Lapidus procedure. Furthermore, a number of surgeons have recommended a postoperative course of non-weightbearing for up to 6 to 8 weeks or longer after Lapidus arthrodesis. In the present retrospective cohort study, we have described an alternative internal fixation option for the Lapidus procedure that will provide increased construct stability and, ultimately, allow the patient to bear weight on the operated foot early in the postoperative period. The construct consists of the combination of

a retrograde plantar to dorsal lag screw directed from the plantar aspect of the first metatarsal to the superior aspect of the medial cuneiform, combined with a low-profile, medially applied, locking plate placed across the arthrodesis site.

Patients and Methods

To be included in the cohort, consecutive patients had to have undergone Lapidus arthrodesis with a plantar to dorsal retrograde lag screw combined with a low-profile locking plate applied medially across the arthrodesis site and to have had a minimum of 1 year of follow-up. Two surgeons (J.M.C., A.M.V.) performed all the procedures, and the patients were identified in the surgeons' practices. A retrospective chart assessment was performed of all patients with a minimal follow-up of 1 year, and the data were reviewed by both of us (J.M.C., A.M.V.). Additional inclusion criteria were a painful HAV deformity for which conservative treatment had failed, an IMA greater than 10° , clinical or radiographic evidence of first MTC instability in the coronal or sagittal plane (ie, plantar gapping of first MTC joint on lateral view), clinical signs of systemic laxity, and any revision hallux valgus correction procedure. The exclusion criteria included any previous attempted Lapidus fusion, Charcot neuropathy, diabetes, an intermetatarsal angle less than 10° , and first metatarsal-phalangeal joint arthritis.

The demographic variables, including gender, age, extremity involved, pre- and postoperative first IMAs, follow-up duration, and interval to full weightbearing were recorded. The radiographic review included evaluation of the interval to union of the arthrodesis site and evaluation of the weightbearing preoperative and postoperative

Financial Disclosure: None reported.

Conflict of Interest: Drs. Cottom and Vora are consultants for Arthrex, which had no role in the design of the investigation, data analysis, or writing of the report.

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first IMAs. The first IMA was measured and compared using the technique described by Sangeorzan and Hansen (2) with a digital caliper. Osseous union was ascertained by the presence of trabeculation across the fusion site on 3 radiographic views taken with a digital x-ray machine and evaluated by us (J.M.C., A.M.V.). Any hardware complications were recorded, along with the removal of hardware and the mean interval to removal. Adjunct procedures performed in conjunction with the Lapidus arthrodesis were also recorded. In addition, the American Orthopaedic Foot and Ankle Society preoperative and postoperative midfoot scores were compared (3,4).

The data were considered in regard to type and distribution. Statistical comparisons were made between the preoperative and postoperative radiographic values and American Orthopaedic Foot and Ankle Society scores. Statistical significance was defined at the 5% level ($p \leq .05$).

Surgical Technique

The surgical procedure was performed according to the technique described by Cottom (5). A standard lateral release of the first metatarsal-phalangeal joint was performed. Next, after meticulous preparation of the fusion site, a guide wire for a 4.5-mm screw was placed in the central aspect of the first metatarsal base and driven inferior, aiming for the proximal metaphyseal–diaphyseal junction of the first metatarsal (Fig. 1). The wire was driven through the plantar skin under the first metatarsal; the tip of the wire should just be visible within the first metatarsal so that the joint surfaces can be apposed. If deemed necessary, demineralized bone matrix (used by J.M.C.) or autogenous bone (used by A.M.V.) can be placed within the fusion site. The first IMA was then reduced with a large, pointed, bone reduction clamp. This was done by placing 1 arm of the clamp on the lateral aspect of the second metatarsal head through the incision used to perform the lateral release, with the other arm placed over the medial aspect of the first metatarsal. The clamp was then closed, and the first IMA was “dialed” to the desired amount of correction (Fig. 2). The hallux was then dorsiflexed, and the surgeon was able to compress the fusion site and manipulate the base of the first metatarsal in the sagittal plane to the desired level. The guide wire was then driven in a retrograde manner into the medial cuneiform. Placement of the wire was confirmed with both anteroposterior and lateral views intraoperatively to ensure the navicular–cuneiform joint was not compromised (Fig. 3). Through a small stab incision plantarily, and with careful retraction of the soft tissues, a 4.5-mm cannulated screw was then inserted and compression of the arthrodesis site noted. At that point, a low-profile, locking plate (LPS Lapidus Plate, Arthrex, Naples, FL) was positioned along the medial aspect of the first metatarsal and medial cuneiform. Careful attention must be given to avoid transecting the insertion of the anterior tibial tendon. A small “pocket” was then created with a small hemostat, lifting as little as possible of the anterior tibial tendon off the medial aspect of the medial cuneiform, to create room for the plate. The plate was then provisionally fixed to the medial column and the position checked using fluoroscopy (Fig. 4). Occasionally, a bony prominence will be noted at the base of the first metatarsal and must be resected to allow the plate to lie flush with the bone. Once the position was confirmed, locking screws were inserted proximally within the plate into the medial cuneiform. Next, the compression slot within the plate was drilled, aiming either proximally across the fusion site between the locking screws or, alternatively, eccentrically and perpendicular to the shaft of the second metatarsal. If the screw was to be placed proximally, it was inserted using a lag technique. Finally, the



Fig. 2. Bone reduction clamp placed on the first and second metatarsal heads and the first intermetatarsal angle is reduced and checked with fluoroscopy. One must be careful not to fracture the metatarsal heads with this maneuver.

distal locking screw was inserted within the plate, and the bone reduction clamp was removed. At this point, the hypertrophic bone at the medial aspect of the head of the first metatarsal can be resected if necessary (Fig. 5). Closure was performed in anatomic layers, and a sterile gauze bandage was applied. Postoperatively, the patient used a short-leg boot walker and crutches. Postoperatively, the patient was kept non-weightbearing for 7 to 10 days until skin wound healing had occurred. The patient was then allowed full weightbearing in the boot walker, with an attempted return to regular shoe gear at 6 to 8 weeks postoperatively, as allowed by the swelling about the operative site. In addition, once the patient returned to regular shoe gear, physical therapy was initiated.

Results

A total of 88 patients met our inclusion criteria and were included in the analyses. No patients were lost to follow-up. The mean duration of follow-up was 16.76 (range 12 to 36) months. Of the 88 patients, 72 were females (81.82%) and 16 were males (18.18%). Their mean age

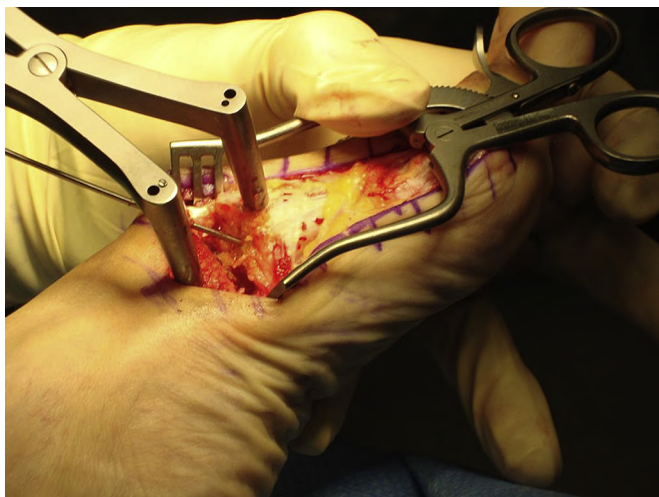


Fig. 1. Guide wire for 4.5-mm cannulated screw introduced into base of first metatarsal and directed out the plantar aspect of the first metatarsal at the proximal diaphyseal–metaphyseal junction. The wire should exit the plantar aspect of the foot. Note, the central placement of the wire in the first metatarsal base.

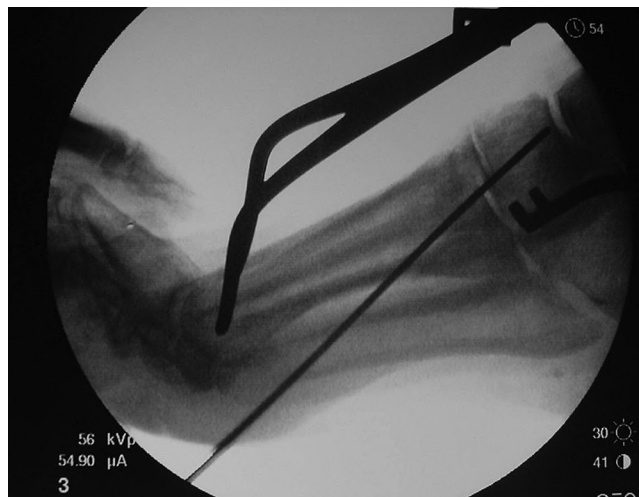


Fig. 3. The hallux is dorsiflexed and the Windlass mechanism engaged. The first metatarsal can be manipulated in the sagittal plane and the fusion site compressed. The guide wire is then moved retrograde into the medial cuneiform. The position of the wire is checked using fluoroscopy.

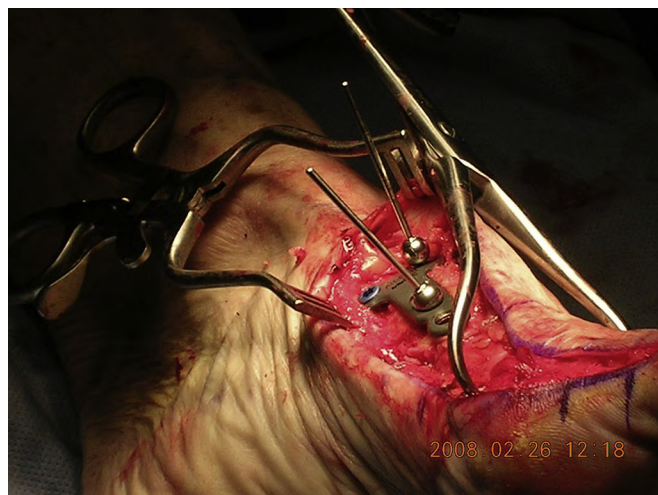


Fig. 4. Low-profile locking plate applied to the medial aspect of the fusion site. Careful attention should be paid not to disrupt the insertion of the anterior tibial tendon. The position of the plate is checked with fluoroscopy before definitive fixation is placed.

was 61.9 (range 22 to 81) years at surgery. The right foot was involved in 55 cases (63%) cases and the left in 33 (37%). No bilateral cases were included in the present series. The mean interval to full weightbearing in a controlled ankle motion walking boot was 10.9 (range 7 to 28) days. Radiographic union at the Lapidus arthrodesis site was deemed complete at a mean of 51 (range 41 to 68) days. Adjunct procedures included distal soft tissue first metatarsophalangeal joint lateral release in all 88 patients (100%). Additional procedures included bone marrow aspiration from the ipsilateral calcaneus and deposited at the fusion site in 66 (75%), autogenous calcaneal bone graft harvest and interposition at the fusion site in 22 (25%), Weil osteotomy of a lesser metatarsal in 51 (57.8%), DuVries lesser metatarsal head condylectomy in 19 (21.6%), tailor's bunionette correction in 4 (4.55%), Youngswick-modified chevron bunionectomy in 4 (4.55%), and an Akin hallux osteotomy in 10 (11.36%). In 2 patients, (2.27%), nonunion occurred at the Lapidus fusion site; 1 patient (1.14%) underwent revision at 6 months and the other at 9 months postoperatively. One of the nonunion cases was revised with hardware removal, distal tibial bone graft, and revision plate and screw fixation. In this revision, a similar construct with an additional dorsal to plantar screw was used. The plate was applied further dorsally than normally to allow for better screw purchase, given the bone void from the previous plate

and screw construct medially. The second nonunion case was suspicious for infection; thus, this patient underwent hardware removal and bone biopsy. The bone biopsy did not reveal any microorganism growth and was deemed an aseptic nonunion. To date, the latter patient has remained minimally symptomatic and has not required revision of the arthrodesis.

The first IMA was measured and compared with a weightbearing radiograph both preoperatively and postoperatively once the patients were full weightbearing after their Lapidus fusion procedure. The mean preoperative first IMA was 19.73° (range 10.5° to 31°); postoperatively, it was 4.32° (range 0° to 6.5°; $p < .001$). The American Orthopaedic Foot and Ankle Society midfoot scoring system was used in the present study and demonstrated a mean preoperative score of 54.48 (range 37 to 78) and a mean postoperative score of 88.24 (range 72 to 95), and this improvement was statistically significant ($p < .001$). The overall change in the preoperative and postoperative scores was +33.76 (range 12 to 73). A total of 15 medial low-profile locking plates (17%) were removed at an average of 22.5 (range 12 to 32) months because of symptomatic prominence of the hardware in all 15 patients. Six patients (6.82%) displayed radiographic evidence of recurrent hallux valgus, defined as the hallux drifting laterally more than 20° postoperatively; however, none was clinically symptomatic or required additional surgery. Two patients (2.27%) developed hallux varus, 1 (1.14%) of whom underwent subsequent surgical revision. The other patient with hallux varus was asymptomatic and has not required additional surgery to date. Two patients (2.27%) developed nonunion of the arthrodesis site. One patient (1.14%) remained asymptomatic with a pseudoarthrosis and has not required additional surgical intervention. In the 1 patient (1.14%) who underwent revision surgery for nonunion of the Lapidus arthrodesis, the patient also had dorsiflexion malunion and transfer metatarsalgia that was addressed surgically during the revision procedure. No other patients in the present series developed transfer metatarsalgia symptomatic enough to require additional surgical intervention.

Discussion

Hypermobility of the first ray and medial column has been associated with the onset of hallux valgus and lesser metatarsal overload (6–8). Albrecht (9) was the first to describe a first tarsometatarsal arthrodesis in 1911. In 1934, Lapidus (10) described his technique for correcting hallux valgus through a wedge osteotomy of the first metatarsal and fusion into the medial cuneiform, with fusion of the first and second metatarsal bases without internal fixation. Since

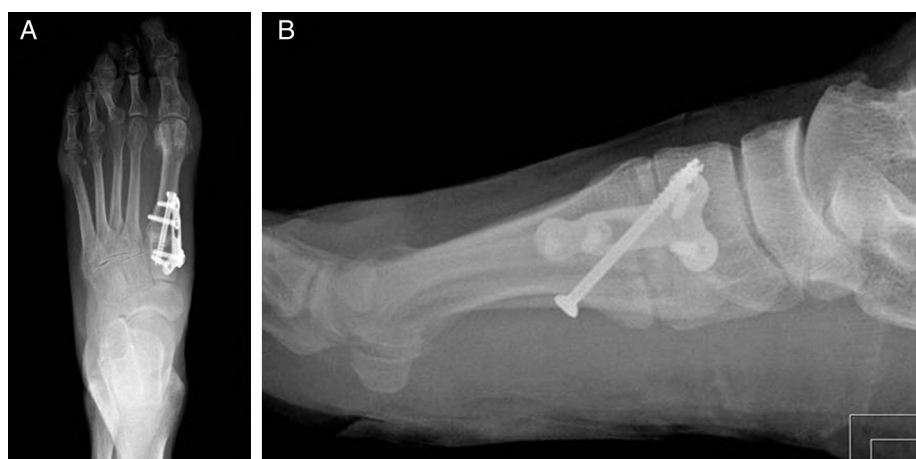


Fig. 5. (A) Anteroposterior radiograph showing excellent reduction of the first intermetatarsal angle with all hardware in good position. (B) Lateral view demonstrating placement of the plantar interfragmentary screw and plate fixation.

then, numerous modifications to the original Lapidus procedure have been introduced, including minimal bone resection and the addition of multiple screws and/or plates to assist fusion (7,9,11–17). Multiple fixation constructs have been well documented within published studies of first metatarsal–medial cuneiform arthrodesis. In 2010, Klos et al (6) reported on the stability of a medial locking plate with a dorsal to plantar compression screw versus fixation with 2 crossed screws. Eight pairs of fresh-frozen human specimens were used in a matched pair test. In the plate and screw group, an “X-plate” (X-locking plate 2.4/2.7 Synthes, Solothurn, Switzerland) was used. The plates were first secured into the first metatarsal by screws into the distal holes. Next, a 4-mm-diameter, cannulated, partially threaded, stainless steel screw was inserted dorsally into the first metatarsal and driven into the plantar aspect of the medial cuneiform. Then, screws were inserted into the proximal holes within the plate. In the crossed screw group, two 4-mm-diameter, cannulated, partially threaded, stainless steel screws were inserted, the first from dorsally to plantarly from the first metatarsal into the medial cuneiform and the second from dorsally to plantarly from the medial cuneiform into the proximal aspect of the first metatarsal. The screws crossed at a point on the longitudinal axis of the first metatarsal. The specimens were then tested in a 4-point bending test. The investigators found that during cyclic loading conditions, the construct using a medial locking plate with adjunct compression screw was superior to the construct using 2 crossed screws.

Saxena et al (18) compared the outcomes of the Lapidus procedure fixed with crossed lag screws versus a dorsal-medial locking plate with a plantar lag screw. A total of 40 patients were included in their retrospective study, with 19 patients in the crossed screw group and 21 in the plate with plantar lag screw group. In the plate group, a solid 3.5-mm screw was inserted plantarly from the base of the first metatarsal into the medial cuneiform with a Darco Modular Rearfoot System LPS Lapidus Plating System (Wright Medical Technology, Arlington, TN) locking plate. The plate was applied dorsomedially across the fusion site. This method was compared with 2 crossing 3.5-mm cortical fully threaded titanium screws applied in lag fashion. One was directed from the plantar–medial aspect of the first metatarsal into the medial cuneiform and the other from the dorso-lateral aspect of the first metatarsal into the medial cuneiform. The investigators noted no statistically significant differences related to postoperative complications between the 2 groups but did note that the plate group allowed for earlier weightbearing (4 weeks versus 6 weeks in the screw group).

Scranton et al (17) reported on 10 matched pairs of cadaver feet that had either undergone the standard crossed 4.0-mm compression screw or fixation with a medial LPS locking Lapidus Plate (Arthrex). The cadaver constructs were stressed to failure using the INSTRON (Norwood, MA) and Wavemaker software (San Diego, CA) and noted that the load to failure was greater with the Lapidus plate and that the increased rigidity provided by these plates might minimize the risk of nonunion or malunion. A similar biomechanical study comparing the construct mentioned in our report and in the study by Scranton et al (17) was completed by 1 of us (J.M.C.). The study is pending publication in the “*Journal of Foot and Ankle Surgery*” and has demonstrated an increase in the strength of the fixation construct by 86.4%.

In 2008, Gruber et al (13) reported on 10 matched lower extremity pairs that either underwent a Lapidus procedure with 2 crossed, 4.0-mm, partially threaded, cannulated screws or a dorsomedial locking plate (Darco Modular Rearfoot System) LPS Lapidus Plating System (Wright Medical Technology), with a 4.0-mm, partially threaded, cannulated screw inserted from the dorsal aspect of the first metatarsal into the medial cuneiform. The specimens were then loaded in 4-point bend configuration until failure or 3 mm of deformation. The results demonstrated no difference in the load to failure

or stiffness between the 2 groups, and the plate construct did not show different rigidity compared with the screw group.

Sorensen et al (8) reported on 21 patients who underwent a modified Lapidus procedure with a dorsomedial locking plate. Of the 21 patients, 19 had concomitant application of an interfragmentary screw, which was a partially threaded cannulated titanium screw. The investigators did not describe the orientation of the interfragmentary screw in their series. The locking plate was applied after screw fixation. They reported an average of 6.95 weeks to radiographic fusion, an average of 2 weeks to ambulation, a 9.52% rate of asymptomatic malunion, a 0% rate of delayed union or nonunion, and no revisions.

Klos et al (14) completed a cadaver study in 2011 to investigate the possible benefit of a compression screw combined with a plantarly applied, anatomically precontoured, plate versus a plate applied dorsomedially. Six pairs of human cadavers were randomized to receive either a dorsomedial H-shaped plate (Wright Medical Deutschland GmbH, Raisting, Germany) or a plantar Lapidus plate (Wright Medical Deutschland GmbH). In all samples, a 4-mm, cannulated, self-tapping, compression screw with a partial thread pattern was introduced first from the dorsal cortex of the first metatarsal into the medial cuneiform. The specimens were then loaded quasistatically, followed by cyclic loading to failure. The investigators noted in the static tests that the plantar plate construct was superior to the dorsomedial plate construct (14). They, therefore, concluded that plantar plating appears to offer a biomechanical benefit in the Lapidus arthrodesis (14).

We believe that the fixation construct we have described is a useful option for the Lapidus procedure. When a segment of bone is loaded vertically, there is congruent contact between the ends of the bone. During the stance phase of gait, potential disruptive distraction forces are created at the inferior aspect of the fusion site. Placement of a lag screw on the tension side of the arthrodesis can actually convert those forces into compression. Biomechanically, this should be a more stable and an inherently stronger fixation construct than the construct with a screw oriented across the dorsal aspect of the fusion site. Additional augmentation of plantar screw fixation with a medial locking plate might provide greater stability and strength to the fusion.

The present study had several limitations, primarily those inherent to all retrospective studies. First, just as with any radiographic evaluation, errors in patient positioning and rotation of the foot might account for some variability in radiographic measurements. We attempted to keep these errors to a minimum by having 1 of us (J.M.C.) perform all the measurements using a digital caliper. The small number of patients in the present series, the absence of a control group, and the relatively short follow-up period, all contributed to a less than perfect model. In addition, with the present study, we noted an increased rate of complications, most of the additional issues was related to the need for hardware removal only and were easily addressed once the hardware had been removed. We believe that hardware removal might be justified by the significantly lower percentage of nonunion and recurrence in deformity, which are more difficult to salvage, such as noted within our study.

The techniques described within the present report are additional modifications to the Lapidus procedure and provide a rigid internal fixation construct. In addition, this method has allowed early weightbearing with reproducible and reliable results. The traditional concept of the Lapidus procedure as a technically challenging procedure with high risks, prolonged non-weightbearing, and extensive postoperative recovery can perhaps be mitigated by this rigid construct design.

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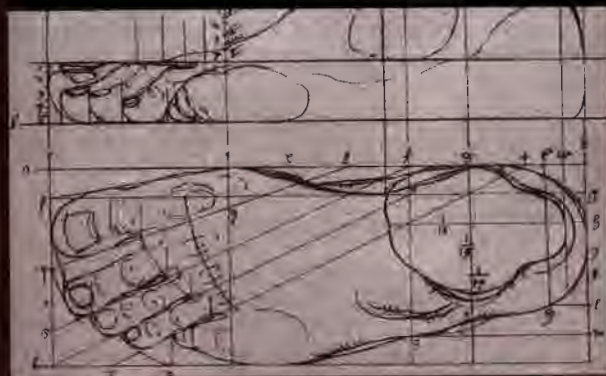
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Arthrodesis Techniques, Part I

CLINICS IN PODIATRIC MEDICINE AND SURGERY OF NORTH AMERICA



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Vincent J. Mandracchia, DPM, MS

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The advantages, disadvantages, and indications of external fixation in foot and ankle arthrodesis are reviewed in this article. External fixation offers the surgeon an opportunity to treat complex foot and ankle deformities, trauma, chronic infections, pseudoarthroses, soft tissue contractures, and limb length discrepancies in ways that were unavailable before its advent. The Ilizarov technique requires considerable experience and patient compliance for the best postoperative outcome. In addition, an understanding of musculoskeletal physiology and the biomechanics of bone and soft tissue are essential for a competent application of external fixators in general, and Ilizarov frames in particular. The surgeon should be aware of all the surgical options before the application of a complex external apparatus.

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Surgical correction techniques for digital deformities are often debated in podiatric surgery. Multiple techniques have been described and used throughout the past century. Common techniques include arthroplasty, arthrodesis, flexor tendon transfer, lesser digital implants, and amputation. Arthrodesis has been advocated as an effective and predictable method of treatment for digital deformities,

including hammertoes and clawtoes. Successful digital arthrodesis provides permanent and reliable correction of deformities and is considered by the senior author to be the favored technique.

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Jolene Moyer, Clinton Lowery, Jason Knox, and
Amanda Mudrey

Surgical arthrodesis of the hallux interphalangeal joint (IPJ) can be used to address painful contraction deformities of the hallux. There are many biomechanical, congenital, and traumatic etiologies that account for contraction deformities of the hallux IPJ. These deformities add extra risk in neuropathic patients and may need to be surgically addressed to prevent ulcerations. Several of these etiologies, as well as surgical techniques used to achieve hallux IPJ arthrodesis, are discussed in this review article.

