

Surgical Strategies: The Lapidus Procedure

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BACKGROUND

In 1934, Paul W. Lapidus published his experience with an operation for the correction of hallux valgus that would later bear his name.¹⁰ He did not claim the originality of this operation and readily acknowledged many other surgeons had already reported similar approaches for hallux valgus. With this manuscript, Lapidus intended "to stress the mechanical importance of the metatarsus primus varus, as one of the most frequent and most prominent factors of the hallux valgus deformity." He described an operation composed of an arthrodesis of the first tarsometatarsal joint, the creation of a bony bridge between the bases of the first and second metatarsals and a distal soft-tissue release and repair similar to the Silver procedure that effectively corrected an atavistic "square foot" that he believed had a congenital predisposition toward hallux valgus. He emphasized the importance of resecting bone only from the lateral portion of the joint while denuding it of its articular cartilage to obtain acceptable correction of the deformity and a condition favorable for fusion.

Lapidus refined his indications and modified his operative technique over his career and reported these changes in two subsequent publications.^{11,12} Over time he concluded that only the subset of the patients with hallux valgus who manifested a fixed metatarsus primus varus and an intermetatarsal angle larger than 15 (later revised to larger than 10 to 12) degrees required more than a distal soft-tissue procedure. He reported his technique of obtaining an anteroposterior radiograph with the forefoot tightly bandaged to determine the mobility of the first tarsometatarsal joint. He found that leaving the cortical bone chips he had osteotomized from the first and second metatarsals and

adding bone morselized from the resected medial eminence fostered the formation of a robust bony synostosis that prevented recurrence of the metatarsus primus varus. Lapidus also learned that minimal resection of bone laterally from the joint was sufficient to correct the metatarsus primus varus and foster prompt union of the arthrodesis. He emphasized the importance of maintaining close apposition between the metatarsal and the medial cuneiform during preparation of the articular surfaces. He also began stabilizing his arthrodesis with an O chromic catgut suture placed from a bone tunnel in the dorsolateral base of the metatarsal to the dorsal ligaments overlying the first intercuneiform joint. In summarizing his 28-year experience with this procedure, Lapidus found the results "most gratifying."

MODIFICATIONS

Several authors have reported positive results with various modifications of Lapidus procedure.^{2,3,7,13,14,16} Many have offered techniques to maintain the length the first ray and to improve the stability of the arthrodesis. Giannestras⁷ and Buston² independently reported on the insertion of the resected medial eminence into the joint and fixation of the first metatarsal to the second metatarsal with Kirchner wires.^{2,7} Butson² reported 92% good or excellent results with no nonunions in his series of 119 feet performed with these modifications. However, 11 feet had persistence or new onset of a painful callus beneath the head of the second metatarsal. Sangeorzan and Hansen¹⁶ incorporated rigid screw fixation to allow earlier mobilization and to maintain the position of the metatarsal after surgery. They used a wedge-shaped tricortical bone graft from the iliac crest to restore length in patients with shortened metatarsals. They reported a nonunion rate of 10%, a revision rate of 13% and an overall failure rate of 20% in their preliminary study. They attributed the high rate of failure to the technical complexity and learning curve associated with the operation. Previously, Clark et al.³ reported more favorable results in adolescent bunions treated with the modified Lapidus procedure. Mauldin et al.¹⁴ circumvented shortening of the

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first ray by creating a rectangular trough across the joint which was filled with the bone from the medial eminence and the resected bone block. A Steinmann pin stabilized the arthrodesis. With this modification, they prevented transfer metatarsalgia and observed a 90% rate of satisfaction with the procedure. However, the authors could confirm definite trabecular bridging across the joint in only 25% of their patients.

The collective results of numerous recent reports indicate that the modified Lapidus procedure reliably and consistently corrects moderate to severe metatarsus primus varus and hallux valgus with a high rate of pain relief and satisfaction and a low incidence of recurrence and nonunion.^{1,4,6,9,15} A prospective study found less than a 1-degree increase in the intermetatarsal and hallux valgus angles over the first 4 years after the operation.⁴ In a large retrospective series of 201 cases, Thompson et al.¹⁷ reported a 4% nonunion rate and a 2% revision rate of for pain. The authors cited meticulous preparation of the joint with multiple fenestrations of the surface with a Kirschner wire, use of shear-strain relieved grafting (bone-filled recesses at the interface of the arthrodesis) with local autologous bone, and concomitant management of an equinus contracture with lengthening of the Achilles tendon or recession of the gastrocnemius tendon as possible explanations for their high rate of union.