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Gerard V. Yu and Paul O. Gorbey

Since the initial description of first metatarsophalangeal arthrodesis with an ivory peg by Clutton in 1894, numerous technique modifications and refinements have been described. Regardless of the technique employed, the procedure continues to be a time-honored procedure for the treatment of various disorders and pathology of the first metatarsophalangeal joint.

Lapidus Bunionectomy: Arthrodesis of the First Metatarsocunieform Joint

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Babak Baravarian, Gary B. Briskin, and Patrick Burns

Fusion of the first metatarsocunieform (MC) joint allows for correction of the first metatarsal in three planes, including adduction, plantarflexion, and rotation. It also allows for decreased jamming of the great toe joint and increased medial column stability. As knowledge about other medial column procedures grows, fusion of the first MC joint will continue to grow in popularity. It is an excellent procedure for hallux limitus and also for metatarsus primus elevatus cases.

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Thomas Zgonis, Patrick Burns, and Richard Gehl

Fracture-dislocation of the tarsometatarsal joint is a major injury and can be associated with a chronic disability. The incidence is low, but the long-term results can be a devastating problem to the patient. This article reviews the anatomy, mechanism of injury, classifications, diagnostic procedures, treatment, and long-term results of a fracture-dislocation to the tarsometatarsal joint complex.

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Thomas J. Chang and David J. Soomekh

The lateral column of the human foot includes the calcaneus, the cuboid, and the fourth and fifth metatarsals and their respective joints—calcaneocuboid, cuboidometatarsal, and intermetatarsal joints. Injuries to the midtarsal joints are uncommon, yet when these injuries do occur there is a debate on the best way to approach the treatment. It has been the authors' experience that there can be success in fusion of the calcaneocuboid joint or fourth and fifth cuboidometatarsal joints or a combined fusion for lateral column pathologies. This article discusses some of the authors' experience and opinion on the subject that may bring about some interest for future study of the topic.

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The naviculocuneiform (NC) joint is subject to abnormal stresses through the foot that can often lead to arthrosis and collapse of the medial longitudinal arch. This article discusses the indications and surgical techniques for NC arthrodesis.

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Lapidus bunionectomy: arthrodesis of the first metatarsocunieiform joint

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Arthrodesis of the first metatarsal cuneiform joint (MCJ) was first described in 1911 by Albrecht [1]. Truslow [2] and Kleinberg [3] revisited the procedure shortly thereafter. But it was not until 1934 when Lapidus published his first article on the etiology and surgical technique that the procedure became popular. He followed this with two more articles further discussing the rationale for the procedure [4–6].

Lapidus believed that certain types of hallux abducto valgus are a result of an atavistic trait. The metatarsal is excessively adducted (what he described as metatarsus primus varus) because of an arrest of ontogenic development. More importantly, Lapidus understood that the deformity should be corrected at its apex. He realized that the metatarsal cuneiform joint was abnormally angulated and that correction should therefore be directed to that joint. He also stated, “Osteotomies of the first metatarsal, particularly over the distal part, never have seemed mechanically sound” [5].

The procedure Lapidus described included fusion of the first metatarsal cuneiform joint and fusion of the base of the first metatarsal to the base of the second metatarsal. The fusions were held in place with drill holes and catgut suture. Lapidus never published objective reports but did say that after 25 years he found the procedure useful in “properly selected cases.” Over the next 70 years, modifications of the Lapidus procedure have gone in and out of favor. Many surgeons find it technically demanding, there are problems with shortening, and some report high nonunion rates. But for the surgeon who feels comfortable with the procedure, it can be a “versatile means of addressing positional and structural problems with the medial column” [7].

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Indications

Some of the indications for fusion of the first MCJ include severe metatarsus primus adductus (MPA), patients with moderate MPA with hypermobility of the first ray, generalized ligamentous laxity, adolescent hallux abducto valgus deformity (HAV), degenerative changes of the first MC joint from arthritides, hallux limitus with elevatus of the first ray in cases of mild to moderate degenerative changes of the first metatarsophalangeal joint (MPJ), and salvage of failed HAV surgery. Unfortunately, one of the main indications for the procedure is difficult to define and more difficult to quantify, yet few argue its existence. Root [8] stated, “In an individual with a normal first ray, the full range of motion will move the first metatarsal head above and below the transverse plane of the dorsiflexed lesser metatarsal heads by the same distance in each direction.” In other words, the motion of the first ray should be equally divided into dorsiflexion and plantarflexion. With current understanding of the first ray and its range of motion, hypermobility is then defined as excessive motion about this joint during gait. But, the amount of motion has not been defined, and holding the foot in a neutral position and measuring the excursion are subjective findings leading to inconsistency. Radiographs have also been discussed as a tool for diagnosis of hypermobility of the first ray. Attention is paid to the first MCJ angle and cortical thickening of the second metatarsal as a sign of lesser metatarsal overloading secondary to a hypermobile first ray. Because of the difficulty quantifying hypermobility, the diagnosis continues to be clinical.

Examination

Examination of the patient begins with a gait analysis. Abduction of the rearfoot with elevation of the first ray may be noted. An early heel off may be a sign of tightness of the posterior muscle group.

Seated examination confirms laxity of the first ray, tracking of the great toe and any crepitus. Adjunct gastrocnemius or Achilles equinus and rearfoot deformity is also checked. Proper vascular and neurologic testing is performed. The quality of the skin should also be checked to avoid scarring and to alert the patient to any potential complications before surgery.

Proper informed consent of the patient is essential to avoid discrepancy. It is important to inform the patient of the rate of nonunion/delayed union and other associated complications, including numbness, scar formation, and joint stiffness.

Procedure

To perform the procedure with a minimum of strain to the surgeon, patient positioning is essential. The patient is placed on the table in a supine position with attention to foot position. The foot is placed at the most distal aspect of the bed and bumping of the ipsilateral hip is performed to place the foot in a rectus position. The

procedure may be performed under local or general anesthesia. Our preference is to perform the procedure under monitored anesthesia care in combination with a popliteal fossa block. The popliteal fossa block allows for a high ankle tourniquet placement and also allows for anesthesia of the Achilles tendon and gastrocnemius muscular junction for adjunctive tendon lengthening procedures. Tourniquet use is the surgeon's choice; however, it is essential to place an ankle tourniquet proximal enough to allow for proper positioning of the hand during placement of the distal to proximal screw across the joint. If the ankle tourniquet is distal, it is difficult to position the drill properly for the medial cuneiform to first metatarsal screw.

The procedure is started with a dorsal incision placed over the first MC joint. To properly identify the joint, fluoroscopy may be used. An easy technique to identify the joint is to wet the region and run one's finger over the first metatarsal toward the base. A ledge will be palpated, which is the joint line. A second important point to consider is placement of the incision of the dorsum of the joint. It is more difficult to perform the procedure if the incision is too far medial. The incision is deepened to the level of deep fascia. A communicating branch between the medial and intermediate dorsal cutaneous nerves is usually found traversing the joint. This nerve, if in the incision site, should be sacrificed because it will be difficult to perform the procedure otherwise. The extensor hallucis longus and brevis tendons are identified and retracted medially. The extensor hallucis brevis tendon may be released at the location as desired. A dorsal periosteal incision is performed to access the joint. It is ideal to perform the incision on the dorsum of the joint and not make a medial approach. Periosteal flaps are raised. The dorsal periosteum is well adhered and need to be released with sharp dissection. Once the medial and lateral aspects of the joint are reached, a periosteal elevator may be used. Preservation of the periosteum is essential to increase the rate of arthrodesis and protect neurovascular structures. Dissection of the periosteum as far plantar as possible should be performed to allow greater access to the joint.

It is the surgeon's choice as to joint resection technique, though a saw is commonly used. If this is the desired technique, a long blade must be used as the joint resection depth is approximately 2 cm. A wedge is resected off the base of the first metatarsal and a joint resection of the medial cuneiform is performed. It has been the authors' experience that this is not necessary for joint alignment, and it often decreases joint stability. The authors' current technique for joint preparation is a combination of curettage and sharp resection of the articular surfaces. The preparation is begun with the use of sharp osteotomes. The osteotome is held firmly by hand and run from dorsal the plantar along the articular surfaces. The procedure is repeated until as much articular cartilage is resected as possible. From time to time, a rongeur is used to remove the loose cartilage in the joint. A curette is then used to remove any remaining cartilage, especially at the base of the joint. It is essential to remove the most plantar cartilage to avoid a plantar ledge. If a plantar ledge is left behind, dorsiflexion of the metatarsal may occur. Following removal of all articular cartilage, the subcortical bone is prepared with subchondral drilling or shingling of the joint surface. It has been the authors' experience that use of a small



Fig. 1. Preoperative AP and lateral radiographs of hallux valgus deformity with mild elevatus of the first ray.

osteotome and mallet for joint shingling causes no burning associated with drilling had allows for subchondral bleeding. The subchondral bone is approached at an angle, and the joint surface, if raised slightly. The raised piece is turned 45 degrees and left in the joint.

Attention is then directed to the first MPJ. The joint may be approached with a continuation of the dorsal first MC incision or through a medial incision. It has been the authors' experience that the medial approach allows for better cosmesis. The medial incision is centered over the medial first MPJ and deepened to the joint capsule. The dorsal skin may be raised to allow for lateral release, or a second dorsal incision may be made over the first interspace for lateral release. A dorsal medial capsular incision is then performed and the medial collateral ligament is released. The lateral collateral ligament may be released from a plantar or dorsal joint approach. The medial eminence is removed and the first metatarsal is positioned. An excellent positioning tip is to push medially at the first metatarsal head and dorsiflex the great toe simultaneously. This will reposition and compress the first metatarsal. The first metatarsal is then displaced plantar in cases of elevatus. If proper alignment is not achieved, the lateral first metatarsal base may need to be resected. This is rarely necessary, and repositioning is often difficult if the fibular sesamoid is not positioned plantar to the metatarsal head adequately.

Once anatomic alignment is achieved in the sagittal and transverse planes, temporary fixation is achieved with the use of a Kirschner wire. If a cannulated screw set is used, the wire may be from the set. The first wire is run from the base of the first metatarsal to the base of the medial cuneiform. To achieve proper wire position, the wire is aimed at the navicular tubersity. This will place the wire directly in the central portion of the medial cuneiform. A second wire is placed from the medial cuneiform to the lateral base of the first metatarsal. Fluoroscopy is used to check position in the dorsal plantar plane and a lateral plane. Screw placement is then performed with the surgeon's choice of screw. If there is a problem with screw placement or the dorsal ledge fractures and instability of the screw placement is found to be present, a screw may be run from the medial first metatarsal base to the intermediate cuneiform or into the second metatarsal base. A screw into the second metatarsal base will need to be removed after healing is achieved. The authors' choice in cases of difficult fixation of soft bone or cortical fracture is the placement of a dorsal miniplate. The plate may be a compression



Fig. 1 (continued).



Fig. 2. Traditional fixation technique with crossing screws and mild plantar translation of the first metatarsal.

system if compression of the joint is poor, or a stability plate if adequate compression is achieved with a lag screw across the joint.

Before closure, alignment of the metatarsal base and great toe joint and screw placement are checked with fluoroscopy while the foot is loaded. Periosteal and skin closure is performed for both joints. Dressings are applied and a splint or bivalved cast is applied to the region.

The patient is kept non-weight bearing for a period to 4 to 6 weeks or until adequate joint healing is noted with radiographic examination. The patient is then gradually allowed to bear weight on the surgical site with the use of a surgical shoe or below-the-knee walking boot until full healing is noted. Physical therapy of the great toe joint can begin at 3 to 4 weeks postsurgery to prevent stiffness and scarring. It is more difficult to return the plantarflexion motion of the great toe; therefore, plantarflexion exercises are emphasized. Weight-bearing physical therapy is not started until full healing is noted.

Adjunct procedures

Often the underlying hallux limitus/hallux valgus deformity is caused by excessive pronation or tightness of the posterior leg musculature. Two common adjunctive procedures are calcaneal osteotomies (Evans or medial calcaneal slide) and posterior musculature lengthening (Achilles or gastrocnemius tendon lengthening). It is essential to perform these adjunct procedure, when necessary, to achieve adequate outcomes.

Clinical outcomes

In the literature, few articles have been written with objective results, probably due to the technical difficulty and complications. Sangeorzan in 1989 [9] reported on 40 foot procedures for first MCJ fusion. Hypermobility was defined as “relatively increased dorsiflexion of the first ray with soft end point on examination, combined with second metatarsal overload.” They also related patients having a medially oriented cuneiform and second metatarsal cortical thickening, indicating overload. The fusion was fixated with two screws, one crossing the fusion and another crossing from the first metatarsal into the second metatarsal base



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Fig. 2 (continued).

or second cuneiform. The second screw was not for fusion between the metatarsals but to “ensure rotational stability” and later removed. The intermetatarsal angle changed from 14 degrees preoperatively to 6 degrees postoperatively, and there were four reported nonunions. Good or excellent results were reported at 74%.

Mauldin in 1990 [10] described a modification of the Lapidus in which there was a limited fusion technique, emphasizing the first metatarsocunieiform joint, to maintain length. Fifty-one patients were reviewed with average preoperative



Fig. 3. Preoperative AP and lateral radiographs of early hallux limitus secondary to laxity of the first ray. Note mild dorsal spurring of the first metatarsal on the lateral image and mild decreased joint space on the AP image.

intermetatarsal angles of 14.6 degrees, reducing to 8.7 postoperatively. Nonunion rates were difficult to determine and not well reported. Hallux varus was reported in 15.7% of the patients.

An estimation of “excessive motion of the first metatarsal in both sagittal and transverse planes” was the definition of hypermobility used by Myerson in 1992



Fig. 4. Postoperative AP and lateral radiographs with traditional fixation technique and realignment of the first metatarsal. Note extensive plantar translation of the first metatarsal.



Fig. 4 (continued).

[11]. Cortical thickening of the second metatarsal shaft was also a typical radiographic finding. Sixty-seven MCJ fusions were reviewed, with seven non-unions. The intermetatarsal angle decreased from 14.3 preoperatively to 5.8 postoperatively. Myerson placed fixation from the first metatarsal into the second metatarsal but states that “since this further increases stiffness, incorporating the base of the second metatarsal in the arthrodesis is probably unnecessary” [11].

Chang and Ruch in 1994 [7] published an article discussing the procedure and outlining their technique for fixation. The article was not a study, but discussed the author’s technique involving a five-hole one-third tubular plate and a compression screw. The plate is prebent to match the contour of the medial aspect of the first metatarsal cuneiform joint. After joint preparation, the fusion site is held in place with a Kirschner wire. The plate is then held in place with two screws in the cuneiform. A screw is then placed into the metatarsal using eccentric drilling through the plate to aid in compression. Next, axial compression is achieved by a placing a cancellous screw across the fusion site. Finally, the remaining holes in the plate are filled with standard concentric drilling.

Grace et al in 1999 [12] published a retrospective review of the modified Lapidus in adolescent HAV. The authors worked with reports of high recurrence rates of adolescent hallux valgus and, in these, report that the initial surgery done probably did not address the instability of the first ray. The theory was that fusion of the first MCJ would give stability to the first ray and reduce recurrence. Radiographs revealed second metatarsal hypertrophy in 60% of the 30 cases they reviewed. First intermetatarsal angles decreased from 13.3 preoperatively to 5.4 postoperatively, and 90% of the patients had good to excellent results in the short term. They reported two recurrences and only one symptomatic nonunion.

Later in 1999, Catanzariti et al [13] reported their review of 47 modified Lapidus procedures. The patients all had HAV and some degree of hypermobility. Again, no consistent measure of hypermobility was discussed. In the same patient population, different combinations of planar resection, bone grafting for short metatarsals, and varying types of fixation were used. Allogenic graft was used if preoperative metatarsal protrusion distance warranted. Three nonunions were reported with average intermetatarsal angles preoperatively (13.8) decreasing to 2.1. Average shortening without grafting was 4.7 mm.

Kenrin et al in 2000 [14] authored an article discussing the modified Lapidus procedure and its use in rheumatoid patients. Twenty-one patients were retrospectively evaluated. Hallux valgus is commonly seen in this patient population; however, first metatarsal phalangeal joint fusions and arthroplasties are more commonly performed. The authors noticed that early and intermediate rheumatoid patients had hallux valgus but maintained a reasonable first metatarsal phalangeal joint space. This observation led the authors to preserve the first metatarsal phalangeal joint and correct the deformity more proximally. This would also help the failing arch. The fusion was achieved with one or two staples. The patients were then evaluated and first intermetatarsal angle decreased from 13 degrees preoperatively to 8.3 degrees postoperatively. There were no reports of nonunions.

McInnes and Bouche in 2001 [15] published on the topic, giving a comprehensive history of the literature and a retrospective study of 25 patients. Fusions were preformed with two 3.5-mm cortical screws, and the average follow-up time was 39 months. The authors also divided the patients into athletic, active, and sedentary. Hypermobility was diagnosed preoperatively by the senior author and used a combination of subjective, objective, and radiographic criteria. It was defined as “excessive motion in the sagittal and transverse planes in conjunction with signs and symptoms of lesser metatarsal overload.” Subjective and objective scoring systems were then used.

Five patients stated that the surgery was “ineffective,” and 78% regarded the surgery as “completely” or “very” effective. Average preoperative IM measured 16.7 degrees and decreased to 8.2 degrees postoperatively. First metatarsal shortening was 4.5 mm in the patients with a curettage method and 7.5 mm in the patients that had undergone planar resection. There was no significant difference in the subjective and objective scores among the three activity levels; however, the population size was small with only eight patients in the sedentary group. Return to activity in athletes was only 30%, compared with the 86% and 75% of active and sedentary, respectively. Five nonunions, three of which were asymptomatic, were reported (Figs. 1–6).

Coetzee et al in 2003 [16] reported prospectively on 26 modified Lapidus procedures performed as salvage after failed treatment of hallux valgus. The study included the visual analog scale and the American Orthopedic Foot and Ankle Society (AOFAS) Hallux Metatarsophalangeal-Interphalangeal Scale preoperatively and at 24 months. The visual pain scale improved from 6.2 to 1.4, and the AOFAS scale improved from 47.6 to 87.9 with no “dissatisfied” patients. The procedure involves screw fixation across the first tarsometatarsal joint and from the base of the first metatarsal to the base of the second. Coetzee stated, “The tarsometatarsal and first and second metatarsal fusions eliminate any rotation or translation of the first ray,” thereby making it “almost impossible for the hallux valgus or metatarsus primus varus deformity to recur” [16]. The procedure addresses the hypermobility that could have contributed to the initial deformity and its recurrence.

The authors have reviewed results on 47 cases with a follow-up of 1 to 3 years. Preoperative diagnosis was hypermobility and hallux valgus deformity in 37 cases,



Fig. 5. Preoperative AP and lateral radiographs of a hallux valgus deformity.



Fig. 6. Postoperative AP and lateral radiographs of a hallux valgus deformity with correction of the first metatarsal angle in two planes (sagittal and transverse) and plate fixation because of softness of the bone and lack of adequate screw fixation attempts.

hallux limitus in nine cases, and degenerative arthritis of the first MC joint in one case. The results revealed only one asymptomatic nonunion in a noncompliant patient who began weight bearing at 2 weeks. Joint resection and realignment of the joint resulted in similar alignment and outcome as wedge realignment of the joint. Intermetatarsal angle was reduced from an average of 14.8 degrees to 6.2 degrees. Time to full healing has been dramatically decreased with atraumatic technique and prevention of joint heating. Time to full fusion has been decreased by 2 weeks with joint curettage and shingling as compared with subchondral drilling or saw resection of the joint surfaces. Two cases of plate use in addition to compression screw use have resulted in adequate fusion. The plates have not needed to be removed to this date. Patient satisfaction has been excellent in 41 cases, good in four cases, and adequate in two cases. The two adequate cases complained of sesamoid pain during exercise secondary to ray plantarflexion. The mild pain was well controlled with orthotic use during exercise. All patients stated that they would undergo the procedure again.

Discussion

Arthrodesis of the first MC joint has grown in popularity as more experience and knowledge as to the function and stability of the medial column has developed. The procedure was originally thought to be difficult, and the rate of nonunion was high. With the advent of internal fixation and increased experience in resection techniques, the rate of nonunion has dramatically decreased.

Fusion of the first MC joint allows for correction of the first metatarsal in three planes, including adduction, plantarflexion, and rotation. It also allows for decreased jamming of the great toe joint and increased medial column stability. Although hypermobility is a difficult diagnosis to make in certain cases, it is best to perform a first MC fusion bunionectomy if there is any doubt as to the stability of the first ray.

As knowledge about other medial column procedures grows, fusion of the first MC joint will continue to grow in popularity. It is an excellent procedure for hallux limitus and also for metatarsus primus elevatus cases.

Although there is no comparison study to date, the authors' opinion is that limited heating of the joint and curettage techniques will produce higher fusion rates. This study is now being undertaken, with results to follow.

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Exhibit 1018

Clinical Orthopaedics

ANTHONY F. DePALMA

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Number Sixteen



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Philadelphia and Montreal

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12

The Author's Bunion Operation From 1931 to 1959

PAUL W. LAPIDUS, M.D.*

The author's bunion operation was first performed at the Hospital for Joint Diseases on April 8, 1931, and thus far has stood the test of time; it is still being done successfully. The details of it were published as a preliminary communication in February, 1934.

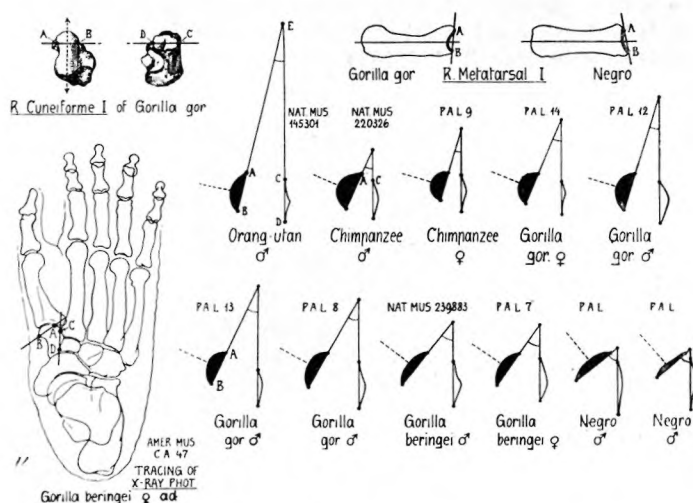
The purpose of this chapter is to describe our present-day approach to the bunion problem. Since the earliest days of his ortho-

paedic practice, the author has been aware of the frequent association of the metatarsus varus primus with bunions. What he was *not* aware of at that time was the fact that the same observation was made by anthropologists long before orthopaedic surgeons thought of it. Already in 1882, Leboucq pointed out that the divergence of the first metatarsal was due to the extreme angle made by the plane of the distal articular facet of the first cuneiform bone with the

* New York, N. Y.

FIG. 1. Tracing of the roentgenogram of the skinned foot of an adult female mountain gorilla (*beringei*) showing the location of the section through the joint of the hallux and the first cuneiform. Figures on the right are accurate copies of these sections through the first cuneiform bones of various higher primates. Line A-B represents a section through the center of the first cuneiform-metatarsal joint in the plane roughly parallel to the sole of the foot. Line C-D is drawn through the middle of the joint between the first and the second cuneiforms and was found always to have

practically the same direction as the morphologic axis at the foot. The angle B-E-D (see orangutan) determines the medial slant of the plane of the first cuneiform-metatarsal joint. The greater this angle the less the slant and, likewise, the divergence of the first metatarsal. According to Schultz, in man this angle is 56 to 50°; in the terrestrial gorilla *beringei* it is 39 to 35°; in the arboreal Gorilla gorilla it is 30 to 18°; and in monkeys it is 24 to 13°. The black semicircle represents the shape of the first cuneiform-metatarsal joint, which is more ball-and-socketlike in movable hallux of the lower primates and becomes flattened in higher primate and especially in man, with the loss of mobility of the first metatarsal. (Reprinted from Human Biology, vol. 2, no. 3 [chapter entitled "The Skeleton of the Trunk and Limbs of Higher Primates," by Adolph H. Schultz] by permission of the Wayne State University Press)



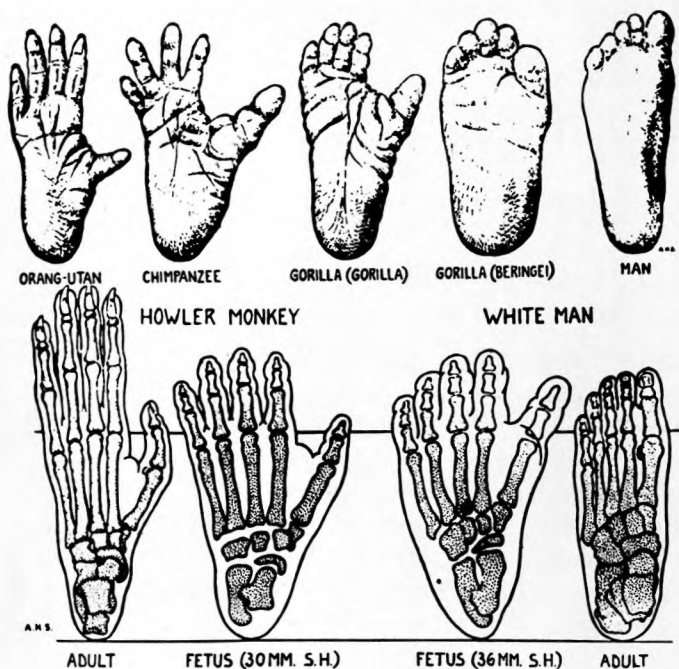


FIG. 2. Note the shortening of the hallucial ray from man to orangutan and also the increased divergence of the big toe in prehensile foot of lower primates as compared with man (upper row). The difference between the big toe in gorilla beringei and that of the Gorilla gorilla is most interesting. Although they are very closely related, the first spends a great deal of time walking on the ground; therefore, his big toe resembles very closely that of man, while the hallux of the prevalingly arboreal Gorilla gorilla still retains simian features and is more like that of the chimpanzee. In the lower row is a semidiagrammatic drawing of feet of fetal and adult man, and howling monkey, showing ontogenetic reduction of the lesser digits in adult man and their increase in a grown-up monkey. Also note that the hallucial elements are almost similar in both embryos, but the first ray of the adult man becomes stouter and loses its divergence while the reverse growth changes take place in the monkey's foot. Distance from heel to second metatarsophalangeal joint is same absolute length in all 4 drawings. (Schultz, A. H.: Quart. Rev. Biol. 1:465)

elements are almost similar in both embryos, but the first ray of the adult man becomes stouter and loses its divergence while the reverse growth changes take place in the monkey's foot. Distance from heel to second metatarsophalangeal joint is same absolute length in all 4 drawings. (Schultz, A. H.: Quart. Rev. Biol. 1:465)

long axis of the foot. This angle approaches that found in the prehensile arboreal foot of the primates (Fig. 1). In 1927, Straus, an anthropologist, who probably never saw a patient with bunions, stated:

In the adult human, the long axis of the basal phalanx of the hallux is not, as a rule, in line with the long axis of the first metatarsal. The phalangeal portion is bent toward the other digits. Adduction of the hallucial phalanges is the rule for all human development, being quite as marked in the fetus as in the adult. This condition cannot be ascribed to wearing boots, for it is general among the lower primates and was present in a howler fetus as well. In man it persists most likely as a relic of the days when the foot was a grasping organ and the hallux was bent as a hook toward the other toes.

Figure 2 (Schultz, 1926) illustrates the trend of ontogenetic development of the foot in the howling monkey and man, and also

shows the changes of the big toe as it gradually lost its prehensile functions from ape to man.

Figure 1 (Schultz, 1930) shows the changes of the first cuneiformometatarsal joint, also from ape to man. The two cardinal features are (1) diminution of medial slant of the first cuneiformometatarsal joint and, consequently, also of the medial divergence of the first metatarsal, and (2) the flattening of the first cuneiformometatarsal articulation, which is more ball-and-socket-like in the mobile hallux of the lower primates.

The following table (Straus, 1927) brings out the fact that the varus of the first metatarsal, measured by the angle between the long axes of the first and the second metatarsals, is more marked in the human embryo, being 32.0° in an eight-week human fetus, and diminishes to 6.2° in an adult

ANGLE (APPROXIMATE) BETWEEN LONG
AXES OF METATARSI I AND II DURING
GROWTH OF MAN AND HOWLING MONKEY
AND IN SOME OTHER PRIMATES

AGE	AVERAGE IN DEGREES	RANGE OF VARIATION IN DEGREES
<i>Man</i>		
8th week fetus	32.0	
3rd mo. fetuses	18.7	14.0-30.0
4th mo. fetuses	11.1	3.5-14.0
5-6 mo. fetuses	10.1	6.5-15.5
7-8 mo. fetuses	6.1	3.0- 9.5
9th mo. fetuses	8.9	3.0-19.5
Newborn	5.8	4.0- 8.0
Juvenile	5.0	2.0- 8.0
Adult	6.2	3.0- 9.0
<i>Anthropoid Apes</i>		
Orangutan, adult	46.2	42.0-49.5
Chimpanzee, juvenile	42.0	
Chimpanzee, adult	39.0	
Gorilla, juvenile	25.0	18.0-30.0
Gorilla, adult	25.0	20.0-30.0
Hylobates, adult	17.5	11.0-33.0
<i>New World Monkeys</i>		
Alouatta, fetus 111 mm., C.R.	55.0	
Alouatta, newborn	40.0	
Alouatta, adult	23.0	

Note gradual ontogenetic diminution of hallucial divergence in man from 32.0° in the 8th month fetus to 6.2° in adult. Anthropoids have a much greater angle, which reaches an average of 46.2° in prevailing arboreal orang-utan. It is interesting to note the diminution of divergence with growth also in *Alouatta* (howling monkey) (Straus, W. L., Jr.: *Contrib. Embryol.*, No. 101, 19:119)

man. In other words, the hallux of the human embryo has simian features that gradually are lost with growth.

The above-quoted anthropologic works seem to support the postulations made by the author in his preliminary report in 1934, that the bunion is more prone to develop in an "atavistic" foot with metatarsus varus primus. This type of foot apparently became arrested in its ontogenetic development and

retained some features normally present in the human embryo and in the adult foot of the lower primates. It may be considered as a reversion to a primitive state, presenting "congenital potential predisposition toward hallux valgus formation, and thus the often observed hereditary predisposition toward this deformity can be readily understood" (Lapidus, 1934). When harelip and cleft palate are repaired, or an operation for undescended testicle is performed both being typical examples of an arrest of ontogenetic development, the surgeon attempts to complete the process that normally takes place during natural growth. By the same token, if the persistence of the metatarsus varus primus, together with hypermobility and the apelike shape of the first cuneiform-metatarsal joint, allowing excessive tibial abduction of the first metatarsal in an adult man, is accepted as an arrest of development and is one of the main predisposing factors for bunion formation in a great number of patients, it is only logical to conclude that surgical repair should also consist of correction of metatarsus varus primus. If the divergence of the first metatarsal in an adult is explained as a failure of nature to complete its normal cycle of growth, then it is up to the surgeon to complete what nature failed to do, similar to harelip, cleft palate or undescended testicle.

The idea that the metatarsus varus primus is a primary factor with subsequent formation of hallux valgus is not a new one. It has been advanced by a number of orthopaedic surgeons, as can be seen from Figure 3 (after Timmer), a schematic illustration of some of the numerous operative procedures devised for correction of the bunion. Once more the author wishes to repeat that, except for the details of the operation, he does not claim priority or originality. Quite a few surgeons in the past and a number of them today approached this problem in somewhat similar manner, attempting to correct the metatarsus varus primus.

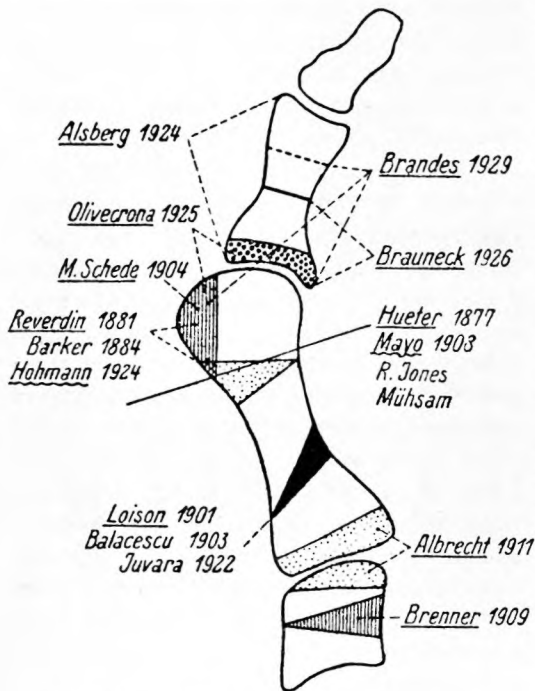


FIG. 3. Schematic drawing of various operative procedures devised for correction of bunion. The name of the author and the year of description of the operation are indicated. (Timmer, H.: Die Behandlung des Hallux valgus, Leipzig, Barth)

As already stated, the degree of divergence of the first metatarsal away (tibialward) from the second depends upon the shape and the range of motion in the first metatarsocuneiform joint. The long axis of the first metatarsal forms an obtuse angle, open tibialward, with the long axis of the first cuneiform; the apex of this angle is at the first cuneiformometatarsal joint.

Osteotomy to correct an angulation deformity of any long bone is performed usually at the apex of the angulation, and not distally or proximally to it; otherwise, a bayonet-shaped deformity is produced. An ankylosed knee joint with genu valgum or with flexion deformity is best corrected by an osteotomy placed right through the former line of the joint and not over the femur or the tibia. Therefore, it is the

author's preference to correct the metatarsus varus primus at the first cuneiformometatarsal joint; numerous and variable osteotomies of the first metatarsal shaft, and particularly so over its distal part, never have seemed to the author to be mechanically sound (Fig. 3).

Furthermore, any osteotomies require adequate and prolonged immobilization to prevent displacement of fragments and to ensure their firm bony union. This, again, makes them undesirable. In another group of operative technics, attempt is made to utilize soft tissues (muscles, tendons or fascia) to approximate the first metatarsal head to the second and, thus, to correct the metatarsus varus primus. For a number of years it has been our preoperative routine in bunion cases to take dorsoplantar roentgenograms of the foot tightly bandaged across the metatarsal heads in addition to other routine exposures. We learned that in some cases we were unable to approximate closely the first and the second metatarsal heads, with some persistence of metatarsus varus primus even on tight bandaging. This was obviously due to a fixed tibial abduction contracture at the first cuneiformometatarsal joint. Consequently, is it reasonable to expect a small intrinsic muscle of the foot, as, for instance, the abductor hallucis, when it is transplanted onto the first metatarsal neck, to adduct the first metatarsal fibularward, and especially when there is fixed tibial abduction contracture present in the joint? Fascial or tendinous transplants anchored to the metatarsal necks to correct their spreading, advocated by some surgeons today, have also been tried by the author (1933) but were abandoned in favor of the bony fusion of the first metatarsocuneiform joint with creation of a bone bridging the first and the second metatarsal bases. Of course, it goes without saying that when correction of the first metatarsus varus is indicated, it is always combined with the correction of the valgus deformity of the big toe itself. In the latter procedure, not only do we depend on passive re-establishment

of balance between (tibial) abduction and (fibular) adduction of the big toe, but also we utilize the abductor hallucis muscle to supply the active power to maintain the big toe in proper alignment with the first metatarsal, as will be described below (Fig. 4).

Another group of operative technics consist of resection of the first metatarsophalangeal joint itself. The old Mayo-Küttner resection of the first metatarsal head never appealed to the author, and he is even more convinced now than he was in 1934 that "any operation creating shortening of the first metatarsal, or of the big toe, is emphatically condemned as unphysiological, and causing static and dynamic disturbance of the foot."

The resection of the base of the proximal phalanx according to the Keller-Brandes procedure has gained some popularity recently, mainly because of its simplicity and allegedly short postoperative disability. However, not infrequently after this procedure the big toe becomes a short, dangling appendage held above the ground, and the important "shove-off" function of the big toe may be lost permanently. Consequently, if one wishes to obtain as close as possible restoration of normal anatomic and physiologic relations, one cannot accept the Keller-Brandes operation.

INDICATION FOR OPERATION

Bunions are very common, especially in females, who, using their feet primarily for sex appeal, locomotor function being given only secondary consideration, succumb to the dictates of fashion and develop the deformity. The poorly fitting, narrow woman's shoe with a high heel is a factor in developing the malformation in a foot, which most of the time possesses a congenital and often hereditary predisposition toward bunion formation. In this respect, the shoe may be compared with a developing solution that only brings out the picture in a previously exposed photographic film.

We have operated upon a large number

of female feet. Only a few male patients have sought surgical correction. A large percentage of bunion feet give very little, if any, discomfort, and can be treated adequately with properly fitted shoes. On the other hand, even mild bunions, especially in females, may produce a great many complaints, especially while "breaking in" a new shoe.

In addition to actual functional disturbances and disability, quite a few patients request the operation for cosmetic reasons. As a rule, we limit our surgical correction to selected cases in which functional and cosmetic consideration seem to warrant it. Therefore, although for the past many years we have operated upon a large number of patients, they represent only a small percentage of extremely numerous patients with bunions treated conservatively. Furthermore, if surgical procedure is undertaken, we do not attempt to correct the metatarsus varus primus as frequently as we did originally. We must admit that with the accumulation of larger experience through many years, we have become more conservative and in a number of cases have limited our procedure to correction of the hallux valgus alone. It has been our observation that after satisfactory correction of hallux valgus, using our modification of the Silver procedure, the varus of the first metatarsal may diminish simultaneously, provided that there is adequate mobility of the first cuneiform-metatarsal joint to allow the approximation of the first and the second metatarsal heads. This mobility is estimated on roentgenograms with tight bandaging across the metatarsal heads, as already described. It has been our impression that in spite of the fact that metatarsus varus primus may be the main factor, hallux valgus developing subsequently, in a number of cases successful correction and maintenance of this correction of the big toe deformity are more important and often may be performed alone. On the other hand, additional correction of the first metatarsus varus, when it is

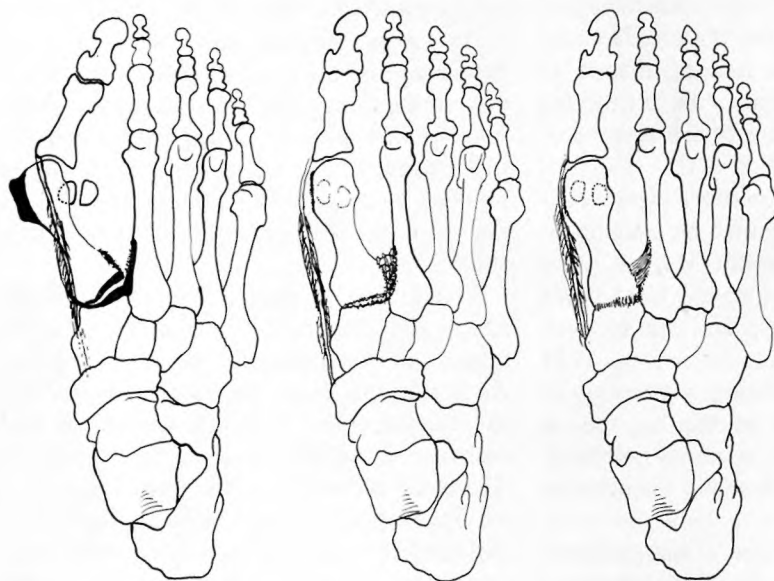


FIG. 4. Operative technic. (Lapidus, P. W.: Surg. Gynec. & Obst. 58:183.) Note the plantar displacement of the abductor hallucis in bunions and its action as a plantar flexor. It is relocated along the medial aspect of the first metatarsal, and its *abduction* action is re-established.

pronounced, with first and second metatarsals forming an angle of 10° to 12° or more, may ensure better results in the long run.

A survey of end-results of various operative procedures for correction of hallux valgus performed at the Hospital for Joint Diseases during 10 years (1931-1940) has seemed to indicate that better results were observed when metatarsus varus primus also was corrected.

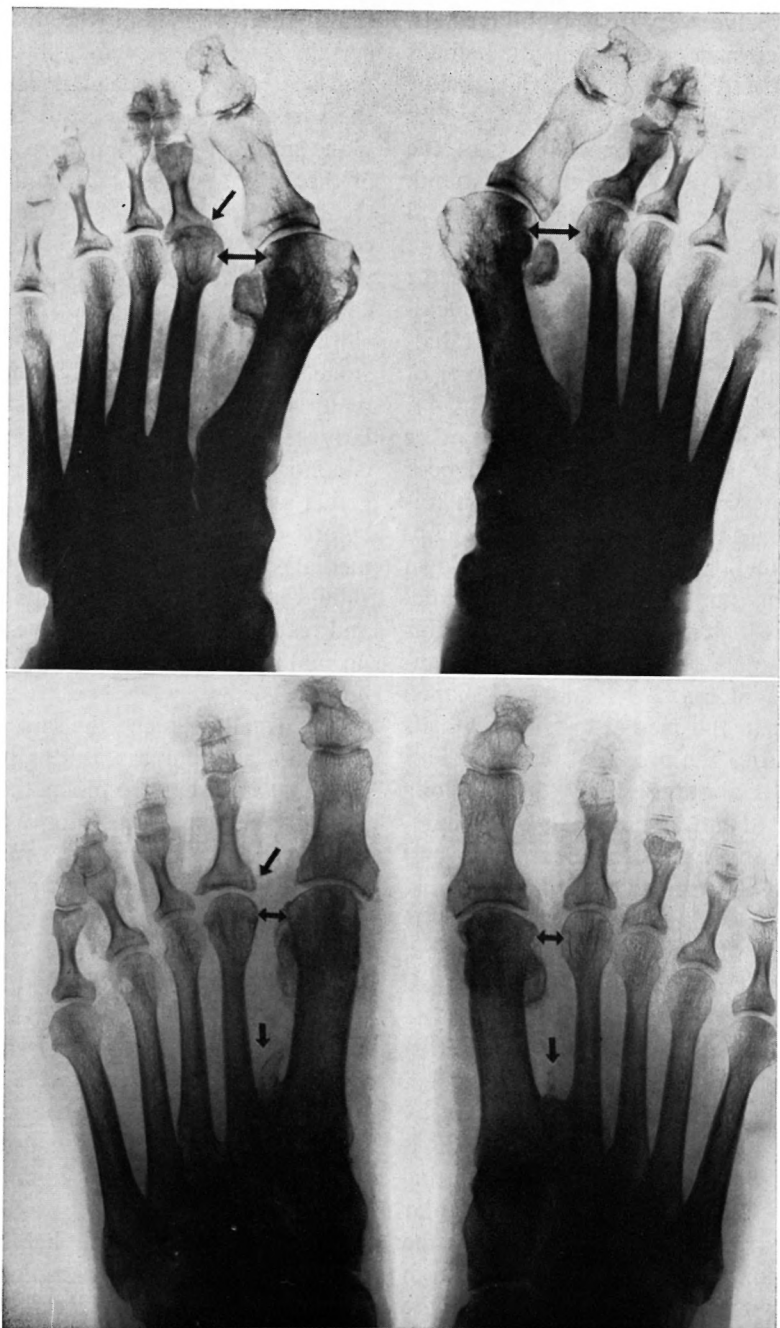
We have operated upon a considerable number of patients under local anesthesia when we limited ourselves to correction of the hallux valgus alone. There is no need for a tourniquet in this procedure, which also requires less time to perform, and the postoperative recovery may be a few days shorter. On the other hand, when correction of metatarsus varus is undertaken, a tourniquet is used, and, therefore, general anesthesia is required. The decision, of course, should depend on the judgment and the personal experience of the surgeon, as well as on the condition and the requirements of each patient. If the patient is not too old and is robust, and is willing to invest an extra week or two in anticipation of a somewhat better eventual result, and if the sur-

geon is quite confident in his hospital facilities and is fully familiar with the foot, the combination of both procedures may be indicated. Otherwise, mere correction of hallux valgus alone will be a preferable and a safer undertaking, and may also give a very satisfactory final result.

OPERATIVE TECHNIC

The present operative technic remains essentially the same as described originally in 1934 (Fig. 4). If the correction of metatarsus varus primus is planned, the operation is performed under general anesthesia. An Esmarch rubber bandage is first applied from the toes up to the lower quarter of the leg, where it is bandaged tightly over a towel and is used as a tourniquet.

The operation over the big toe joint is performed first. A straight longitudinal incision about $3\frac{1}{2}$ to 4 inches (9-10 cm.) long is made along the medial aspect of the big toe and the first metatarsal. The subcutaneous veins are ligated. The medial cutaneous nerve frequently seen in the wound is identified and retracted. The bursa over the bunion is opened, and further dissection is carried proximally in the same plane, as the



FIGS. 5 to 8, 3 cases (L.K., B.K. & A.S.) following correction of metatarsus varus primus in hallux valgus. (L.K. and A.S. also had bilateral second hammertoe operations; in Case A.S., the second toes also overlapped the big [see Fig. 7, *top*]). FIG. 5, L.K. (*Top*) Before operation. (*Bottom*) About 6 years after operation.

tissues here have very few blood vessels. The fascia covering the abductor hallucis muscle is incised longitudinally just below the insertion of this fascia along the first metatarsal shaft. A muscular belly of the abductor hallucis pops out into the wound. Its loose connection with the first metatarsal shaft may be separated by blunt dissection. As a rule, in nearly all bunions the abductor hallucis is found displaced plantarly, blending with the medial belly of the flexor hallucis brevis and acting as a plantar flexor of the big toe rather than its abductor (Fig. 4). These muscles are separated from each other also mostly by blunt dissection. The slender tendon of the abductor hallucis is then followed distally and separated from the capsule of the metatarsophalangeal joint down to its insertion onto the base of the proximal phalanx, care being taken not to sever this tendon or to open the joint capsule. The tendon is retracted plantarly, and a U-shaped flap is made in the medial capsule, with its base attached to the proximal phalanx. This flap usually is about $\frac{3}{4}$ inch (2 cm.) long and $\frac{3}{8}$ inch (1 cm.) wide at its distal base, tapering proximally to the neck of the first metatarsal. The capsular flap is reflected distally, care being taken to dissect it from the medial aspect of the first metatarsal head, preserving its full thickness. Usually a small artery is cut over the metatarsal neck. The joint now is opened by reflecting the flap distally. The neck of the metatarsal is exposed. The "sagittal groove," so well described by Haines and McDougall (1954), is noted. It runs in dorsoplantar direction, separating the normal lateral cartilaginous articular surface that remains in contact with the laterally subluxated proximal phalanx from the fibrously degenerated cartilage of the medial part of the head. This groove often is quite deep in marked cases of bunion and is reddish, containing denuded rough bone. The "bunion" itself is represented usually by the dorsomedial prominence of the first metatarsal head. This prominence is shaved

off so that the medial, the dorsal and, to a certain extent, the medioplantar flare-up of the first metatarsal head is removed. Now the medial part of the head is in the same plane and is the continuation of the cortex of the neck and the shaft of the metatarsal. Occasionally there is a dorsal prominence over the first metatarsal head, which likewise has to be shaved off. Small wood-carving chisels obtainable in any hardware store in a set, together with a sharpening stone, have been used by the author for many years and are indispensable, particularly for resection of the first metatarsocuneiform joint. They are sterilized, together with the stone, and sharpened just before the operation. When resecting the medial part of the first metatarsal head, care should be taken to preserve its round shape, and especially its part covered with the normal cartilage, without excising too much bone.

We usually replace the capsular flap and the skin and palpate through them to be sure that no bony prominences are left.