CURRENT INDICATIONS AND CONTRAINDICATIONS

The Lapidus procedure is indicated for the correction of moderate to severe hallux valgus with metatarsus primus varus.⁵ It also is indicated for the correction of hallux valgus in adolescents with clinical findings of generalized ligamentous laxity³ and for the correction of associated hypermobility of the first ray as determined by physical and radiographic examination of the first tarsometatarsal joint with or without concomitant clinical signs of deficient weightbearing function of the first ray.¹ These coexistent signs could include transfer metatarsalgia to the second ray, presenting as a painful plantar keratosis beneath the second metatarsal head; synovitis of the second metatarsophalangeal joint with attenuation or rupture of the plantar plate with a supple or fixed hammertoe; or mechanical overload of the second ray, manifesting as cortical hypertrophy of the shaft or primary arthritis of the second tarsometatarsal joint. Also, the Lapidus procedure is a salvage operation for recurrent hallux valgus after prior operative treatment.⁵

This procedure is contraindicated in adults with arterial insufficiency, active infection, Charcot neuroarthropathy, or when noncompliance with the postoperative protocol is anticipated. Children with an open proximal physis of the first metatarsal should not have this procedure. The Lapidus procedure also is not indicated in patients with a short first metatarsal secondary to a congenital, traumatic, or postoperative etiology unless an ancillary procedure to



Fig. 1: A dorsal view of the foot demonstrating a 4-cm incision centered over the first tarsometatarsal joint and following the lateral border of the extensor hallucis longus tendon.

restore the length of the first ray is included. Patients with hallux valgus and arthritis or prior resection of the first metatarsophalangeal may not be candidates for this procedure because the results of combined arthrodesis of the first tarsometatarsal and metatarsophalangeal joints are unknown.

OPERATIVE TECHNIQUE

- The operation usually is performed as an outpatient procedure with a peripheral nerve block. The patient is placed supine on the operative table. A small bump beneath the ipsilateral buttock internally rotates the limb and positions the foot for the operation.
- The procedure is performed through a dorsal longitudinal incision centered over the first tarsometatarsal joint. The incision follows the lateral border of the extensor hallucis longus tendon. An incision 4 to 6 cm in length facilitates adequate exposure during the operation (Figure 1). The location of the joint may be determined by palpation along the subcutaneous dorsomedial border of the foot or by observation of motion at the joint while applying a dorsally directed force to the plantar aspect of the first metatarsal head.

- After the skin and subcutaneous fat have been incised, the interval between the tendons of extensor hallucis longus and the extensor hallucis brevis is identified through the thin, translucent retinacular fascia. The fascia is incised in line with the skin incision, and the two tendons are mobilized. The larger extensor hallucis longus tendon is released and retracted medially to expose the underlying joint. Dissection adjacent to the narrower tendon of the extensor hallucis brevis requires caution because of the close proximity of the dorsal pedis artery and the deep peroneal nerve. The neurovascular bundle is located immediately deep and lateral to this tendon and can be damaged during the exposure of the joint if the plane of deep dissection strays lateral to this tendon.
- With the tendons mobilized, the periosteum of the base of the first metatarsal and the medial cuneiform and capsule of the joint are exposed. These tissues are incised sharply and elevated as one continuous layer. The initial incision follows the dorsal ridge of the first metatarsal to the level of the joint and then angles slightly medial to remain centered over the medial cuneiform and avoid the first intercuneiform joint and the neurovascular bundle. The medial periosteal-capsular flap elevates easily with sharp dissection using the scalpel. This flap should be elevated completely to the plantar-medial aspect of the joint. This will allow better appreciation of the dorsal-to-plantar inclination of the joint during the debridement of the articular surfaces.
- Elevation of the lateral flap is not as extensive; however several factors are critical to the efficacy and safety of this phase of the dissection. The metaphyseal base and proximal shaft of the first metatarsal have a triangular shape with a steep, vertically oriented lateral cortex. Therefore, as the lateral periosteal-capsular flap is elevated off of the bone, the blade of the scalpel rapidly changes from a horizontal to a vertical orientation, aiming directly plantar into the webspace between the first and second metatarsals. If the blade does not follow the steep face of the lateral cortex, the first plantar branch of the dorsal pedis artery may be injured as it enters the webspace 1 to 2 cm distal to the level of the joint. As the elevation of the flap moves proximally and approaches the base of the first metatarsal, the webspace narrows and care must be taken not to injure the neurovascular bundle as the plane of dissection continues onto the medial cuneiform. Lateral dissection on the dorsal aspect of the medial cuneiform is minimal (2 to 3 mm) to avoid encroaching upon the first intercuneiform joint.
- The proximal articular surface of the first tarsometatarsal joint is resected as a biplanar, lateral, and plantar-based wedge osteotomy of the medial cuneiform. The osteotomy is made along the dorsal aspect of the cuneiform perpendicular to the longitudinal axis of