The subcutaneous tenotomy and capsulotomy then are performed over the fibular aspect of the first metatarsophalangeal joint from a dorsal approach, while the big toe is forced gently into varus (10° - 15°) position. A stout sharp tenotome should be used for this, and it should be inserted to hug the bone and the joint closely, as the blood vessels and nerves pass more superficially to bone in surrounding soft tissues. The medial tongue-shaped flap of the capsule is sutured to the tendon of the abductor hallucis longus with considerable tension, several No. 00 chromic stitches being used. The plantar and the dorsal capsular wounds are also closed. At the same time the abductor hallucis belly, together with its tendon, is shifted dorsally, running now along the medial aspect of the first metatarsal instead of plantarly to it, and its action as an "abductor" (tibialward) instead of a plantar flexor of the big toe now is re-establish-

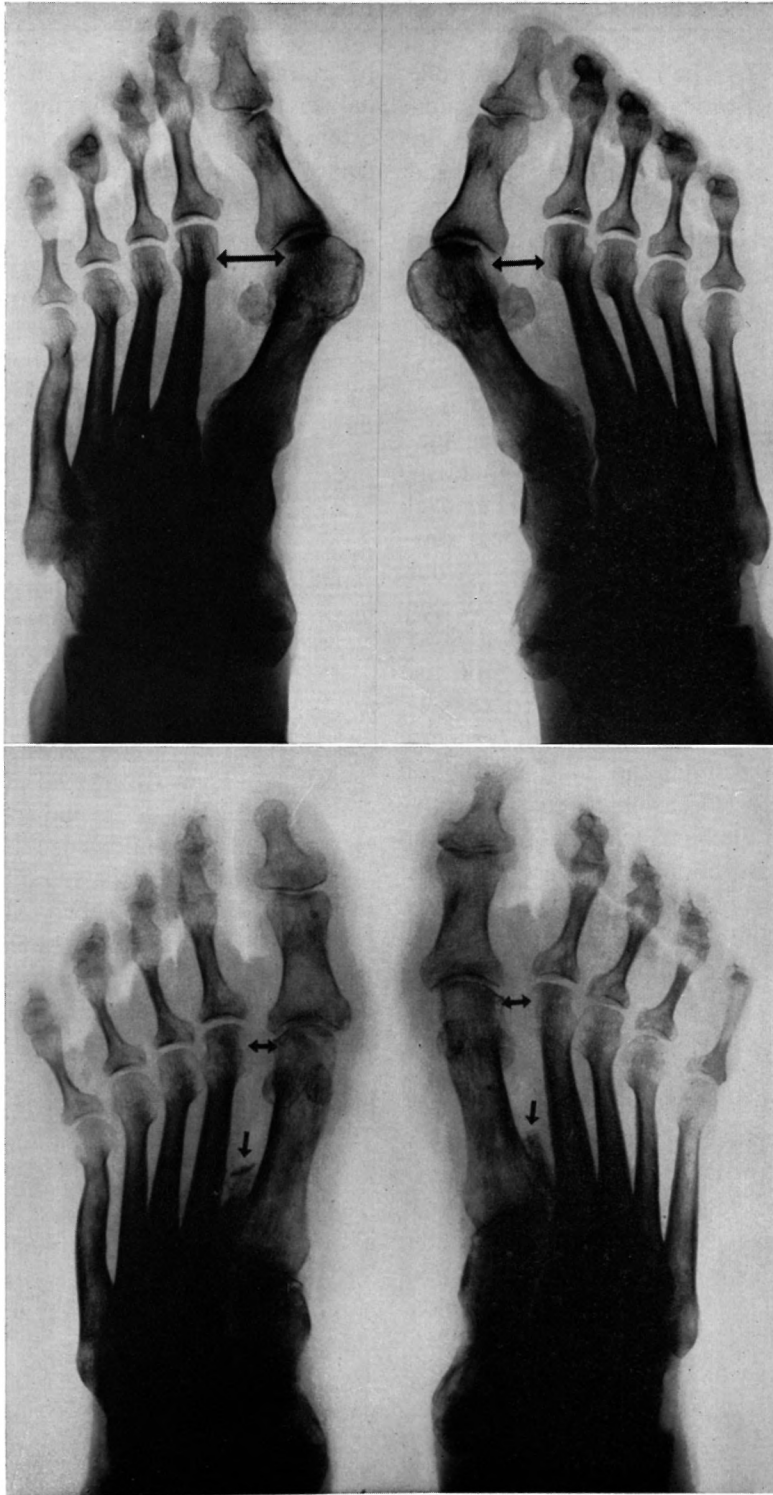


FIG. 6, B.K. (*Top*) Before operation. (*Bottom*) About 6 months after operation.

lished (Fig. 4). The closing of the capsule should be performed carefully and judiciously. All capsular slack produced by resection of the medial part of the head should be removed, but at the same time the capsule should not be sutured too tightly as later to cause limitation of motion of the big toe; a good balance between abduction and adduction and dorsal and plantar flexion should be created. As a rule, the big toe in hallux valgus is in internal rotation, so that both big toenails face each other. This also should be corrected. In ordinary cases no removal of the bursa is ever attempted unless suppurative bursitis is present. In a few of our patients, there was communication of the infected bursa with the joint. In these cases, after thorough débridement of the infected tissue, we were able also to perform the bunion operation with primary union of the wound and used antibiotics postoperatively. Occasionally there is communication of the bursa with the joint also in cases without infection. In one case there was a very extensive deposition of uric acid in the bursa, and the joint surfaces were canary yellow, all impregnated with uric acid crystals. Perfect primary healing was also obtained in this 69-year-old man. The skin is closed without suturing the subcutaneous structures. If the procedure is carried out adequately, the big toe remains well corrected without any external support.

As already stated, in a number of our cases we were able to obtain very satisfactory and lasting results after this procedure alone. If, however, the correction of the metatarsus varus primus is indicated, it is carried out as a second step following completion of the operation on the big toe. A longitudinal incision about $3\frac{1}{2}$ inches (9 cm.) is made along the dorsum of the first metatarsal and the first cuneiform. The first cuneiformometatarsal joint is exposed

by retracting the tendon of the extensor hallucis longus medially and that of the extensor hallucis brevis laterally. The cutaneous nerve branches are identified and protected. The V-shaped space between the first and the second metatarsal bases is exposed by dissection, hugging the first metatarsal closely. The perforating plantar branches of the dorsalis pedis vessels are retracted distally and fibularward with the soft tissues when exposing the second metatarsal base. Occasionally the veins are ruptured, but we have never had any complications from that.

The cortex from the adjacent surfaces of the base of the first and the second metatarsals is removed, leaving the bone chips in situ. The first cuneiformometatarsal joint is opened on its dorsal aspect. The adjacent cartilaginous articular surfaces of the first metatarsal and the first cuneiform are shaved off. Here a small wood-carving chisel about 5 inches (13 cm.) long and about $\frac{3}{8}$ inch (about 1 cm.) wide, is indispensable! We learned that no real wedge resection was necessary, that mere shaving off of the articular cartilage down to subchondral bone was not only enough but also essential in order to produce close linear coaptation of the resected joint surfaces and ensure prompt "primary union" of the bones.

One has to become familiar with this bean-shaped joint, which measures almost $1\frac{1}{8}$ inches (2.9 cm.) in dorsoplantar direction, and approximately $\frac{1}{2}$ inch (1.3 cm.) from side to side in its widest dimension. It also faces plantarward and medially (Fig. 1). The articular facet of the first metatarsal is slightly concave, while that of the first cuneiform is correspondingly convexed in sagittal plane. There is also a similar concavity of the first metatarsal and convexity of the first cuneiform in the horizontal plane. A snug fitting and close approximation of the resected surfaces should be obtained. A hole is then made with a shoemaker's awl

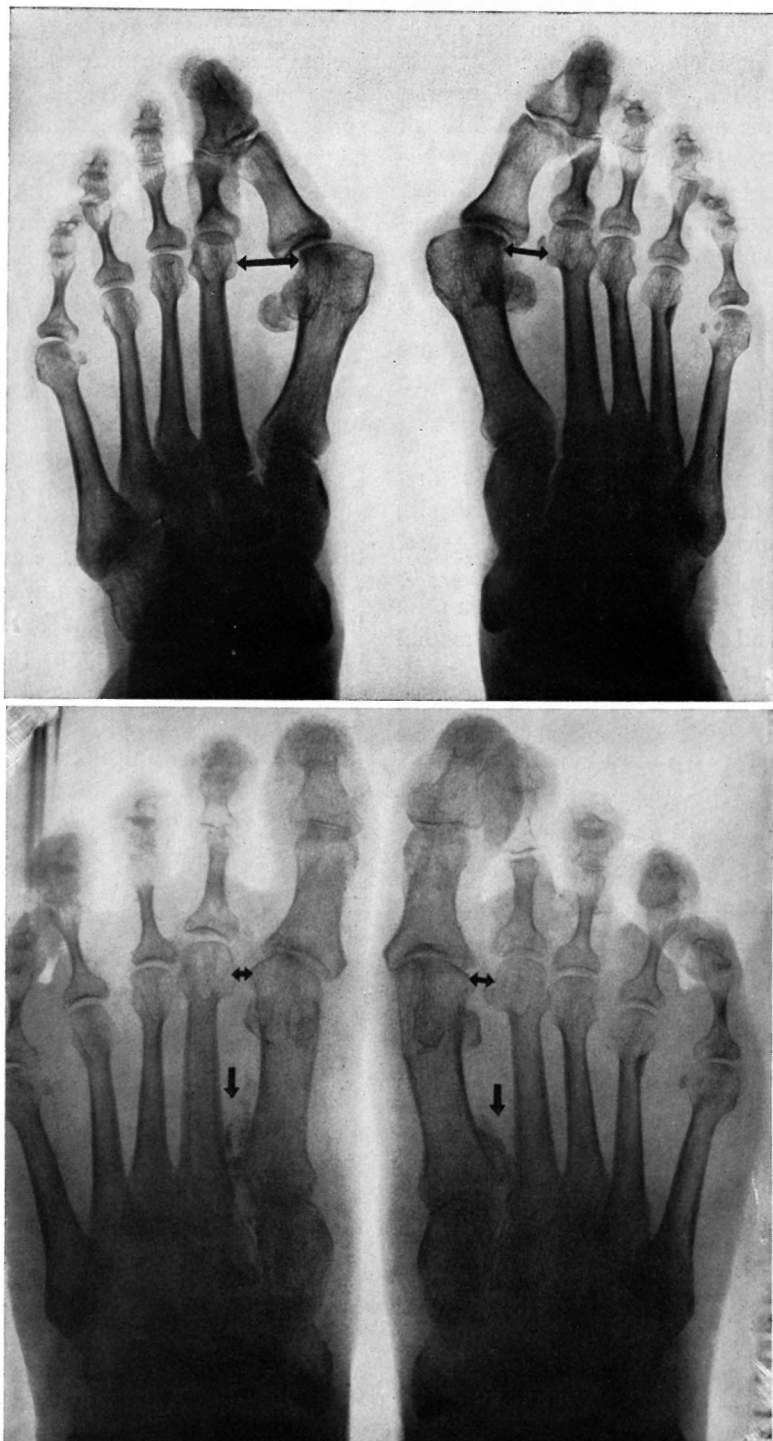


FIG. 7, A.S. (*Top*). Before operation. (*Bottom*) About 6 weeks post-operatively.

over the dorsolateral part of the first metatarsal base, and No. 0 chromic catgut is passed through it, using a curved needle. Proximally, the needle is introduced through the strong dorsal ligamentous structures between the first and the second cuneiforms. When this stitch is tied, a close approximation is maintained. The pieces of bone obtained from the first metatarsal head are denuded from soft tissue and cartilage and cut in very small bone chips, which are inserted abundantly between the denuded bases of the first and the second metatarsals. They later form a bony bridge that maintains permanently the correction of the first metatarsus varus. Skin is closed with silk without suturing the subcutaneous tissues. A 5-inch (about 12 cm.) long and 5/16-inch (7 mm.) wide steel corset stay is used as a splint and is inserted along the medial aspect of the first metatarsal over well-padded dressing. The big toe is strapped to it at about 10° of varus and in slight external rotation. The first dressing should be done snugly, but not too tightly. After adequate correction, one will find on postoperative

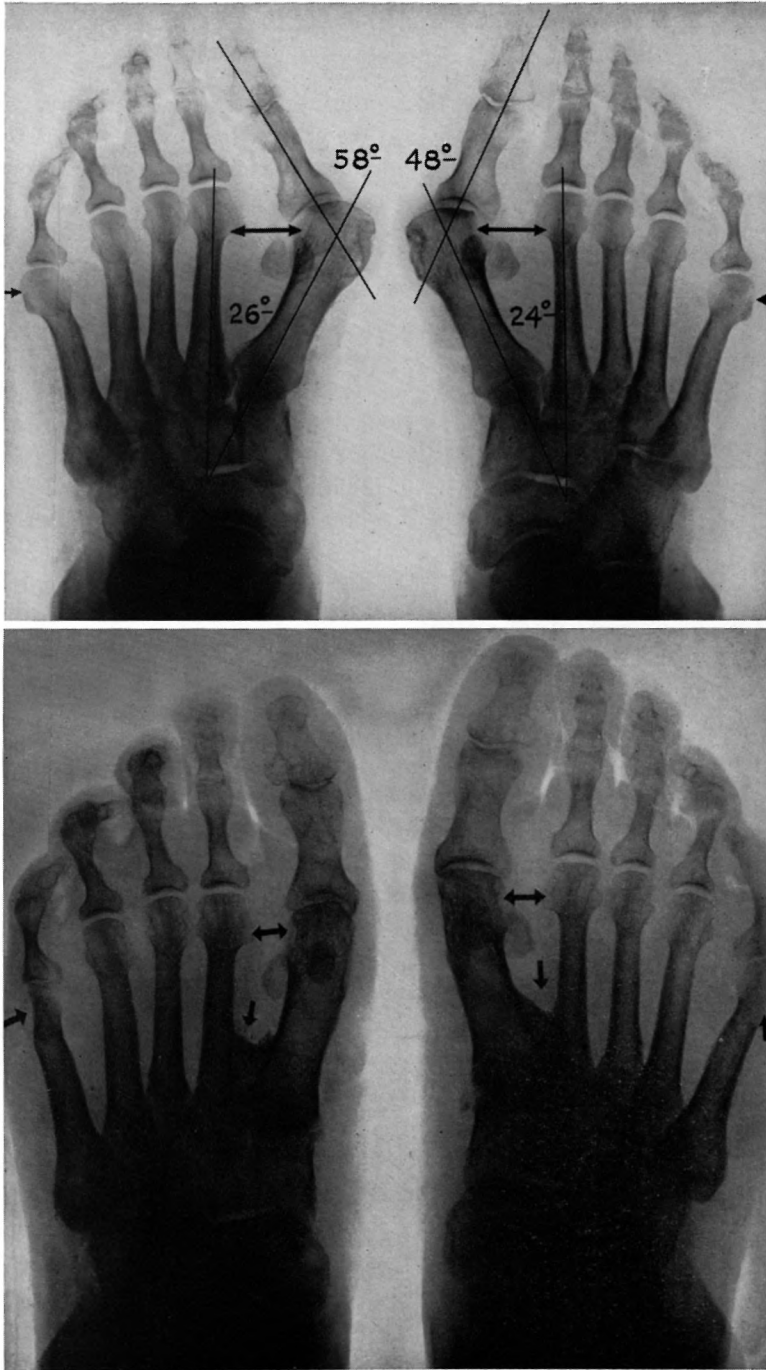
roentgenograms complete correction of metatarsus varus primus without tight bandaging across the forefoot. Likewise, the splinting of the big toe should be done most carefully in order to avoid pressure over the suture line. This is very important. One should depend primarily on an adequate surgical correction, the splinting being aimed only at maintaining it, rather than on increasing the correction.

Since the introduction of the antibiotics we have applied an antibiotic ointment routinely to the suture line* and also given the patient an antibiotic starting from one day before the operation and continuing for about 1 week postoperatively. It was noted that better wound healing was gained with prophylactic use of the antibiotics. Particularly, the wound over the bunion showed a more frequent tendency to form stitch abscesses and to separate in our early cases, and that tendency appeared to be greatly decreased by the antibiotics. There was not a single case of true infection in our latest

* Lately we have been using only Telfa.



FIG. 8. Result at the time stated after operation.



FIGS. 9 and 10, H.H., a 52-year-old female with metatarsus varus primus of 26° on the right and 24° on the left, and right hallux valgus of 48° and left of 58°. FIG. 9 (*Top*) Preoperative roentgenograms of both feet showing very marked deformity. (*Bottom*) Same feet about 2½ years after the operation performed on November 4, 1953. Note the heavy bone bridge between the first and the second metatarsals. Lateral prominence of both fifth metatarsal heads was also removed (arrow). (Lapidus, P. W.: Bull. Hosp. Joint Dis. 17:404)

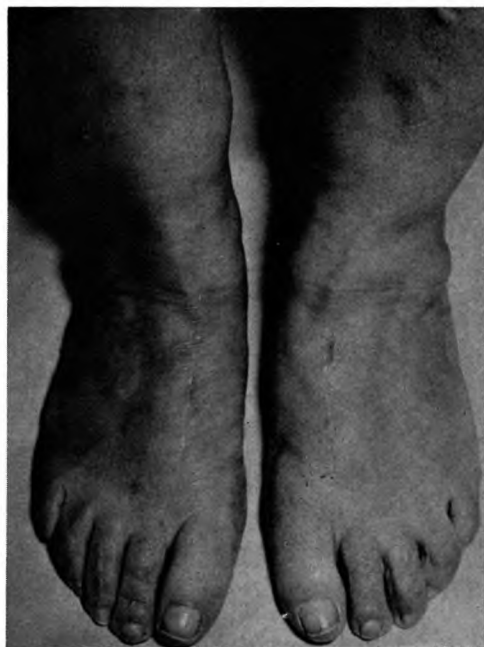


FIG. 10. Both feet on February 13, 1956, 2½ years after the operation. Patient still has very satisfactory correction at the present time. (Lapidus, P. W.: *Bull. Hosp. Joint Dis.* 17:404)

(treated with antibiotics) cases. In two cases there was pressure necrosis of the soft tissue over the bunion; in one of these (not done by the author), a satisfactory result and complete healing were obtained 4 months after the operation. The second case subsequently developed involvement of the bone of the base of the proximal phalanx of one big toe that later required resection of the Keller-Brandes type. The postoperative disability lasted on and off for about 1 year, and the final result after the Keller-Brandes operation on one foot was considered to be unsatisfactory by our standards. Although we had only two cases with this complication in our large series, we recommend most

careful postoperative after-care, especially during the first postoperative week. Usually we change the dressing on the second or the third postoperative day and replace carefully the steel corset stay, maintaining the big toe at 10° of varus. A great number of our patients have been able to go to the bathroom bearing weight on their heels on the second or the third postoperative day and were discharged from the hospital at the end of the first week after operation. Only a few patients required the use of crutches for the first week or two. A number of housewives were able to begin some light housework 2 or 3 weeks after the operation.

The stitches usually are removed at the end of 2 weeks, and snug bandaging and adhesive strapping across the metatarsal heads over an adequate padding are continued for about 4 to 6 weeks. The splinting of the big toes may be discontinued 3 or 4 weeks after the operation, depending on the amount of correction. During the first 2 weeks there may be slight overcorrection with a few degrees of varus of the big toe. This should not be allowed to remain permanently. Control postoperative dorsoplantar roentgenograms are taken to ascertain the amount of the approximation of the first and the second metatarsal heads and the relation of the big toe to its metatarsal. Also, they show the amount of bone bridge formation between the first and the second metatarsal bases and the degree of fusion of the first cuneiformometatarsal joint. Both are usually quite solid at the end of 3 months, with subsequent roentgenograms showing further consolidation of the intermetatarsal bridge.

At first, special canvas shoes or wool socks with leather soles are worn. During the second postoperative month, the patient may wear wide soft shoes or sandals. After

FIG. 11 (on facing page), C.J., a 16-year-old girl. About 2 years previously, she had been operated upon elsewhere. Bilateral osteotomy (large arrows) at the first metatarsal base was performed (Mitchell's procedure) in addition to bunionectomy; also successful correction of second and third hammertoes had been performed (arrows). There was prompt recurrence of

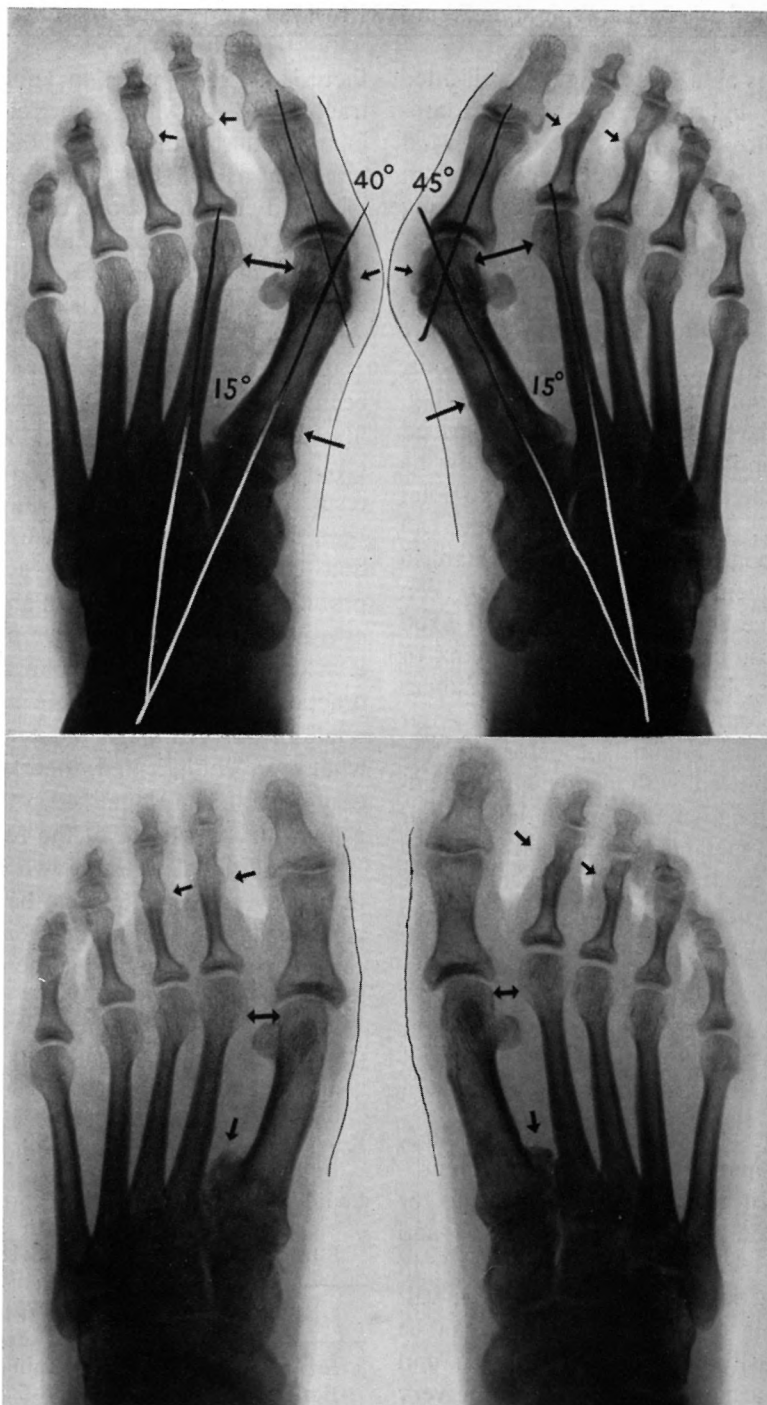


FIG. 11 (Continued from facing page)
 bunions and extensive keloid formation over the postoperative scars
 (skin outline retouched over the bunions).

(Top) 1 year and 8 months following the first operation elsewhere.
 (Bottom) 3½ months after the second operation by the author. Note
 the distance between the first and the second metatarsal heads and
 bony bridging already present between their bases. Excellent correc-
 tion is still maintained.

that time he is able to use regular well-fitted but perhaps slightly larger shoes. Housewives, as a rule, can resume their usual work about 2 months after the operation; patients having to do a great deal of walking or standing may require another week or two before going back to their 8-hour workday.

Hammertoes and overlapping hammer-toes, frequently associated with bunions, usually are corrected at the same sitting. Essentially, the technic used is that described by the author in 1939, except that now he also resects the distal 3 mm. of the proximal phalanx, care being taken to remove all prominent bone edges and to establish proper alignment of the toe. He has been able to reduce the sometimes present fixed dorsal subluxation of the basal phalanx of the lesser toes by a thorough dorsal subcutaneous tenotomy and capsulotomy. After correction of the hammertoe deformity, the toe is immobilized with gently applied adhesive strapping, maintaining the plantar flexion at the metatarsophalangeal joint and dorsiflexion at the interphalangeal joints, care again being taken not to produce any ischemic changes.

SUMMARY

A very large number of our bunion cases were treated conservatively and required no surgery.

When surgical correction was indicated, we used our modification of the Silver procedure, consisting of anchoring the abductor hallucis tendon into mediocapsular flap and thereby supplying active muscular power in addition to a passive correction of the valgus of the big toe. This operation can be performed easily under local anesthesia and needs no tourniquet. It may give a very satisfactory result in cases without metatarsus varus primus or when the varus of the first metatarsal is not very extensive and is correctible.

In cases with pronounced and unreducible metatarsus varus—in other words, when

there is a fixed abduction (tibialward) contracture of the first cuneiformometatarsal joint—better results were obtained following resection of the first cuneiformometatarsal joint and creating a bony bridge between the first and the second metatarsal bases in order to maintain permanent correction. This procedure is especially advisable in robust and not too old individuals.

Our present-day operative technic has been described in detail. Our operation, first performed on April 8, 1931, has been given adequate trial over the years, and our results—particularly in recent years—have been most gratifying and warrant continuation of our surgical approach in bunion problems. The popular Keller-Brandes type operation is a much simpler procedure, but it seldom, if ever, results in restoration of practically normal anatomic and functional relationship. Although our technic is somewhat more complicated, it certainly is within easy reach of any qualified orthopaedic surgeon with knowledge of the foot.

An additional week or two of postoperative recovery seems to us to be a very sound investment for the ultimate results in our cases reviewed years after the operation.

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Le Operation del Autor ab 1931 Usque 1959

Summario in Interlingua

Es discutate le tractamento del tumescencia in le bursa mucose del eminentia al pollice del pede que es hic designate per le termino angese "bunion."

Un grande numero de nostre casos de buniones esseva tractate conservatorimente e requireva nulle intervention chirurgic.

Quando un correction chirurgic esseva indicate, nos ha servite nos de nostre modification del technica de Silver que consiste in ancorar le musculo abductor del halluce in un panno del capsula medie pro provider active fortia muscular in ultra del correction passive del pollice valge. Iste operation es facile e effectuar sub anesthesia local e non require le uso de un tourniquet. Illo produce multo satisfacente resultatos in casos sin metatarso prime varo in que le aspecto var del metatarso prime non es extense e pote esser corrigite.

In casos con metatarso marcatamente e irreducibilemente var—in altere parolas: in casos con fixate contraction abductional (verso le tibia) in le prime articulation cuneiforme-metatarsal—melior resultatos esseva obtenite per primo resectionar le prime articulation cuneiforme-metatarsal e crear un ponte ossee inter le prime e le secunde

base metatarsal pro assecurar le permanentia del correction. Iste technica es specialmente recommendate in subjectos robuste e de etate non troppo avantiata.

Le technica chirurgic que nos usa currentemente es describe in detalio. Nostre operation—primo effectuate le 8 de april 1931—ha essite testate satis perennemente, e nostre resultatos (particularmente in recente annos) ha essite multo incoragiante e justifica le continue uso de nostre methodo operatori in casos de bunion problematic. Le frequentemente usate typo de operation secundo Keller-Brandes es multo plus simple, sed illo resulta raramente—si del toto—in le restauration de practicamente normal relationes anatomic e functional. Ben que nostre technica es un pauco plus complicate, illo certo non excede le capabilities de un qualificate chirurgo orthopedic qui possede un bon cognoscentia del pede.

Un o duo septimanas additional de recuperation postoperatori impressiona nos como un molto sage investimento de tempore si on considera le ultime resultatos que nos ha obtenite per nostre methodo a judicar secundo un revista del casos annos post le execution del operation mesme.

Exhibit 1019

Surgery, Gynecology and Obstetrics

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OPERATIVE CORRECTION OF THE METATARSUS VARUS PRIMUS IN HALLUX VALGUS

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THE enormous wealth and great diversity of the operative procedures devised for the correction of hallux valgus deformity is eloquent proof that this problem is far from being adequately solved. However, it is not within the scope of this preliminary communication to go into any review of the very abundant literature on this subject.

The operation for correction of hallux valgus, as given below, is the result of the writer's personal study of this condition. There is no priority or originality claimed by the writer, except for the details of the operation, as he is fully aware, after a review of the literature, that there were a few surgeons in this country, as well as abroad, who had approached this problem in more or less a similar way to the one here presented.

The purpose of this paper is to stress the mechanical importance of the metatarsus varus primus, as one of the most frequent and most prominent factors of the hallux valgus deformity.

The cases of hallux valgus may be classified under three groups.

1. Cases with congenital predisposition toward hallux valgus formation, due to metatarsus varus primus. (The deformity may appear in early youth (Fig. 1) and is often hereditary.)

2. Arthritic hallux valgus, due to inflammatory periarticular contractures.

3. Paralytic hallux valgus, caused by loss of muscular balance.

It is unnecessary to say that this classification is more or less artificial, and there are possibilities of combinations of any of the features of these three classes in the same case.

The first group is the largest one, and the one mainly considered in the presentation.

It is admitted that in the process of phylogenetic development, the *homo sapiens* went through an arboreal stage of life. During this period, the foot had to adapt itself to a grasping motion when climbing trees, and therefore resembled the hand—because of greater mobility of the joints, and the presence of opposition of the big toe, similar to that of the thumb.

Sameness between the hand and the foot is also observed in primates, who use their feet for grasping. In man, the foot serves mainly as a supporting limb, and therefore the human foot had to

lose its mobility—the hallux becoming strengthened, and the other toes diminishing. The hallux of primates resembles more the thumb, because of its freer range of motion, and the large angle formed by the first and second metatarsals (Fig. 2). To a lesser degree, it may be noted in the human embryo, and infants.

Among many changes that took place in the plantigrade human foot, due to special demands made upon it, in the course of human evolution, there is a marked differentiation between the hallux and the thumb. The first metatarsal in the well developed human foot is nearly parallel to the second (Figs. 3, A and B). Classical paintings and sculpture depict the long and rather narrow foot as an example of beauty and perfection, long before orthopedic surgeons thought of it. Thus it may be assumed that the adult foot, presenting marked fan-shaped spreading of the metatarsals (*spreiz-fuss* of German authors), with a large angle between the first and second metatarsals (metatarsus varus primus), and therefore with a large space between the first and second metatarsal heads, must be considered as an atavistic foot, which never became fully developed. This is a type of foot which most commonly forms a hallux valgus (Fig. 1) and thus the often observed hereditary predisposition toward this deformity can be readily understood.

An excellent illustration of this atavistic type of foot, with metatarsus varus primus, presenting congenital potential predisposition toward hallux valgus formation was observed by the author in a case of middle aged brother and sister. The sister developed "bunions" in young age, as a result of wearing the usual distorting ladies' shoes, while her brother's feet remained normal, because of wide, straightlast shoes, which checked this potential tendency (Fig. 4, A and B).

The first precursors of incipient "bunion" as a rule are observed in girls with atavistic foot at the age of about thirteen and fourteen when they first start to wear a narrow pointed shoe with a high heel. The weight bearing is thrown more on the forefoot, and the force of gravity itself tends to produce further spreading of metatarsals and to increase the metatarsus varus primus.

The thumb-like hallux has no room in the narrow, and often short, shoe. It is gradually de-

¹From the service of Dr. Leo Mayer.

²From the service of Dr. Percy Willard Roberts.



Fig. 1. Roentgenogram of feet of a girl 9 years old. Typical atavistic foot with metatarsus varus primus and hallux valgus deformity in spite of the fact that the child had never worn narrow shoes.

viated toward the second toe and adopts a valgus position, which consequently becomes fixed. The base of the proximal phalanx subluxates laterally upon the first metatarsal head and pushes the latter medially. The already congenitally relaxed transverse ligament between the first and second metatarsal heads becomes even more stretched, thus contributing to the increase of the original metatarsus varus primus.

The first metatarsal head protrudes medially and sometimes a bony proliferation forms over its medial part as a result of chronic trauma against the shoe. As pointed out by Hiss, the abductor hallucis is the only muscle preventing hallux valgus formation. This muscle is much weaker than the adductor hallucis, the latter's action favoring the valgus position of the big toe. Besides that the short and long flexors and extensors of the big toe also contribute to the hallux valgus deformity as they become displaced laterally to the first metatarsophalangeal joint and their pull increases the angulation between the first metatarsal and the basal phalanx. The lateral displacement of the sesamoids over which run the tendons of the two heads of the flexor hallucis brevis is a commonly observed condition (Fig. 5, A and others).

In cases of considerable varus position of the first metatarsal, there is a large space between the first and second toes. This space may accommodate the big toe in hallux valgus position (sometimes over 45 degrees) without the big toe overlapping the second or being overlapped by the latter. On the other hand, this overlapping of the big toe by the second, or the reverse, must necessarily take place, even in mild cases of hallux valgus deformity, without presence of the metatarsus varus primus, because the first and second toes lie very close to each other.

I believe that the congenital metatarsus varus primus in the majority of cases is the primary deformity leading to secondary formation of the hallux valgus. In other words, the medially opened angulation between the first cuneiform and the first metatarsal, causes the compensatory angulation open laterally between the big toe and the first metatarsal. This occurs in somewhat similar manner as the dorsal kyphosis of the spine is compensated by an increased lumbar lordosis. It can readily be seen that any attempt at correction of hallux valgus by only adducting medially the big toe and bringing it in alignment with the first metatarsal, will be futile, in a foot presenting metatarsus varus primus. In this case, after successful correction, the big toe will be widely separated from the second toe, and will protrude medially. This kind of foot with a *thumb-like hallux* would fit more easily into a glove than a shoe, unless the big toe were again brought back to hallux valgus position (Fig. 6).

Consequently any operative procedure designed only to straighten the secondary angulation between the first metatarsal and the big toe, or only correcting the hallux valgus itself, is prone to have a recurrence of the deformity, unless the varus position of the first metatarsal will also be corrected, as the latter is the primary underlying cause in the majority of cases of hallux valgus. A few operative procedures in the past aimed to correct the medial deviation of the first metatarsal, by means of varied osteotomies at different parts of this bone, or through the first cuneiform.

The only way to make a straight line of two lines forming an angle less than 180 degrees, is by moving the free end of one of the lines around the point of their cross section as a center, until the two lines will form an angle of 180 degrees. In order to correct any bony angulation, the osteotomy should be made at the apex of the angulation. The knock knee deformity is treated by an osteotomy as near the knee joint as possible, as the apex of the angulation between the tibia and the femur is usually located near this

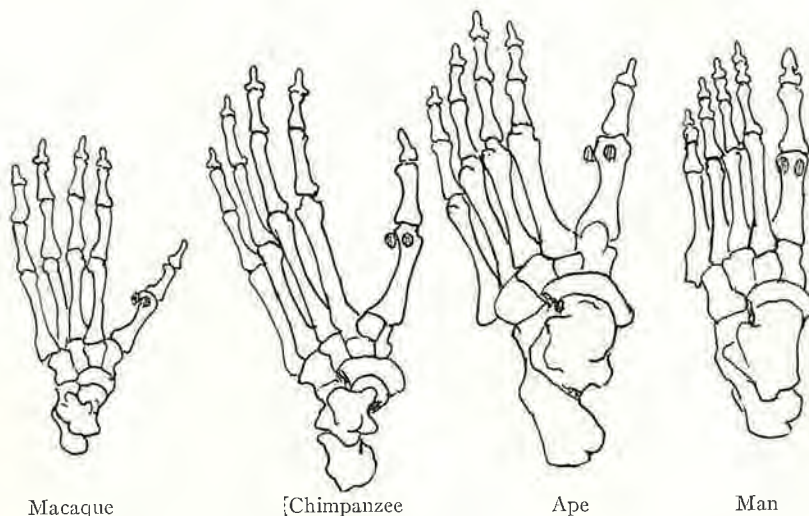


Fig. 2. Note the thumb-like big toe of primates with marked varus position of the first metatarsal. (Adapted with modification from Hiss, J. M. *Am. J. Surg.*, 1931, xi, 53).

joint. No one would try to correct a knock knee by osteotomizing at the middle of the tibia, or of the femur, for example. Therefore, the only mechanically sound osteotomy for correction of metatarsus varus primus should be located at the first cuneiformometatarsal joint, which is the apex of the angulation between the first metatarsal and the first cuneiform.

Without going into detailed description of the anatomy of the region of the first cuneiformometatarsal joint, a few important points should be mentioned. The articulating facets of the first metatarsal and the first cuneiform resemble a lima bean, the long axis of which lies in a dorsiplantar direction. The concavity of the bean is toward the second cuneiform—the convexity toward the medial border of the foot. The plane of this joint extends from dorsal, anterior, and lateral to plantar, posterior, and medial directions; in other words, the articular facet of the first cuneiform, after removal of the first metatarsal, will face medially and slightly plantarward. The more medial slanting of the facet of the first cuneiform, the more pronounced is the varus position of the first metatarsal.

The occasionally present intermetatarsal articular facet and the lateral dorsal part of the first metatarsal base impinge against the adjacent medial aspect of the base of the second metatarsal, and prevents lateral abduction of the first metatarsal, toward the second metatarsal. That is why this part of first metatarsal base should be chiseled off in correcting metatarsus varus primus.

The second cuneiform is shorter than the first. Therefore the line of the second cuneiformometatarsal joint on the dorsum of the foot lies about 1 centimeter proximally from the line of the first cuneiformometatarsal joint. The dorsalis pedis artery with its plantar branch passes closely between the bases of the first and second metatarsal bones and should be spared during the operation.

DESCRIPTION OF THE OPERATION

The operation is better performed without the use of a tourniquet, as the bleeding is negligible, and it is preferable to control it during the operation.

A longitudinal incision, about 5 centimeters long, is made on the dorsomedial aspect of the foot. The incision should correspond to the line of the joint between the first and second cuneiforms. The line of the first cuneiformometatarsal joint should cross the middle of the incision. The tendon of the extensor hallucis longus is retracted medially without opening its synovial sheet. Occasionally it is necessary to lengthen this tendon. The first cuneiformometatarsal joint and the adjacent parts of the bases of the first and second metatarsals are exposed subperiosteally, care being taken not to cut the dorsalis pedis artery and its branches.

The tuberosity of the first metatarsal, impinging against the second metatarsal base, is chiseled off, the plane of the chisel being held parallel with the long axis of the first metatarsal, and strictly in dorsiplantar direction (Fig. 7, A). The adja-



A.

Fig. 3. A, Long narrow feet. The big and second toes lie close together. B, Roentgenogram of the same feet showing first and second metatarsals almost parallel to each other. This type of foot had no potential tendency to hallux valgus formation. Note that even in this type of foot there is a slight "physiological hallux valgus." Two sisters and father of this patient had also similar type of feet.

GH I



B.

cent part of the second metatarsal base is also roughened with a curette.

After that, a small wedge with the base laterally, is removed from the articular surfaces of the first metatarsal and the first cuneiform, only over their lateral aspect (Fig. 7, B and C). The medial part of the first cuneiformometatarsal joint should be left intact except being denuded from its cartilaginous covering. The base of either wedge removed from the first metatarsal and the first cuneiform should not be wider than about 3 or 4 millimeters each (somewhat more bone should be removed from the cuneiform). The last two points—(1) not to osteotomize the medial part of the adjacent articular surfaces of the first metatarsal and the first cuneiform; and (2) not to remove too wide a wedge—are of extreme importance, especially the first one. The aim of the operation is to produce a bony fusion of the first metatarsocuneiform joint and adjacent bases of the first and second metatarsals in corrected position. Too large a resection of bone, creating a large gap, may be not favorable for bony fusion.

Transverse resection of the whole first cuneiformometatarsal joint (also over its medial part) as advocated by a few surgeons, will produce a shortening of the first metatarsal, causing considerable disturbance of the statics and dynamics of the foot. The first metatarsal bone serves as a medial buttress of the foot, preventing its pronation. The head of the first metatarsal with the underlying two sesamoid bones, is the medial anterior weight-bearing point of the foot. Any

shortening of the first metatarsal, will, therefore, result in an increase of pronation of the foot. Beside that, the second metatarsal head will be much longer, compared with the first, and will become the weight-bearing point, instead of the first metatarsal head, resulting in pain and formation of tender callosity, beneath the anterior arch.

The big toe plays an important part in the process of locomotion. There is a phase in walking, and especially in running, when the whole weight of the body is borne by the first metatarsal head, with the big toe in extreme dorsiflexion (Fig. 4, A, left foot). Shortening of the first metatarsal will weaken the action of the plantar and dorsal flexors of the big toe, because the distance between the origin and insertion of these muscles will become diminished. This will create some disturbance of gait.

Case 1 serves as a good illustration (Fig. 8). About a year following the operation, the patient developed pain and tender callosities beneath the metatarsal heads, especially the second, and markedly diminished power of motion of the big toe was also observed, as a result of the shortening of the first metatarsal. Thus any operation leading to the shortening of the first metatarsal should be emphatically condemned, because the sacrifice of functional disturbance of the foot is too great a price to pay for cosmetic correction of bunion.



A.

Fig. 4. A, Square shaped atavistic feet with widely separated big and second toes. This type of foot has a potential tendency toward hallux valgus formation. The sister

After the resection of the first cuneiform-metatarsal joint described, the first metatarsal head can be abducted laterally, without much effort, bringing it closer to the second metatarsal head, and thereby easily correcting the metatarsus varus primus. The capsule and the ligaments of the first cuneiformometatarsal joint should be preserved as much as possible, especially over its plantar aspect.

Most cases of hallux valgus are also associated with a weak foot, presenting flattening of the longitudinal arch and pronation. This is, to some extent, due to the dorsiflexed attitude of the first metatarsal in the cuneiformometatarsal joint. It is advisable, therefore, when resecting the first cuneiformometatarsal joint, to remove slightly more bone over the plantar aspect of this joint, creating, in this way, another wedge with a plantar base. The plantar flexion attitude of the first metatarsal is thereby produced and will increase the longitudinal arch and diminish pronation.

A second incision, also about 5 centimeters long, is made over the dorsomedial aspect of the first metatarsophalangeal joint. The medial part of the joint capsule is bluntly exposed. A tongue-shaped flap, with its base attached to the proximal phalanx, is made over the medial part of the



of this man, with same type of foot, developed hallux valgus. Left foot is shown during a phase of gait when the whole weight is borne mainly on the first metatarsal head with the big toe in extreme dorsiflexion. B, Roentgenogram of the same feet showing metatarsus varus primus of 12 degrees. Note wide space between big and second toes easily permitting lateral deviation of the big toe in hallux valgus position.

joint capsule. The bony projection over the medial, and often over the dorsal, part of the first metatarsal head is chiseled off, care being taken to remove all the bony projections interfering with motion of the big toe, especially in its dorsiflexion. The adductor tendon and the lateral part of the joint capsule are tenotomized, if necessary, so that the big toe may now be freely brought in an overcorrected position, without using any force. Usually the big toe in hallux valgus has a tendency toward a slight internal rotation, around its long axis, so that the nail is facing medially (Figs. 5, A, 10, A). That tendency may be a remainder of opposition of the big toe, present in primates, and should be taken into consideration during the suturing of the capsule. A heavy chromic mattress suture is inserted first over the plantar distal part of the capsule in front and medially to the tibial sesamoid. The needle is then brought through the dorsal proximal part of the joint capsule and the deep aponeurosis. This suture crosses obliquely the medial part of the first metatarsophalangeal from its plantar and distal toward the dorsal and proximal parts.

After tying of this suture four important points are gained: (1) the big toe is fixed in adduction medially; (2) the internal rotation of the big toe is corrected; (3) the lateral displacement of the sesamoids together with the plantar flexors of the



Fig. 5. A, Case of "bunion" with marked medial protrusion of the first metatarsal head and lateral subluxation of the big toe. Note the lateral displacement of the sesamoids and inward rotation of the big toes, the nail facing

medially. The foot is very wide across metatarsal heads. B, Same feet after the operation. Note also the correction of internal rotation of the big toe and practically normal position of the sesamoids.

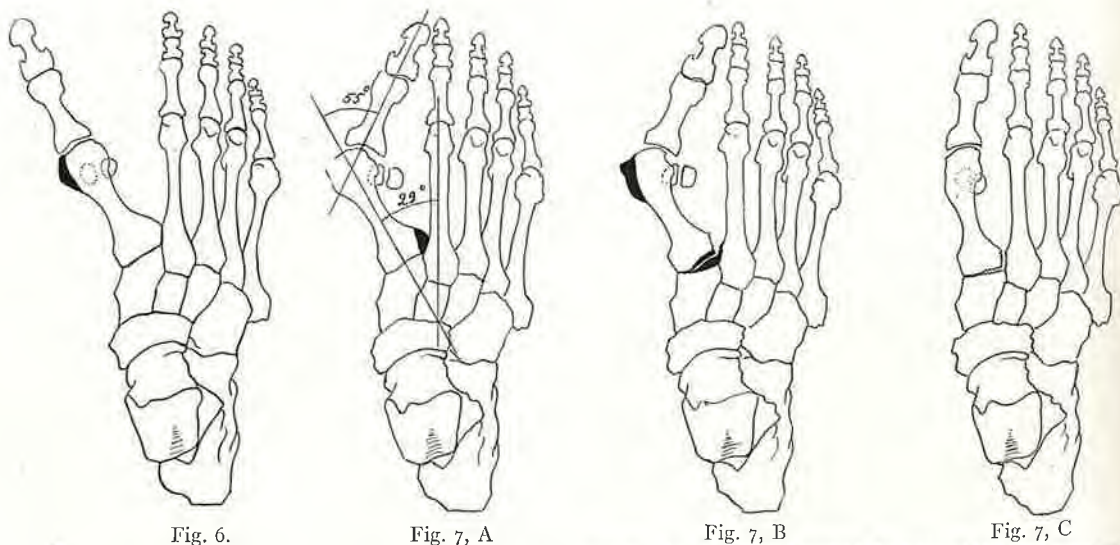


Fig. 6. Imaginary postoperative appearance of the foot in case of successful straightening of the big toe without correcting the metatarsus varus primus. (All relations slightly exaggerated.) Note close resemblance with the foot of primates shown in Figure 2. Black area shows the bony prominence which is usually removed.

Fig. 7. Varus position of the first metatarsal is slightly exaggerated for the sake of demonstrability. (The angle between first and second metatarsals is made 29 degrees, while it is seldom over 20 degrees; hallux valgus of 55 degrees is rather common.) Black areas show the parts of bone which are removed. Note the lateral displacement of

sesamoids. A, Lateral part of the base of the first metatarsal impinging against the second, is removed. B, Resection of the first cuneiformometatarsal joint over its lateral part only. Note that slightly more bone is removed from the first cuneiform. The adjacent part of the second metatarsal base is roughened with a curette. Removal of the bony proliferation over the first metatarsal head and plastic of the capsule over the medial aspect of the first metatarsophalangeal joint. C, Metatarsus varus primus and hallux valgus are corrected. Note the sesamoids returned to their normal location.

big toe is reduced and this reduction maintained; (4) the deep dorsal aponeurosis with the extensor hallucis longus tendon is pulled medially preventing lateral displacement of this tendon. The tongue-shaped flap of the capsule is now resutured, with the big toe held in adduction, and slight external rotation. The tendon of the abductor hallucis may also be reattached to the medial flap of the joint capsule, thus providing active force, correcting the hallux valgus deformity. The removal of the lateral prominence of the fifth metatarsal heads may also be indicated in some cases.

The deformity must be entirely corrected by the operative procedure alone, so that the big toe will maintain this correction, even if left unsupported. A tight flannel bandage is applied over the well padded forefoot keeping the metatarsals closely approximated. In about 2 or 3 weeks a plaster-of-paris casing is applied to the foot maintaining the correction of metatarsus varus primus. The big toe is not included in the casing and its active and passive motion is encouraged.

A few points in pre-operative preparation of the skin are worth mentioning, as insuring primary union of the wound. It is advisable to prepare the skin over the "bunion" by means of shaving off the callosity and applying salicylic acid ointment a few days or sometimes a few weeks before the operation. A very often present, but usually overlooked, trichophytosis of the foot should be cured before the operation is undertaken.

The writer also believes that the often used oval excision of the skin around the "bunion" should not be practiced, as it may cause tension when the skin is resutured and lead to separation and sloughing of the wound edges. No attempt to remove the bursa is made by me, as a rule, as both the callosity and the bursa readily disappear after the underlying cause—the undue pressure—is eliminated with the correction of the deformity.

It is also important to stress the postoperative care in these cases. A rigid metal plate should be worn by every patient for a few months following the operation, as the keystone of the longitudinal arch—the first cuneiformometatarsal joint—is weakened by this operation, and has to be protected until it will regain its strength. Full weight bearing should not be allowed before 6 or 7 weeks in order to insure solid fusion of the resected cuneiformometatarsal joint.

The somewhat prolonged period of postoperative disability and the resection of the joint supporting the longitudinal arch may be considered the weak points of this operative procedure. The



Fig. 8. Case 1. Right foot of girl 21 years old before and after the operation. (Operated upon April 8, 1931.) Excellent correction of the hallux valgus. Note the marked post-operative shortening of the first metatarsal. About one year after the operation this patient developed heavy callosity over the whole anterior arch, which became markedly convex. There was tenderness over projecting plantarward second metatarsal head. When she stood the big toe was kept above the floor and there was marked loss of power on motion of the big toe. Functional result is therefore considered by the author as unsatisfactory because of shortening of the first metatarsal.

number of cases is too small as yet, and the time following the operation too short, to make any definite conclusions. (The first case was operated upon April 8, 1931.) However, the writer feels that both the functional and cosmetic results thus far obtained are more than encouraging, and therefore warrants giving this operation further trial in cases of hallux valgus with metatarsus varus primus (Fig. 9, A, B, C, D, 10, A, B).

Not every patient with "bunion" should be operated upon, operation being limited to cases of functional disturbance, or where cosmetics plays an important part. Each case requires individual study.

SUMMARY

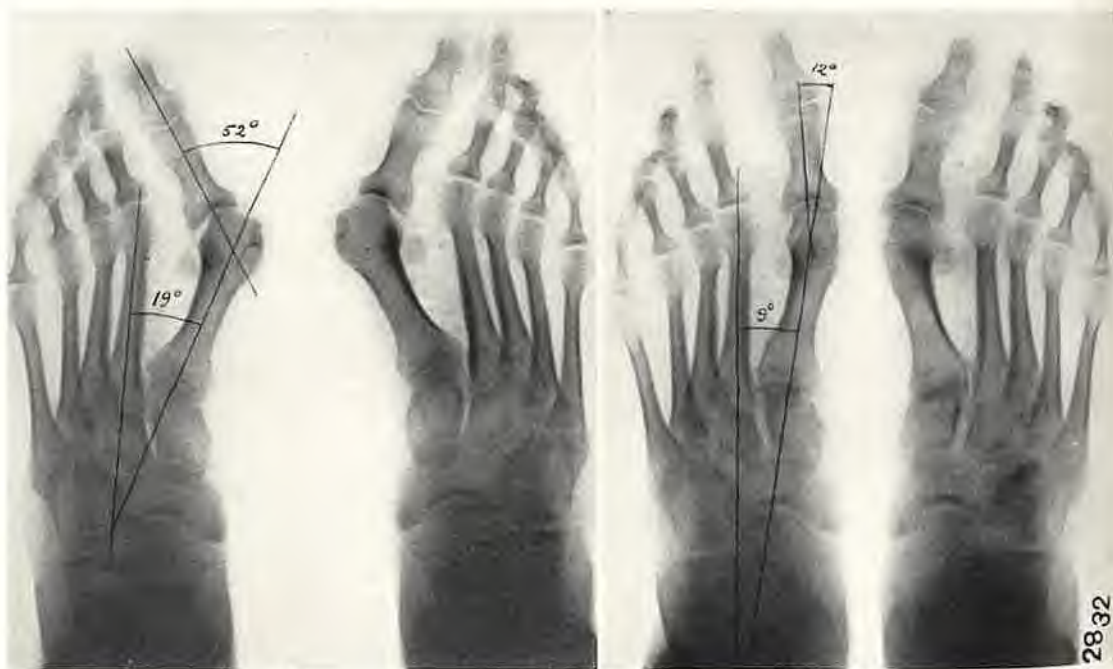
1. In a great majority of cases of hallux valgus, there is metatarsus varus primus, which is the primary underlying cause of the deformity—hallux valgus occurring secondarily because of shoe pressure.

2. Hallux valgus, or "bunion," is not so much a lateral deviation of the big toe, as the medial



A.

C.



B.

D.

Fig. 9. Case 2. A, Feet of a girl 21 years old. Note that in spite of very marked hallux valgus deformity, there is no overlapping of the big and second toes. B, Roentgenogram in the same case showing atavistic feet with metatarsus varus primus of 19 degrees and hallux valgus of 52 degrees. C, Appearance of the same feet 6 weeks after the operation performed on February 3, 1932. Excellent cos-

protrusion of the first metatarsal head forming bony proliferation because of constant trauma.

3. There is a type of square foot, with a widely spread metatarsal head and metatarsus varus

metic and functional result. The circumference of the foot across metatarsal heads became about 2 centimeters less than before the operation. D, Postoperative roentgenogram in the same case. The metatarsus varus primus is reduced from 19 degrees to 9; the hallux valgus from 52 degrees to 12.

primus. This foot closely resembles that of primates and is considered atavistic. In a well developed human foot, the first and second metatarsals lie almost parallel; the latter type very seldom developing "bunion."

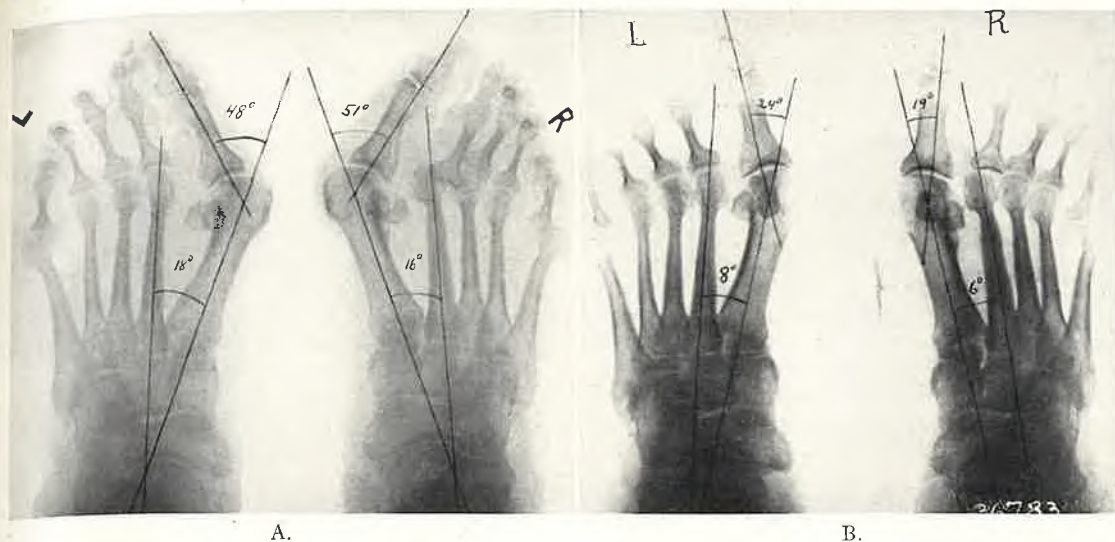


Fig. 10. Case 3. A, Feet of woman 35 years old. Note also dorsal subluxation of the basal phalanx of the right second

toe and the lateral projection of the fifth metatarsal heads. B. Postoperative roentgenogram in the same case.

4. This atavistic foot has a congenital potential tendency toward hallux valgus formation, and therefore hallux valgus is often hereditary, appearing in youth, mostly in women, because of their type of shoe.

5. No operative procedure is satisfactory, unless correction of the metatarsus varus primus is accomplished.

6. Operation for correction of metatarsus varus primus by resection of a small wedge, at the lateral part of the first cuneiformometatarsal joint, is described.

7. Any operation creating shortening of the first metatarsal, or the big toe, is emphatically condemned as unphysiological, and causing static and dynamic disturbance of the foot.

8. Conservatism and individualization in indication for operative correction of "bunion" is advocated.

Indebtedness is acknowledged to Dr. Leo Mayer, for kind permission to use this operation on his service.

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Exhibit 1020

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CONSULTING EDITOR

CLINICS IN PODIATRIC MEDICINE AND SURGERY

The First Ray

THOMAS J. CHANG, DPM, GUEST EDITOR

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THE LAPIDUS PROCEDURE

Mark H. Hofbauer, DPM, DABPS, and
Jordan P. Grossman, DPM

The purpose of this article is to present the authors' experience and clinical results when using the Lapidus procedure for the primary repair of hallux abducto valgus deformity. Many foot surgeons have used this procedure for correction of cavus deformity, flatfoot deformity, medial column instability, or as a salvage procedure for hallux abducto valgus. Many authors have described the procedure as technically difficult, biomechanically unsound, and plagued with complications. These individuals support their views with evidence that Lapidus himself abandoned the procedure. Dr. Kelikian once stated that the failure of a procedure does not always condemn the procedure. Occasionally, it is necessary to condemn the surgeon. We would like to offer our findings, our surgical technique, and our postoperative regimen using the Lapidus procedure, as a primary procedure, in the properly selected patient.

HISTORY

There is an abundance of literature on the deformity of hallux valgus. Kelikian has stated that well over 100 procedures have been described for surgical correction of this condition.¹² Arthrodesis of the first metatarsocuneiform joint has been advocated as a primary procedure for addressing hallux valgus and metatarsus primus adductus since the early 1900s.

Although Paul Lapidus has been credited for popularizing this procedure, Albrecht in 1911 was the first to initially describe a lateral closing wedge with an arthrodesis of the first met-cuneiform joint. Because his original paper was published in the Russian literature, his work wasn't acknowledged until Albrecht worked with Lapidus at The Hospital for Joint Diseases in New York.^{1, 12} The first publication in the English journals occurred in 1925 when Walter

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Truslow described a biplanar first cuneiform wedge resection for arthrodesis and correction of metatarsus primus adductus.^{12, 24}

By 1932 Lapidus was a junior member at the New York Hospital for Joint Diseases, under the guidance of Samuel Kleinberg. Kleinberg published his procedure experience using the first metatarsal-cuneiform arthrodesis for hallux valgus repair. His technique was virtually analogous to Albrecht's, with the addition of resection of the lateral base of the first metatarsal. He wrote "Frequently there is a shoulder or projection of the bone on the outer side of the first metatarsal or the inner side of the base of the second metatarsal, which interferes with the free motion of the first metatarsal and has to be removed."^{12, 13}

Lapidus published his original article in 1934, followed by a series of publications advocating first metatarsocuneiform fusion for the deformity he noted as metatarsus primus varus. In his original paper his technique was very similar to that of Albrecht and Kleinberg, but Lapidus also roughed the adjacent aspect of the second metatarsal base to induce intermetatarsal fusion. He summarized by saying that this procedure is most useful in an "atavistic" or "weak" foot and that by addressing the deformity at the apex he felt was the metatarsal-cuneiform joint (MCJ), the first metatarsal was corrected and served as a medial buttress that helped to prevent pronation and deformity.^{12, 14} In subsequent articles, Dr. Lapidus admitted that, although his procedure was useful in properly selected cases, proper patient selection was important.^{15, 16}

Since Lapidus' work, arthrodesis of the metatarsocuneiform joint and its modification were published by Armstrong (1937),² Hue and Thyes (1938),¹⁰ and Wissel (1952).²⁵ Durman, in 1957, combined first MCJ fusion with a medially based wedge osteotomy of the first metatarsal head. The resected wedge of bone was then used as medially based autogenous bone graft at the arthrodesis site.^{7, 8}

Giannestras, in 1973, used a transcortical K-wire fixation between the first and second metatarsal to prevent the common complication of elevation of the first metatarsal. Additionally, he used the resected medial exostosis of the first metatarsal head as bone graft at the arthrodesis site.^{4, 8} A retrospective analysis of 47 fusions in 33 patients was performed by Maguire in 1973. He concluded that this procedure had some advantages over metatarsal osteotomies and that nonunion, if it occurred, was in the region of a normal joint and was not necessarily considered a complication.^{4, 17} An article by Robert Rutherford in a 1974 issue of the *Journal of the American Podiatric Association* was the first to describe the use of a compression screw for fixation at the arthrodesis site. He emphasized the need for stability to help obviate hypermobility of the first ray.²¹

In 1976, Goldner and Gaines performed first MCJ arthrodesis as a primary procedure for severe juvenile hallux abductovalgus (HAV) deformity. They advocated the procedure when the angle between the first metatarsal and first cuneiform was greater than 30 degrees, and particularly when the first metatarsal was considerably shorter than the second.^{4, 9} Butson, in 1980, published his study utilizing a procedure similar to the technique of Giannestras. He also used the resected exostosis from the first metatarsal as an autogenous graft to maintain first ray length, but immobilized the patient postoperatively for a longer period of time.³

The Lapidus procedure recently came back into vogue over the last eight to ten years as numerous articles have been published in orthopedic and podiatric literature. In 1987, Clark, Veith, and Hansen reported on a long-term retrospective review of 32 feet, using their modified procedure. The authors employed A.O. principles of fixation, using two-screw compression fixation across the arthrodesis site. A high recurrence rate in their patient population prompted

these authors to use dual screw fixation. In addition, a lateral and plantar wedge osteotomy at the first MCJ was performed, removing the articular surfaces and a minimal amount of bone. Iliac bone graft was interposed when clinically indicated to prevent a short first ray.⁶

Sangeorzan and Hansen reported their retrospective analysis at Harborview Medical Center in 1989. They evaluated 40 feet preoperatively and postoperatively. They also used multiscrew fixation, bone graft (autogenous) when indicated, and emphasized plantarflexion of the first ray during the procedure. They used 3.5 mm cortical screws across the first MCJ and from the first metatarsal into the second cuneiform primarily to ensure "rotational stability" of the arthrodesis site and not to induce fusion of the first and second metatarsals.^{4, 23}

Two publications in the recent podiatric literature reviewed the Lapidus procedure. Saffo et al reported a 5-year retrospective analysis. They reported 54 procedures on 44 patients. The procedure they described emphasized minimal bone resection to prevent shortening, and more importantly, stressed the plantarflexion of the first metatarsal. This could be achieved by either a plantar based wedge or plantar transposition of the first metatarsal at the first MCJ and was considered paramount to the success of the procedure. Fixation employed was primarily with K-wires or Steinman pins. Descript surgery technique and multiple intraoperative pearls were discussed.^{4, 22} Also, Hernandez et al in 1989 published an article explaining the proper indications and reasoning for choosing the Lapidus procedure.¹¹

In 1990, Mauldin and colleagues published an intriguing modification, incorporating an inlay block of bone after achieving corrected position of the first metatarsal. A modified McBride bunionectomy is performed, followed by mobilization of the first MCJ. The first metatarsal was manipulated in a more lateral position as a 9/64 Steinmann pin was used for fixation. Finally, a medial rectangular trough was performed across the first MCJ and subsequently firmly packed with autogenous bone chips followed by the inlay cortical graft.¹⁸

Myerson has published two recent articles on metatarsal-cuneiform arthrodesis for hallux abducto valgus and metatarsus primus varus. In his 1990 publication he describes a procedure similarly. Myerson utilizes two-screw fixation but does not employ interpositional bone graft to prevent shortening of the first metatarsal. He advocates plantarflexion of the first metatarsal by bone resection and advises against transposing the first metatarsal plantar. This creates a step-off and increases the technical difficulty of fixation placement.¹⁹ In 1992 Myerson et al published an article which was a long-term, retrospective study of sixty-seven procedures in 53 patients. The authors modified the previously described technique in Myerson's 1990 publication. Instead of resecting a biplanar wedge at the first MCJ, the authors removed only the lateral and plantar articular cartilage, leaving the medial aspect of the joint intact. Manipulation of the first metatarsal in the adducted and plantarward attitude was performed prior to insertion of the screw fixation. This modification allowed the metatarsal to be repositioned with little if any bone resection.²⁰

The most recent article on the Lapidus arthrodesis was written by Chang and Ruch in 1994. The authors' indications were primarily for midfoot stabilization in cases of Lis Franc arthrodesis, Charcot reconstruction and medial column fusion. The technique evaluated four different forms of fixation with the use of mechanical stress apparatus. The authors concluded that a 1/3 semitubular A.O. plate placed medially with a 4.0 mm interfragmental screw directed from plantar-distal provided the greatest amount of strength when medial column stability is critical.⁵

CLINICAL PRESENTATION

Criteria to be considered when choosing the Lapidus procedure are many. The question is often asked, "Why perform a Lapidus procedure when the same can be accomplished with a base wedge osteotomy?" This is by no means true. Patient selection for Lapidus arthrodesis does not necessarily require a large intermetatarsal angle. It is not uncommon for the author to perform a Lapidus on a patient with a ten to twelve degree intermetatarsal angle. Although it is true that patients with extremely high intermetatarsal angles are well-suited to a Lapidus procedure, those with small intermetatarsal angles may also be candidates for this procedure. Hypermobility of the first ray is a primary indicator when selecting the Lapidus procedure. Hypermobility has often been questioned. How do you measure it? Is it important? Does it really exist? Vern Inman noted that with regard to first ray motion 10% of the first ray's range-of-motion is at the first metatarsal cuneiform joint and 90% is at the navicular cuneiform joint. This may be true in patients with a rectus foot; however, it has been the authors' experience through cadaveric research that as hallux abducto valgus deformity increases and the axis of motion changes, the location of motion within the first ray also increases. We have found that in patients with moderate to severe hallux abducto valgus deformity, the amount of motion within the first ray is divided equally between joints. Therefore, it is the authors' opinion that as the axis of motion of the first ray deviates with increasing deformity, so does the apex of the deformity, precisely to the metatarsal cuneiform joint. Hypermobility is not a measurable entity; however, it can be assessed clinically by loading the foot to neutral position and moving the first ray dorsally and plantarly and noting its relationship to the second ray. Any excessive deviation dorsally with regard to the second ray would constitute hypermobility.

Many patients with hallux abductus valgus deformity present with a sub second metatarsal head lesion, or metatarsalgia associated with the second metatarsal. Often these patients demonstrate hypermobility that is leading to redistribution of weight-bearing forces from the first metatarsal to the second. Despite the intermetatarsal angle, this type of patient is a candidate for a Lapidus procedure. Fusion of the metatarsal cuneiform joint with the first ray plantarflexed helps to realign the first metatarsal, thereby distributing weight back to the first ray and alleviating second metatarsal symptomatology.

Patients suffering from hallux limitus or hallux rigidus that have maintained some joint articular surface are also candidates for a Lapidus procedure. Plantarflexing and shortening the first metatarsal will decompress the first MPJ, increase range of motion and alleviate symptomatology.

Other indications include splay foot deformity requiring forefoot reconstruction, metatarsus adductus repair with Berman Gartland, isolated pain at the first metatarsal cuneiform joint, or as a medial column stabilizing procedure.

RADIOGRAPHS

Evaluation of standard weightbearing radiographs are a vital part of the preoperative assessment of hallux valgus deformity. The severity of the hallux abductus angle, the intermetatarsal angle, sesamoid position, and metatarsus adductus angle should be measured prior to surgery.¹⁹ It is also prudent to correlate the congruity of the first MPJ and relative length of the first and second metatarsals with the clinical examination. The relative elevation of the first

metatarsal to the second metatarsal on lateral radiograph may be determined by divergence of the dorsal cortices and by sagittal plane joint breaching with plantar gapping at the first metatarsocuneiform joint.⁴ Hypermobility of the first ray has been suggested to be expressed radiographically as cortical hypertrophy of the second and third metatarsal shaft secondary to excessive weightbearing.⁴ Degenerative joint disease and periarticular osteophytic proliferation at the first metatarsal cuneiform joint can also be reliable signs of hypermobility. Evaluation of the lateral condyle of the base of the first metatarsal should also be noted because this prominence is resected as part of the procedure. The so-called addivistic cuneiform, in the authors' experience, is a radiographic anomaly and not necessarily a true structural entity seen intraoperatively. Preoperative radiographs help determine the possible size and length of a screw that will avoid screw threads across the fusion site and avoid peripheral joint spaces proximally.

THE PROCEDURE

Regional anesthesia along with intravenous sedation is most commonly used for this procedure; however, general anesthesia may also be used. An ankle pneumatic tourniquet is routinely used. Numerous incisional approaches have been described and are dependent on the type of fixation chosen. Screw fixation is generally the choice of the author, and therefore we routinely use a long curvilinear incision, originating just proximal to the first metatarsal cuneiform joint, and extending distally across the first metatarsalphalangeal joint. It is important to begin the most proximal portion of the incision at the most extreme dorsal portion of the joint to aid in visualization when joint resection is required. A more medial incision aids in easier resection at the joint; however, the disadvantages of a medial incision include difficulty in obtaining internal fixation as well as the inability to resect the lateral base of the first metatarsal which allows for lateral displacement and will be discussed later. A two-incisional approach has also been described and also provides fine exposure; however, it is recommended to only use this incisional approach if K-wire or Steinman pin fixation is being used. The two-incisional approach combines a 3 cm incision proximally over the first metatarsal cuneiform joint dorsally and a 3 cm to 4 cm dorsal medial incision over the first metatarsal phalangeal joint.

The incision is then deepened distally at the first MPJ. The extensor hallucis brevis tendon is identified and transected. Dissection medially is not extensive unless an osteotomy is planned distally to realign the cartilage. This is not routinely done. Dissection laterally includes an extensive lateral release of the conjoint tendon of the adductor hallucis and a capsulotomy is performed at the plantar one-half of the joint capsule. An inverted "L" incision is made dorsally in the joint capsule with one arm of the "L" extending plantarly at the medial aspect of the joint but proximal to the joint.

The head of the first metatarsal is freed from soft tissue to allow for adequate resection of the dorsal medial exostosis as well as appropriate release of the sesamoid apparatus. Once this has been completed attention is directed to the proximal portion of the wound where the incision is deepened. The extensor hallucis longus tendon must be retracted laterally. If the EHB tendon is identified, it may be isolated and removed from the wound totally. The first metatarsal cuneiform joint can be identified with a 25-gauge needle. An incision is then made at the most extreme dorsal portion of the joint. Dissection proximal

and distal should be adequate enough to allow for good exposure of the joint that aids in resection. Dissection in this area medially and laterally is best obtained with a freer elevator as well as with a #15 blade. Once adequate exposure is obtained, it is recommended that the lateral base of the first metatarsal be resected from a dorsal to plantar direction. Resection of this condyle makes it much easier to displace the metatarsal laterally and obtain IM correction. It is important when resecting this condyle not to be overzealous and resect so much bone as to leave little surface for bone-to-bone apposition as well as enough bone surface for internal fixation. One must also keep in mind that when resecting this condyle, the metatarsal must be held in a rectus position to avoid resection in an oblique fashion. This mistake is easily made if the metatarsal is held in a varus or valgus attitude.

Resection of the joint begins at the metatarsal base and is made parallel and just distal to the articular cartilage. Resection of the cuneiform is then carried out, again, just proximal to the articular surface but with minimal wedging laterally to allow for IM correction (Fig. 1A and B).

Once articular surfaces have been resected, numerous fenestrations are made on each side at the fusion site with a 1.5 mm drill bit to promote osseous bleeding and fusion (Fig. 2).

Intermetatarsal angle correction is then performed with the goal of correction to zero degrees. The entire first metatarsal is then displaced plantarly on the cuneiform to achieve plantarflexion. The fusion site is then temporarily fixated with two distally threaded guide wires that are used with the Synthes 4.0 mm cannulated screw set. The first guide wire is placed dorsally in the base of the first metatarsal approximately 1.5 cm distal to the fusion site. The guide wire is then directed from distal to proximal and slightly plantar with attention being paid not to deviate laterally, but instead to attempt to purchase solid bone in the medial portion of the medial cuneiform. The second guide wire is then placed from the medial aspect of the base of the first metatarsal approximately 1.5 cm distal to the fusion site and angled from distal medial to proximal lateral into the medial cuneiform and avoiding the intermediate cuneiform. Once the temporary guide wires are in place, each is countersunk and corresponding 4.0 mm cannulated Synthes self-tapping, self-drilling screws are placed across the fusion site (Fig. 3A and B). Intraoperative radiographs or fluoroscopy is obtained to evaluate screw placement. Once it has been determined that no screw threads are crossing the fusion site and that screw length is satisfactory, the guide wires are removed.

Closure of the wound is then carried out in layers with capsulorrhaphy work done at the first metatarsal phalangeal level. A compressive dressing of the Jones type or unnaboot application is achieved and the foot is then placed in a posterior splint.

There are a number of intraoperative decisions that are made that help to determine a successful result. When performing this procedure on children with a growth plate present, .062 Kirshner wires or 5/64 Steinmann pin fixations may be substituted for screw fixation, providing excellent results.

Much debate has been given to the advantage of curettage technique of the joint compared to resection to avoid shortening of the metatarsal. It has been the authors' experience that shortening of the first metatarsal postoperatively is irrelevant, so long as the entire metatarsal has been plantarflexed. Second metatarsal head lesions and metatarsalgia are a result of metatarsus primus elevatus and not necessarily first ray shortening. Resection of the joint allows for easier

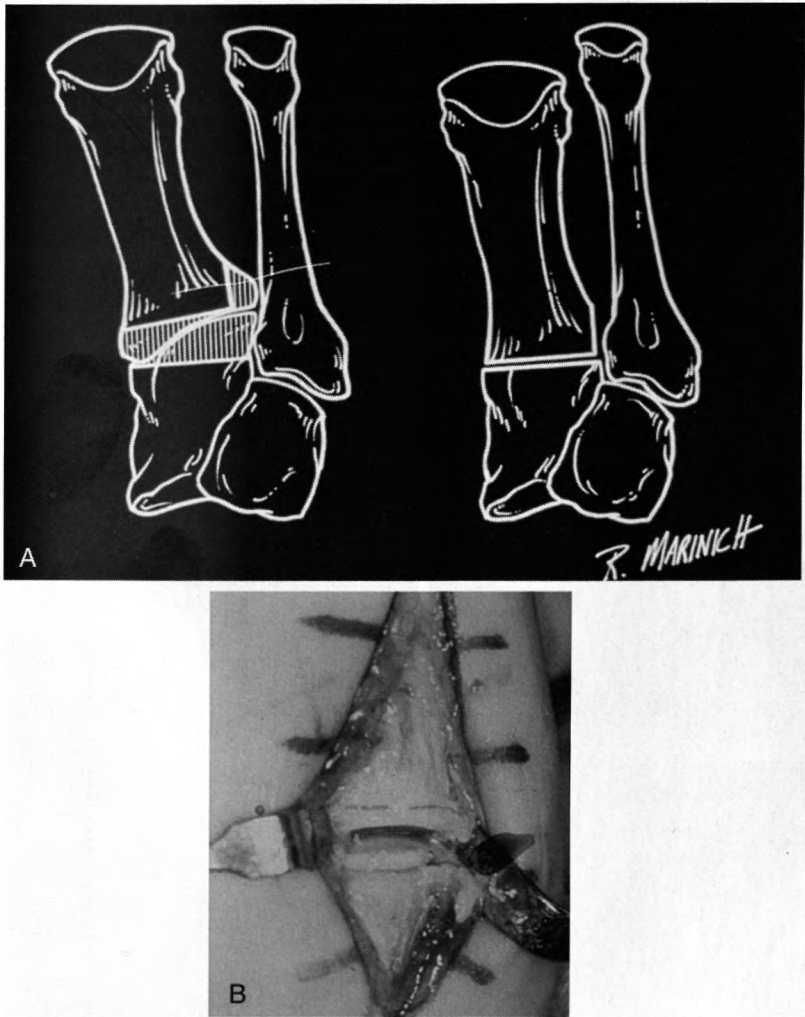


Figure 1. A, Schematic demonstrating resection base lateral condyle, resection base first metatarsal, and resection distal cuneiform with wedge for IM correction. (Courtesy of Dr. Alan Catanzanti.) B, Intraoperative of schematic.

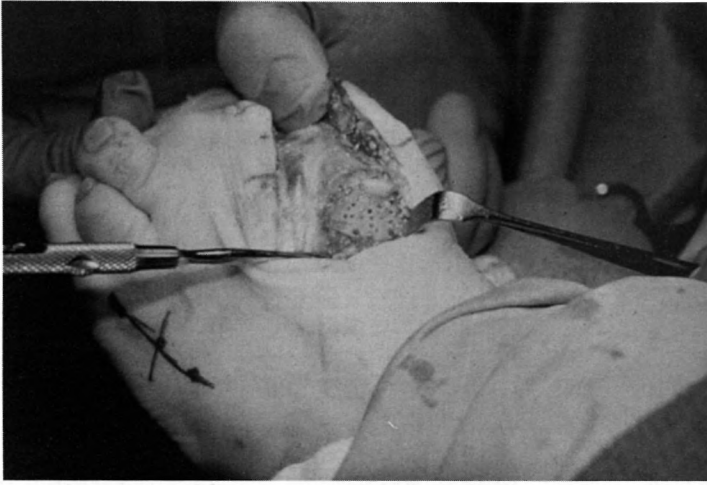


Figure 2. Intraoperative demonstrating 1.5 mm drill fenestrations.

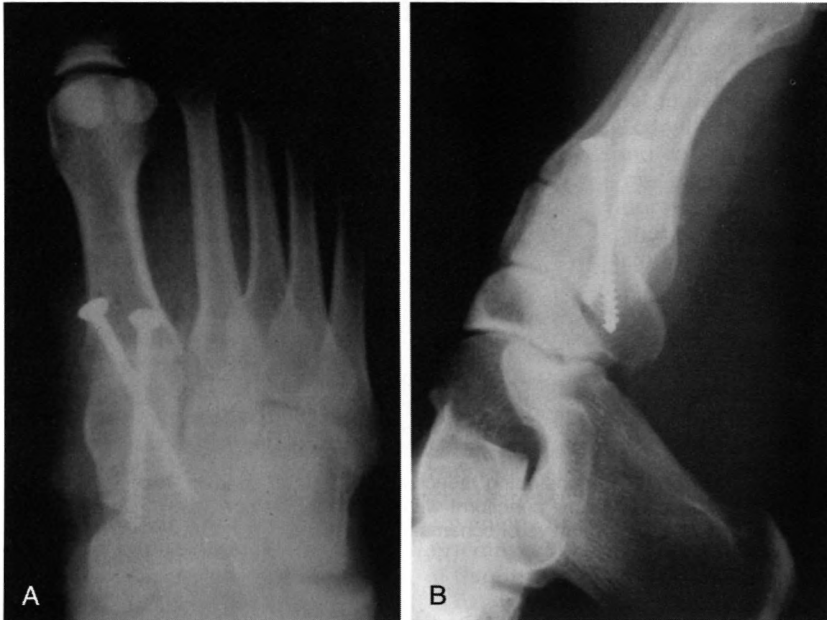


Figure 3. AP (A) and lateral (B) radiographs demonstrating proper positioning of two 4.0 mm cancellous screws. Note plantarflexed position of first metatarsal on lateral view.

reduction of the intermetatarsal angle and provides more surface area for bony apposition when plantarflexing the metatarsal on the cuneiform.

Bone grafting should be reserved for cases that have failed due to non-union or malalignment and require filling of a void or reestablishment of length to the medial column. Bone grafting is generally not indicated when the Lapidus is an initial primary procedure.

Inherent to the procedure is the ability to correct deformity in three planes. One advantage over other procedures is the ability to correct metatarsus primus varus or valgus in the frontal plane. Often the central crista at the head of the first metatarsal is deviated in the frontal plane, and when the sesamoids are realigned, they do not function properly within their sesamoidal groove because of this crista rotation. The Lapidus procedure also allows for rotation of the entire metatarsal to correct this problem.

POSTOPERATIVE COURSE

Control of edema, immobilization and nonweightbearing is started immediately post operation. The patient is maintained in a compressive dressing with a posterior splint and three-point nonweightbearing with crutches or walker. At 1 week the dressing is changed, wound examined, and again placed in a compressive-type dressing with splintage. The dressing is changed after the 2nd postoperative week, at which time the stitches are removed. A below-the-knee cast is then applied and nonweightbearing with crutches is continued. First metatarsal phalangeal joint range of motion exercises are started at home beginning the second postoperative week. The patient is then seen during the sixth to eighth postoperative week at which time the cast is removed, radiographs obtained and clinical assessment is made. Partial weightbearing in a surgical shoe with an unnaboot compression dressing is started if clinical and radiographic signs indicate. Radiographic union may not be evident for months. Clinical evaluation is most important, assessing pain and stability. If 1 week of partial weightbearing is well-tolerated, progression to full weightbearing in a jogging shoe is begun.

Serial radiographs are needed only if bone graft has been used or if some type of complication needs monitoring. In the case of bone grafting, non-weightbearing should be maintained until bony union is evident and clinical signs and symptoms correlate with healing.

Edema of the midfoot, rearfoot, or ankle is a frequent finding at 8 to 12 weeks postoperatively in the Lapidus patient. Control of this edema is by means of antiembolic compression stockings and oral steroid therapy. The patient should be informed that this transient edema resolves uneventfully.

Radiographs obtained following return to weightbearing may demonstrate some metatarsus primus elevatus on a lateral view. It has been the authors' experience that this temporary condition is due in part to weakening of the peroneus longus tendon following resection of the metatarsal cuneiform joint. This condition generally will resolve itself over time with increased activity and eventual strengthening of the peroneal tendon. Occasionally, physical therapy directed at strengthening of this tendon may be indicated. Stiffness of the first metatarsal phalangeal joint is usually not encountered because the plantarflexed and shortened position of the first metatarsal acts to decompress the joint. A number of authors have stated that long-term follow-up of these patients may demonstrate proximal midfoot and rearfoot joint pathology; however, there is

no literature to support this claim and the authors have not witnessed this phenomenon.

RESULTS

The best evidence to support the long-term success of the Lapidus procedure comes from a study done by Saffo et al at our institution in 1989. A 5-year analysis of the Lapidus procedure was performed, and 44 patients comprising 54 procedures were evaluated. The average age was 45 years, ranging from 13 to 64. Minimum follow-up consisted of 1 year with a maximum follow-up of 5 years. Eighty-four percent of the patients studied believed that the surgery adequately addressed their complaint. Eighty-two percent of the patients rated the surgery as excellent or good. Most patients who were unsatisfied were primarily unhappy with concomitant procedures, not with the Lapidus itself.

Clinical results of the study revealed that 14% of the patients developed subsecond metatarsal head lesions, four percent of which were symptomatic. Four percent of the patients had pseudoarthrosis/nonunion of the arthrodesis site; however, none of these were symptomatic. Evaluation of the subtalar and midtarsal joints revealed no evidence of increased range of motion, pain, or signs of degenerative changes.

The intermetatarsal angle was routinely reduced to zero degrees and the metatarsal declination angle of the first metatarsal was shown to increase by an average of 2 degrees. Average first metatarsal shortening was 6mm; however, as demonstrated earlier, this shortening appeared irrelevant with regard to lesser metatarsal symptomatology.²²

It is the authors' experience that the technical difficulty and morbidity that has been often associated with the Lapidus procedure can be avoided if judicious preoperative planning and comprehensive postoperative follow-up are achieved.

Hypermobility has been a highlight throughout this chapter and is a common finding in patients selected for this procedure. We have found that hypermobility and laxity of other joints of the foot in these patients are commonplace. Although no studies are published to substantiate the use of orthotic devices in patients with hallux valgus, it has been the authors' experience that these patients are prime candidates and respond well to orthotics postoperatively. To date, the authors have witnessed no recurrent HAV deformities in patients undergoing the Lapidus procedure.

Other authors have reported similar results. Maguire in 1973 reported on 33 patients undergoing a total of 47 Lapidus procedures. Good to excellent results in 80% of the patients were demonstrated. Maguire also found that nonunions were asymptomatic and not necessarily a complication. He also reported the cosmetic results were very good.¹⁷

Butson reported on 119 procedures in 78 patients with a follow-up of 2 to 16 years. Good to excellent results were demonstrated in 92% of cases with zero incidence of nonunions.³ Sangeorzan and Hansen in 1989 reviewed 32 patients undergoing 40 operations. A 90% union of the arthrodesis site was reported, and 80% of the procedures were reported as successful.²³

Myerson in 1992 reported 67 Lapidus procedures in 53 patients. At 28 months follow-up, 77% of patients had total alleviation of symptomatology, 15% were partially relieved, and 8% were not relieved with regard to comfort, pain, cosmesis, and footwear following surgery. Seven nonunions were reported, one of which was symptomatic.²⁰

The literature has supported the use of the Lapidus procedure as a primary procedure for the repair of the hallux valgus deformity. Good to excellent results have been consistently reported. The authors concur with these findings and have concluded that in the properly selected patient, consistent clinical results can be obtained utilizing the Lapidus procedure for primary repair of hallux valgus deformity.

CONCLUSION

The Lapidus procedure has been used at our institution for many years as a primary procedure for the repair of hallux abducto valgus deformity and has provided excellent results.

Indications range from mild to severe intermetatarsal angles, hypermobility of the first ray with or without pain at the metatarsal cuneiform joint, and patients with sub second metatarsal head lesions or metatarsalgia. Other indications include hallux limitus or hallux rigidus, combined forefoot deformities requiring first ray stabilization including splay foot, and metatarsus adductus.

Successful results are dependent on proper patient selection, appropriate and aggressive intraoperative techniques, properly used rigid fixation techniques, and a well-monitored postoperative regimen.

Complications can occur including mal- or nonunion, pseudoarthrosis, under- or overcorrection of the intermetatarsal angle, failure of fixation devices, and sesamoiditis due to excessive plantarflexion of the first metatarsal. All of these are common complications with any hallux valgus repair. These complications are more amenable to repair following Lapidus fusion compared with other metatarsal osteotomy failures, such as the base wedge osteotomy. Technical difficulties with the Lapidus procedure are primarily encountered with resection of the joint due to extensive, plantar, soft-tissue adherence. With proper dissection and exposure this difficulty can be minimized and should not be considered as a negative factor influencing selection of this procedure.

Long-term results of large numbers of patients that have had first metatarsal cuneiform joint arthrodesis have demonstrated excellent results with recurrence of deformity practically nonexistent. The authors believe that the Lapidus is an excellent procedure for the primary repair of hallux abductus valgus deformity and provides excellent long-term results.

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Attachment 1A

Bibliographic Record - OCLC Number: 27182191

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Attachment 1B

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Attachment 1C

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450 \$a Magazines
550 \$w g \$a Library materials
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670 \$a UMI business vocab. \$b (Journals)
680 \$i Here are entered works on the periodicals of the world and, with appropriate subdivisions, works on special aspects or sections of periodicals. Works on periodicals in a specific language, or in a specific country or larger area, are entered under the adjectival form of the language or area, e.g. \$a Arabic periodicals; Canadian periodicals.
999 f f \$i f3c2f118-a0af-4986-bcda-385995e5c57d \$s 6e61730c-f0c8-4352-b06f-cb3fc2acd8a0

Attachment 1D

MARC record

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Attachment 1E

Ankle MeSH Descriptor Data 2025

[Details](#)[Qualifiers](#)[MeSH Tree Structures](#)[Concepts](#)

MeSH Heading

Ankle

Tree Number(s)

A01.378.610.050

Unique ID

D000842

RDF Unique Identifier

<http://id.nlm.nih.gov/mesh/D000842>

Annotation

primates only; use TARSUS, ANIMAL for non-primate vertebrates; differentiate from ANKLE JOINT; ANKLE BONES see TARSAL BONES is also available; do not confuse X ref TARSUS with tarsus or tarsal referring to the eyelid

Scope Note

The region of the lower limb between the FOOT and the LEG.

Entry Term(s)

Regio tarsalis

Tarsus

See Also

Ankle Joint

Tarsal Bones

Public MeSH Note

1963; see ANKLE INJURIES to search ANKLE/injuries 1966-91; for TARSUS see TARSUS 1988-2001

History Note

1963; use ANKLE INJURIES to search ANKLE/injuries 1966-91

Entry Combination

injuries:Ankle Injuries

Date Established

1963/01/01

Date of Entry

1999/01/01

Revision Date

2019/07/01

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Attachment 1F

Foot MeSH Descriptor Data 2025

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MeSH Heading

Foot

Tree Number(s)

A01.378.610.250

Unique ID

D005528

RDF Unique Identifier

<http://id.nlm.nih.gov/mesh/D005528>

Annotation

vertebrates only: for invertebrates use EXTREMITIES: dis of foot = FOOT DISEASES; skin dis on foot = FOOT DERMATOSES: see note there; neopl of foot: use neopl coords (IM) + FOOT DISEASES (IM); foot prints (like finger prints) = PLANTAR PRINTS see DERMATOGLYPHICS

Scope Note

The distal extremity of the leg in vertebrates, consisting of the tarsus (ANKLE); METATARSUS; phalanges; and the soft tissues surrounding these bones.

Entry Term(s)

Feet

See Also

Foot Bones

Entry Combination

abnormalities:Foot Deformities, Congenital

injuries:Foot Injuries

Date Established

1966/01/01

Date of Entry

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Revision Date

2009/07/31

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250	__ a4th ed. /beditor, Joe T. Southerland ; author editor, Daniel F. Vickers ; section editors, Jeffrey S. Boberg ... [et al.].
260	__ aPhiladelphia :bWolters Kluwer Health/Lippincott Williams & Wilkins,cc2013.
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Attachment 2B

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Attachment 2C

MARC record

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LCCN

Permalink: <https://lccn.loc.gov/sh85050397> (link opens in a new tab)

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Attachment 2D

MARC record

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Attachment 2E

MARC record

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040 \$a DLC \$c DLC \$d DLC
053 0 \$a RD
150 \$a Surgery
\$i subdivision \$a Surgery \$i under classes of persons, individual diseases and types of diseases, and individual organs and regions of the body, e.g. \$a Children--Surgery;
360 Cancer--Surgery; Heart--Surgery; \$i and subdivisions \$a Abnormalities--Surgery \$i and \$a Wounds and injuries--Surgery \$i under individual organs and regions of the body, e.g. \$a Heart--Abnormalities--Surgery; Foot--Wounds and injuries--Surgery
450 \$w nne \$a Surgery, Primitive
550 \$w g \$a Medicine
999 f f \$i 4faaa08d-5919-4a37-befb-1bcc54ec7c95 \$s 2595fbbc-0619-44e3-9e86-1bfa4712f638

Attachment 2F

Foot Deformities MeSH Descriptor Data 2025

Details	Qualifiers	MeSH Tree Structures	Concepts
MeSH Heading	Foot Deformities		
Tree Number(s)	C05.330		
Unique ID	D005530		
RDF Unique Identifier	http://id.nlm.nih.gov/mesh/D005530		
Annotation	general or unspecified; prefer specifics		
Scope Note	Alterations or deviations from normal shape or size which result in a disfigurement of the foot.		
Entry Term(s)	Metatarsal Deformity		
Previous Indexing	Foot/abnormalities (1966-1987)		
Public MeSH Note	88		
History Note	88		
Entry Combination	congenital:Foot Deformities, Congenital		
Date Established	1988/01/01		
Date of Entry	1987/04/02		
Revision Date	2016/01/20		

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Foot Injuries MeSH Descriptor Data 2025

[Details](#)[Qualifiers](#)[MeSH Tree Structures](#)[Concepts](#)**MeSH Heading**

Foot Injuries

Tree Number(s)

C26.558.300

Unique ID

D018409

RDF Unique Identifier<http://id.nlm.nih.gov/mesh/D018409>**Annotation**

general or unspecified; prefer specifics; consider also /inj with specific sites of foot

Scope Note

General or unspecified injuries involving the foot.

Entry Version

FOOT INJ

Entry Term(s)

Injuries, Foot

Turf Toe

Previous Indexing

Foot/injuries (1966-1994)

Public MeSH Note

95; was FOOT/injuries 1966-94

Online Note

use FOOT INJURIES to search FOOT/injuries 1966-94

History Note

95; was FOOT/injuries 1966-94

Date Established

1995/01/01

Date of Entry

1994/06/28

Revision Date

2016/02/26

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 550 "Official journal of the American College of Foot and Ankle Surgeons."
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 850 \$a CU-AM \$a CU-SM \$a DLC \$a DNLM \$a laU \$a NNNAM \$a WaU
 859 4 1 \$u <http://www.podiatric.theclinics.com/>
 906 \$a 7 \$b cbc \$c serials \$d 3 \$e ncip \$f 19 \$g n-oclcserc
 590 \$a SERBIB/SERLOC merged record
 890 \$a Clinics in podiatric medicine and surgery. Philadelphia. \$i 86-643213
 920 \$a Keep 1
 984 \$a srvf \$d 2000-12-08
 991 \$b c-GenColl \$h RD563 \$i .C63 \$w SERIALS
 992 \$b Ser \$w SERLOC
 999 f f \$s 7f538697-e18f-4147-a4aa-69a42966ccc2 \$i 7b9758f8-f8e2-5e47-850e-
 86b323097772

Attachment 6B

Bibliographic Record - OCLC Number: 13324960

LDR	Record Status	'c' - Corrected or revised
	Type of Record	'a' - Language material
	Bibliographic Level	's' - Serial
	Type of Control	' ' - No specified type of control
	Encoding Level	' ' - Full level
	Descriptive Cataloging Form	'a' - AACR2
001	13324960	
005	20251105200604.7	
008	Date Entered on File	'860321'
	Type of Date/Publication Status	'c' - Continuing resource currently published
	Date1/Beginning Date of Publication	'1986'
	Date2/Ending Date of Publication	'9999'
	Place of Publication, Production, or Execution Code	'pau' - Pennsylvania
	Frequency	'q' - Quarterly
	Regularity	'r' - Regular
	Type of Continuing Resource	' ' - None of the following
	Form of Original Item	' ' - None of the following
	Form of Item	' ' - None of the following
	Nature of Entire Work	' ' - No specified nature of entire work
	Nature of Contents	' '
	Government Publication	' ' - Not a government publication
	Conference Publication	'0' - Not a conference publication
	Original Alphabet or Script of Title	'a' - Basic Roman
	Entry Convention	'0' - Successive entry
	Language Code	'eng' - English
	Modified Record	' ' - Record is not modified
	Cataloging Source Code	'c' - Cooperative cataloging program
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022 0	0891-8422 \$y 0742-0668 \$z 1559-6486 \$2 1	
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032	000707 \$b USPS	
037	\$b W.B. Saunders, West Washington Square, Philadelphia, PA 19105	
042	pcc \$a nsdp	
043	n-----	
050 0 0	RD563 \$b .C63	

060 0 0 W1 **\$b** CL831DE
 082 0 0 617/.585/005 **\$2** 19
 210 0 Clin. podiatr. med. surg.
 222 0 Clinics in podiatric medicine and surgery
 245 0 0 Clinics in podiatric medicine and surgery.
 246 1 8 Podiatric medicine and surgery
 246 1 **\$i** Vols. for 2004- called: **\$a** Clinics in podiatric medicine and surgery of North America
 260 **\$3** 1986- : **\$a** Philadelphia : **\$b** W.B. Saunders, **\$c** ©1986-
 260 3 **\$3** <2014-> **\$a** New York, NY : **\$b** Elsevier Inc.
 300 18 volumes : **\$b** illustrations, portraits ; **\$c** 24 cm
 310 Quarterly
 336 text **\$b** txt **\$2** rdacontent
 337 unmediated **\$b** n **\$2** rdamedia
 338 volume **\$b** nc **\$2** rdacarrier
 362 0 Vol. 3, no. 1 (Jan. 1986)-
 500 Each volume has also a distinctive title.
 530 Also issued online.
 650 0 Podiatry **\$v** Periodicals.
 650 0 Foot **\$x** Surgery **\$v** Periodicals.
 650 1 2 Podiatry.
 650 1 2 Foot **\$x** surgery.
 651 2 North America.
 650 7 Foot **\$x** Surgery. **\$2** fast **\$0** (OCoLC)fst00931326
 650 7 Podiatry. **\$2** fast **\$0** (OCoLC)fst01067635
 653 Health and medical sciences
 653 Man **\$a** Feet **\$a** Diseases
 655 2 Periodical.
 655 7 Periodicals. **\$2** fast **\$0** (OCoLC)fst01411641
 776 1 **\$t** Clinics in podiatric medicine and surgery (Online) **\$x** 1558-2302 **\$w** (DLC) 2005213182 **\$w** (OCoLC)61680715
 776 0 8 **\$i** Online version: **\$t** Clinics in podiatric medicine and surgery **\$w** (OCoLC)732993715
 780 0 0 **\$t** Clinics in podiatry **\$x** 0742-0668 **\$w** (DLC) 84646078 **\$w** (OCoLC)10255369
 850 CU-AM **\$a** CU-SM **\$a** DLC **\$a** DNLM **\$a** IaU **\$a** NNNAM **\$a** WaU
 856 4 1 **\$u** <http://www.podiatric.theclinics.com/>
 029 1 AU@ **\$b** 000004684678
 029 1 AU@ **\$b** 000023036562
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 029 1 AU@ **\$b** 000043638890
 029 1 AU@ **\$b** 000053310012
 029 1 NLGGC **\$b** 865337578
 029 1 NLM **\$b** 8604974
 029 1 NZ1 **\$b** 3660689
 029 1 ZWZ **\$b** 039989895
 029 1 NZ1 **\$b** 207449

029 1 NLNZL \$b 992074493502836

Attachment 4A

MARC Bibliographic Record

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050	_4	\$a RD701 \$b .C55
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082	00	\$a 617.47 \$223\$1 https://id.oclc.org/worldcat/ddc/E4bWMVWKYJwk8yxJy4W
130	0_	\$a Clinical orthopaedics (Online)

210	0_	\$aClin. orthop.\$b(Online)
222	_0	\$aClinical orthopaedics\$b(Online)
245	10	\$aClinical orthopaedics.
260		\$a[Philadelphia] :\$b[Lippincott]
336		\$atext\$btxt\$2rdacontent
337		\$acomputer\$bc\$2rdamedia
338		\$aonline resource\$bcr\$2rdacarrier
362	1_	\$aPrint began with no. 1, published in 1953.
362	1_	\$aPrint ceased with no. 25.
530		\$aAlso issued in print.
538		\$aMaster and use copy. Digital master created according to Benchmark Library Federation, December 2002.\$uhttp://purl.oclc.org/DLF/bench
538		\$aMode of access: World Wide Web.
555		\$aNo. 1 (spring 1953)-no. 6 (fall 1955). 1 v.; No. 7 (spring 1956)
583	1_	\$adigitized\$c2011\$hHathiTrust Digital Library\$lcommitted to preser
588		\$aDescription based on print version record.
650	_0	\$aOrthopedics\$vPeriodicals.
650	_0	\$aOrthopedic surgery\$vPeriodicals.
650	_2	\$aBone and Bones\$vPeriodicals.
650	_2	\$aOrthopedics\$vPeriodicals.
650	_2	\$aBone and Bones.
650	_2	\$aOrthopedics.
650	_7	\$aOrthopedic surgery.\$2fast\$0(OCOLC)fst01048559

650	_7	\$aOrthopedics.\$2fast\$0(0CoLC)fst01048565
655	_2	\$aPeriodical.
655	_7	\$aPeriodicals.\$2fast\$0(0CoLC)fst01411641
776	08	\$x0095-8654
785	00	\$tCLINICAL ORTHOPAEDICS AND RELATED RESEARCH\$w(CKB)954925391294\$w(
906		\$aJOURNAL

MMS IDs

Document ID:

9911121818302121

Network Electronic IDs:

9911121818302121

Network Physical IDs:

999482902802121

mms_mad_ids:

991021974301802122

mms_lc_ids:

99992913402125

Attachment 4B

MARC record

LC control no.: sh2010104613

LCCN

Permalink:

<https://lccn.loc.gov/sh2010104613> (link opens in a new tab)

000	00519nz a2200169n 4500
001	sh2010104613
005	20250804140332.9
003	DLC
008	100324 anannbabn n ana
010	\$a sh2010104613
035	\$a (DLC)460600
035	\$a (DLC)sh2010104613
040	\$a DLC \$b eng \$c DLC
150	\$a Orthopedics \$v Periodicals
667	\$a Record generated for validation purposes.
670	\$a Work cat.: Acta orthopaedica Scandinavica,
999 f f	\$i 6dd91cee-a6fd-452c-be0f-1ef731200a69 \$s cd994a32-f7b6-4854-9409-927ebeed5163

Attachment 4C

MARC record

LC control no.: sh 85095812

LCCN

Permalink: <https://lccn.loc.gov/sh85095812> (link opens in a new tab)

000	00530nz a2200193n 4500
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005	20250804133344.9
003	DLC
008	860211i anannbabn b ana
010	\$a sh 85095812
035	\$a (DLC)sh 85095812
035	\$a (DLC)92436
040	\$a DLC \$c DLC \$d DLC
053 0	\$a RD701 \$b RD789
150	\$a Orthopedic surgery
450	\$a Operative orthopedics
550	\$w g \$a Orthopedics
550	\$w g \$a Surgery, Operative
999 f f	\$i d2582f55-4a55-40b3-bd9c-1fe66278bd7e \$s 2c1bacbe-c768-401b-9154-29cf4c263044

Attachment 4D

Bone and Bones MeSH Descriptor Data 2025

[Details](#)
[Qualifiers](#)
[MeSH Tree Structures](#)
[Concepts](#)

MeSH Heading

Bone and Bones

Tree Number(s)

A02.835.232

A10.165.265

Unique ID

D001842

RDF Unique Identifier

<http://id.nlm.nih.gov/mesh/D001842>

Annotation

/cytol: consider also OSTEOLASTS; OSTEOLASTS; OSTEOLASTS; /embryol: consider also OSTEOGENESIS; /surg: consider also OSTEOTOMY or ARTHRODESIS or FRACTURE FIXATION & its specifics; differentiate from SKELETON which is almost never used: restrict SKELETON to bone arrangement as a whole & not for "skeletal" which usually means "bone" (= BONE AND BONES); inflammation = OSTEITIS; necrosis = OSTEONECROSIS;

Scope Note

A specialized CONNECTIVE TISSUE that is the main constituent of the SKELETON. The principal cellular component of bone is comprised of OSTEOLASTS; OSTEOLASTS; and OSTEOLASTS, while FIBRILLAR COLLAGENS and hydroxyapatite crystals form the BONE MATRIX.

Entry Version

BONE BONES

Entry Term(s)

Bone

Bone Tissue

Bone and Bone

Bones

Bones and Bone

Bones and Bone Tissue

Bony Apophyses

Bony Apophysis

Condyle

See Also

Arthrodesis

Calcification, Physiologic

Osteogenesis

Osteotomy

Consider Also

consider also terms at OSSI- and OSTE-

Public MeSH Note

/transplantation was BONE TRANSPLANTATION 1963-65; was BONE AND BONES/transplantation 1966-89

Online Note

use BONE TRANSPLANTATION to search BONE AND BONES/transplantation 1966-89

History Note

/transplantation was BONE TRANSPLANTATION 1963-65; was BONE AND BONES/transplantation 1966-89

Entry Combination

growth & development:Bone Development

transplantation:Bone Transplantation

Date Established

1960/01/01

Date of Entry

1999/01/01

Revision Date

2021/06/30

page delivered in 0.134s

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Bethesda, MD 20894

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Attachment 4E

Orthopedics MeSH Descriptor Data 2025

[Details](#)[Qualifiers](#)[MeSH Tree Structures](#)[Concepts](#)**MeSH Heading**

Orthopedics

Tree Number(s)

H02.403.810.494

Unique ID

D009985

RDF Unique Identifier

<http://id.nlm.nih.gov/mesh/D009985>

Annotation

specialty; ORTHOPEDIC PROCEURES is available for orthopedic therapeutic techniques

Scope Note

A specialty which utilizes medical, surgical, and physical methods to treat and correct deformities, diseases, and injuries to the skeletal system, its articulations, and associated structures.

NLM Classification #

WE 21

See Also

Orthopedic Procedures

Osteology

Entry Combination

instrumentation:Orthopedic Equipment

nursing:Orthopedic Nursing

Date Established

1966/01/01

Date of Entry

1999/01/01

Revision Date

2019/07/05

page delivered in 0.151s

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Bethesda, MD 20894

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FOIA

HHS Vulnerability Disclosure

Attachment 4F

Bibliographic Record - OCLC Number: 1778089

LDR	Record Status	'c' - Corrected or revised
	Type of Record	'a' - Language material
	Bibliographic Level	's' - Serial
	Type of Control	' ' - No specified type of control
	Encoding Level	' ' - Full level
	Descriptive Cataloging Form	'a' - AACR2
001	1778089	
005	20251105200621.8	
008	Date Entered on File	'751101'
	Type of Date/Publication Status	'd' - Continuing resource ceased publication
	Date1/Beginning Date of Publication	'1953'
	Date2/Ending Date of Publication	'1962'
	Place of Publication, Production, or Execution Code	'pau' - Pennsylvania
	Frequency	'u' - Unknown
	Regularity	'u' - Unknown
	Type of Continuing Resource	' ' - None of the following
	Form of Original Item	' ' - None of the following
	Form of Item	' ' - None of the following
	Nature of Entire Work	' ' - No specified nature of entire work
	Nature of Contents	' '
	Government Publication	' ' - Not a government publication
	Conference Publication	'0' - Not a conference publication
	Original Alphabet or Script of Title	'a' - Basic Roman
	Entry Convention	'0' - Successive entry
	Language Code	'eng' - English
	Modified Record	' ' - Record is not modified
	Cataloging Source Code	' ' - National bibliographic agency
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012	3 \$b 3 \$e n \$i 8505	
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016 7	983373248 \$2 DE-101	
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023 0 0095-8654 \$2 1
 042 nsdp \$a pcc
 050 0 0 RD701 \$b .C55
 060 0 0 W1 \$b CL761
 210 1 0 Clin Orthop
 222 0 Clinical orthopaedics
 245 0 0 Clinical orthopaedics.
 260 [Philadelphia] : \$b [Lippincott], \$c [-1962]
 300 25 volumes : \$b illustrations ; \$c 26 cm
 336 text \$b txt \$2 rdacontent
 337 unmediated \$b n \$2 rdamedia
 338 volume \$b nc \$2 rdacarrier
 362 1 Began with: No. 1, published in 1953.
 362 0 -no. 25.
 555 No. 1 (spring 1953)-no. 6 (fall 1955). 1 v.; No. 7 (spring 1956)-no. 12 (fall 1958) in no. 13; No. 13-no. 18, in no. 19; No. 19-no. 24, in no. 25.
 588 Description based on: No. 25, published in 1962.
 650 0 Orthopedics \$v Periodicals.
 650 2 Bone and Bones.
 650 2 Orthopedics.
 650 6 Orthopédie \$v Périodiques.
 650 7 Orthopedics. \$2 fast \$0 (OCoLC)fst01048565
 655 2 Periodical.
 655 7 Periodicals. \$2 fast \$0 (OCoLC)fst01411641
 655 7 Periodicals. \$2 lcgft
 655 7 Periodicals. \$2 rbgenr
 776 0 8 \$i Online version: \$t Clinical orthopaedics (Online) \$x 2332-3906 \$w (DLC) 2013236800 \$w (OCoLC)60624421
 785 0 0 \$t Clinical orthopaedics and related research \$x 0009-921X \$w (DLC) 53007647 \$w (OCoLC)1554937
 850 CU-AM \$a DLC \$a MnSU \$a NjR
 029 1 AU@ \$b 000004480787
 029 1 AU@ \$b 000007253898
 029 1 NLGGC \$b 851924816
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 029 1 UKMGB \$b 012396419

Attachment 5A

MARC Bibliographic Record

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050	00	\$a RD1 \$b .S8
060	0_	\$a W1 SU748
069	1_	\$a S48320000

082		\$a617/.005
210	0_	\$aSurg. gynecol. obstet.
222	_0	\$aSurgery, gynecology & obstetrics
245	00	\$aSurgery, gynecology & obstetrics.
246	0_	\$aSurgery, gynecology and obstetrics
246	10	\$aSurgery, gynecology and obstetrics
246	13	\$aSG0\$f<, Feb. 1976>
260		\$a[Chicago] :\$b[Franklin H. Martin Memorial Foundation, etc.]
300		\$a177 volumes :\$billustrations, color plates ;\$c24-28 cm
336		\$atext\$btxt\$2rdacontent
337		\$aunmediated\$bn\$2rdamedia
338		\$avolume\$bnc\$2rdacarrier
362	0_	\$aVol. 1, no. 1 (July 1905)-v. 177, no. 6 (Dec. 1993).
500		\$aOfficial scientific journal of the American College of Surgeons.
510	1_	\$aExcerpta medica
510	2_	\$aBiological abstracts\$x0006-3169
510	2_	\$aChemical abstracts\$x0009-2258
510	2_	\$aEnergy research abstracts\$x0160-3604
510	2_	\$aIndex medicus\$x0019-3879
510	2_	\$aLife sciences collection
510	0_	\$aNuclear science abstracts\$x0029-5612
555		\$aVols. 1-40, 1905-25. 1 v.; Vols. 41-80, 1925-45. 1 v.; Vols. 8 1945-55. 1 v.; Vols. 101-110, 1955-60. 1 v.; Vols. 111-120, 1960

		v.; Vols. 121-130, 1965-70. 1 v.; Vols. 131-140, 1970-75. 1 v.
500		\$aEditor: 1905-<19> F. H. Martin.
650	_0	\$aSurgery\$vPeriodicals.
650	_0	\$aGynecology\$vPeriodicals.
650	_0	\$aObstetrics\$vPeriodicals.
650	_2	\$aGynecology\$vperiodicals.
650	_2	\$aObstetrics\$vperiodicals.
650	_2	\$aGeneral Surgery\$vperiodicals.
700	1_	\$aMartin, Franklin H.\$q(Franklin Henry),\$d1857-1935,\$eeditor.
710	2_	\$aFranklin H. Martin Memorial Foundation.
710	2_	\$aAmerican College of Surgeons.
770	0_	\$tInternational abstracts of surgery\$w(OCOLC)01587817
785	00	\$tJournal of the American College of Surgeons\$x1072-7515\$w(DLC)sn 93004645\$w(OCOLC)29192491
997		\$aMARCIVE

MMS IDs

Document ID:

999483422602121

Network Electronic IDs:

Network Physical IDs:

999483422602121

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mms_ml_ids:

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Attachment 5B

MARC record

LC control no.: sh2008112392

LCCN

Permalink:

<https://lccn.loc.gov/sh2008112392> (link opens in a new tab)

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150	\$a Surgery \$v Periodicals
667	\$a Record generated for validation purposes.
670	\$a Work cat.: Mémoires de l'Académie royale de chirurgie, 1781-
999 f f	\$i 454f85a5-f458-4dab-a8ce-16eea78b4636 \$s 838d4aed-c618-48e1-98ad-458786f26b21

Attachment 5C

MARC record

LC control no.: sh2008118506

LCCN

Permalink: <https://lccn.loc.gov/sh2008118506> (link opens in a new tab)

000	00516nz a2200169n 4500
001	sh2008118506
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010	\$a sh2008118506
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670	\$a Work cat.: Women's health issues, c1990-
999 f f	\$i b8e567b1-7e1e-4a71-96b8-28bc11a84441 \$s b961b150-1083-4db2-a71e-5384d0cb470d

Attachment 5D

MARC record

LC control no.: sh2008108563

LCCN

Permalink: <https://lccn.loc.gov/sh2008108563> (link opens in a new tab)

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003	DLC
008	080305 anannbabn n ana
010	\$a sh2008108563
035	\$a (DLC)384725
035	\$a (DLC)sh2008108563
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667	\$a Record generated for validation purposes.
670	\$a Work cat.: Current women's health reports, c2001-
999 f f	\$i 72a57dab-01a6-4eb9-96fa-f65add379024 \$s 830a470b-336f-456f-b832-0bb73ab80dcd

Attachment 5E

Gynecology MeSH Descriptor Data 2025

[Details](#)[Qualifiers](#)[MeSH Tree Structures](#)[Concepts](#)**MeSH Heading**

Gynecology

Tree Number(s)

H02.403.763.750

H02.403.810.310

Unique ID

D006176

RDF Unique Identifier

<http://id.nlm.nih.gov/mesh/D006176>

Annotation

specialty; corresponding organ term is GENITALIA, FEMALE

Scope Note

A medical-surgical specialty concerned with the physiology and disorders primarily of the female genital tract, as well as female endocrinology and reproductive physiology.

Entry Version

GYNECOL

See Also

Genital Diseases, Female

Gynecologic Surgical Procedures

Reproductive Medicine

Date Established

1966/01/01

Date of Entry

1999/01/01

Revision Date

2021/03/12

page delivered in 0.148s

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Careers

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Attachment 5F

Obstetrics MeSH Descriptor Data 2025

[Details](#)[Qualifiers](#)[MeSH Tree Structures](#)[Concepts](#)**MeSH Heading**

Obstetrics

Tree Number(s)

H02.403.810.450

Unique ID

D009774

RDF Unique Identifier<http://id.nlm.nih.gov/mesh/D009774>**Annotation**

specialty; do not use for "obstetric diseases" (= probably PREGNANCY COMPLICATIONS, etc.)

Scope Note

A medical-surgical specialty concerned with management and care of women during pregnancy, parturition, and the puerperium.

See Also

Obstetric Surgical Procedures

Pregnancy Complications

Date Established

1966/01/01

Date of Entry

1999/01/01

Revision Date

2008/07/08

page delivered in 0.128s

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Accessibility

Careers

National Library of Medicine

8600 Rockville Pike

Bethesda, MD 20894

Web Policies

FOIA

HHS Vulnerability Disclosure

Attachment 5G

General Surgery MeSH Descriptor Data 2025

[Details](#)[Qualifiers](#)[MeSH Tree Structures](#)[Concepts](#)**MeSH Heading**

General Surgery

Tree Number(s)

H02.403.810.300

Unique ID

D013502

RDF Unique Identifier

<http://id.nlm.nih.gov/mesh/D013502>

Annotation

use for the specialty only; prefer /surg with organs and diseases; use SURGICAL PROCEDURES, OPERATIVE or specifics for the surgery patient or surgical procedures

Scope Note

A specialty in which manual or operative procedures are used in the treatment of disease, injuries, or deformities.

Entry Term(s)

Surgery

See Also

Barber Surgeons

Surgical Procedures, Operative

Public MeSH Note

2009; see SURGERY 1974-2008

History Note

2009 (1974)

Date Established

1966/01/01

Date of Entry

1999/01/01

Revision Date

2015/06/23

page delivered in 0.133s

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Accessibility

Careers

National Library of Medicine

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Bethesda, MD 20894

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HHS Vulnerability Disclosure

Attachment 5H

Bibliographic Record - OCLC Number: 1766861

LDR	Record Status	'c' - Corrected or revised
	Type of Record	'a' - Language material
	Bibliographic Level	's' - Serial
	Type of Control	' ' - No specified type of control
	Encoding Level	' ' - Full level
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008	Date Entered on File	'751101'
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	Date1/Beginning Date of Publication	'1905'
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	Frequency	'm' - Monthly
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	Form of Item	' ' - None of the following
	Nature of Entire Work	' ' - No specified nature of entire work
	Nature of Contents	' '
	Government Publication	' ' - Not a government publication
	Conference Publication	'0' - Not a conference publication
	Original Alphabet or Script of Title	'a' - Basic Roman
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	Modified Record	' ' - Record is not modified
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 260 [Chicago], **\$b** [Franklin H. Martin Memorial Foundation, etc.]
 300 177 volumes **\$b** illustrations, color plates **\$c** 24-28 cm
 310 Monthly
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 338 volume **\$b** nc **\$2** rdacarrier
 362 0 v. 1-177, no. 6; July 1905-Dec. 1993.
 500 Editor: 1905-<19> F.H. Martin.
 510 2 Chemical abstracts **\$x** 0009-2258
 515 Issued in 2 vols. per year; six issues constitute a vol.
 550 Official scientific journal of the American College of Surgeons.
 555 Vols. 1-40, 1905-25. 1 v.; Vols. 41-80, 1925-45. 1 v.; Vols. 81-100, 1945-55. 1 v.; Vols. 101-110, 1955-60. 1 v.; Vols. 111-120, 1960-65. 1 v.; Vols. 121-130, 1965-70. 1 v.; Vols. 131-140, 1970-75. 1 v.
 650 0 Surgery **\$v** Periodicals.
 650 0 Gynecology **\$v** Periodicals.
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 650 2 General Surgery
 650 2 Gynecology
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710 2 Franklin H. Martin Memorial Foundation. **\$1** <https://id.oclc.org/worldcat/entity/E39QH7Jmrdhpj7kdvjfDKqgiRg>

710 2 American College of Surgeons. **\$1** <https://id.oclc.org/worldcat/entity/E39QH7JmpM7CdcGCBKmwk9mCp6>

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Attachment 3A

MARC Bibliographic Record

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500		\$aRefereed/Peer-reviewed
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588		\$aLatest issue consulted: Vol. 22, Issue 3 (Aug. 2005) (Elsevier T
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9911025916302121

Network Electronic IDs:

9911025916302121

Network Physical IDs:

Attachment 3B

MARC record

LC control no.: sh 85103669

LCCN

Permalink: <https://lcn.loc.gov/sh85103669> (link opens in a new tab)

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Attachment 3C

Podiatry MeSH Descriptor Data 2025

[Details](#) [Qualifiers](#) [MeSH Tree Structures](#) [Concepts](#)

MeSH Heading

Podiatry

Tree Number(s)

H02.696

Unique ID

D011032

RDF Unique Identifier

<http://id.nlm.nih.gov/mesh/D011032>

Annotation

for /educ, coordinate with medical education terms if pertinent

Scope Note

A specialty concerned with the diagnosis and treatment of foot disorders and injuries and anatomic defects of the foot.

Entry Term(s)

Chiroprody

NLM Classification

WE 890

See Also

Foot Diseases

Date Established

1966/01/01

Date of Entry

1999/01/01

Revision Date

2008/07/08

page delivered in 0.17s

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Accessibility

Careers

National Library of Medicine

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Web Policies

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HHS Vulnerability Disclosure

NLM | NIH | HHS | USA.gov

Attachment 3D

Bibliographic Record - OCLC Number: 13324960

LDR	Record Status	'c' - Corrected or revised
	Type of Record	'a' - Language material
	Bibliographic Level	's' - Serial
	Type of Control	' ' - No specified type of control
	Encoding Level	' ' - Full level
	Descriptive Cataloging Form	'a' - AACR2
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005	20251105200604.7	
008	Date Entered on File	'860321'
	Type of Date/Publication Status	'c' - Continuing resource currently published
	Date1/Beginning Date of Publication	'1986'
	Date2/Ending Date of Publication	'9999'
	Place of Publication, Production, or Execution Code	'pau' - Pennsylvania
	Frequency	'q' - Quarterly
	Regularity	'r' - Regular
	Type of Continuing Resource	' ' - None of the following
	Form of Original Item	' ' - None of the following
	Form of Item	' ' - None of the following
	Nature of Entire Work	' ' - No specified nature of entire work
	Nature of Contents	' '
	Government Publication	' ' - Not a government publication
	Conference Publication	'0' - Not a conference publication
	Original Alphabet or Script of Title	'a' - Basic Roman
	Entry Convention	'0' - Successive entry
	Language Code	'eng' - English
	Modified Record	' ' - Record is not modified
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 210 0 Clin. podiatr. med. surg.
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 245 0 0 Clinics in podiatric medicine and surgery.
 246 1 8 Podiatric medicine and surgery
 246 1 **\$i** Vols. for 2004- called: **\$a** Clinics in podiatric medicine and surgery of North America
 260 **\$3** 1986- : **\$a** Philadelphia : **\$b** W.B. Saunders, **\$c** ©1986-
 260 3 **\$3** <2014-> **\$a** New York, NY : **\$b** Elsevier Inc.
 300 18 volumes : **\$b** illustrations, portraits ; **\$c** 24 cm
 310 Quarterly
 336 text **\$b** txt **\$2** rdacontent
 337 unmediated **\$b** n **\$2** rdamedia
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 362 0 Vol. 3, no. 1 (Jan. 1986)-
 500 Each volume has also a distinctive title.
 530 Also issued online.
 650 0 Podiatry **\$v** Periodicals.
 650 0 Foot **\$x** Surgery **\$v** Periodicals.
 650 1 2 Podiatry.
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