Fig. 2: A close-up view through the dorsal incision with the extensor tendon retracted of the lateral wedge osteotomy marked on the medial cuneiform. The planned cut will be perpendicular to the longitudinal axis, beginning from the articular margin medially and exiting 2 to 3 mm proximal to the joint line laterally.

this bone extending as a transverse line from the medial border of the bone (Figure 2). Because of the oblique orientation of the joint, this transverse line will exit the lateral border of the cuneiform approximately 2 mm proximal to the joint. When the osteotomy is made in this manner, the resultant lateral wedge will always provide full correction of the metatarsus primus varus deformity when the joint is positioned for arthrodesis. A small plantar wedge of bone also is removed from the cuneiform during the osteotomy to plantarflex the first metatarsal when the joint is positioned for arthrodesis. This maneuver maintains or restores proper weightbearing function to the first ray. Alternatively, the osteotomy can be performed without the plantar wedge of bone and the first metatarsal can be plantarly translated 2 to 3 mm relative to the medial cuneiform when the joint is positioned for arthrodesis. The osteotomy usually is performed with an oscillating saw using a long, narrow (4 × 1 cm) blade, however, hand osteotomes also may be employed (Figure 3).

- The articular cartilage is removed from the first metatarsal with small osteotomes. A flat surface ideally facilitates proper positioning and full apposition of the metatarsal with the cuneiform for arthrodesis (Figure 4). This is a deep joint, commonly measuring 3 cm in the dorsoplantar direction. The cartilage and bone should be



Fig. 3: Lateral and dorsal views illustrating the proper position of the saw blade to perform the biplanar osteotomy. **A**, The blade is slightly plantarflexed relative to the dorsoplantar axis of the joint to resect a wedge of bone that will be slightly thicker plantarly than dorsally. **B**, Keeping the blade perpendicular to the longitudinal axis is important to create a lateral bony wedge of proper thickness. The use of a narrow saw minimizes the risk of inadvertent excursion of the blade into the adjacent second metatarsal.



Fig. 4: With the osteomized bone removed from the joint, the anticipated correction of the metatarsus primus varus may be seen. Also, the dimensions of the fragment can be appreciated. It measured 12 mm in width and 28 mm in height.



Fig. 5: The pilot hole used for the insertion of a distal-to-proximal cortical lag screw has been prepared with a 4-mm burr on the dorsal cortex of the metatarsal. Placing the pilot hole at least 10 to 15 mm distal to the joint provides an adequate bone bridge to avoid fracture during axial compression of the arthrodesis with the screw.

Excessive debridement dorsally or failure to remove bone plantarly will dorsiflex the metatarsal when it is positioned for arthrodesis. The cartilage retained in the central concavity may be removed with small curettes. A small diameter Kirschner wire is used to fenestrate the subchondral bone to expedite union. A wafer of bone, 2 to 3 mm in thickness should be removed from the

debrided with long strokes of the osteotome from top to bottom to ensure an even resection of the surface.

lateral base of the metatarsal. The medial aspect of the second metatarsal is decorticated also to allow union with the lateral base of the first metatarsal. Narrowing the base allows the metatarsal to appose fully with the cuneiform without abutting the medial aspect of the second metatarsal.

- At this time, the distal soft tissue and bony procedures are performed. The tendon of the adductor hallucis and the lateral capsule of metatarsophalangeal joint are released through a small incision in the distal first webspace. Through a medial longitudinal incision centered over the metatarsophalangeal joint, the capsule is incised longitudinally, and a thin wafer of bone medial to the sagittal sulcus is resected. This resection accomplishes full correction of the hallux valgus because it permits the proximal phalanx to abduct on the metatarsal head and clear the sagittal sulcus without bony abutment when the metatarsus primus varus is corrected.
- The metatarsus primus varus and hallux valgus deformities may now be simultaneously corrected by applying a laterally directed force to the metatarsal head. This adduction maneuver apposes the metatarsal base to the osteotomized cuneiform, eradicating the former deformity. As the metatarsal head moves laterally, it reduces over the sesamoids, and the proximal phalanx abducts to eradicate the latter deformity. The tarsometatarsal arthrodesis is stabilized with a 3.5-mm cortical lag screw placed from a pilot hole made in the dorsal aspect of the metatarsal shaft as described by Hansen and Manoli

(Figure 5).^{8,13} This pilot hole is placed at least 1 cm distal to the joint, and the screw is directed parallel to the plantar surface of the foot and perpendicular to the joint to maximize compression (Figure 6). A second cortical lag screw is placed from the dorsolateral aspect of the medial cuneiform through the plantar cortex of the first metatarsal. Alternatively, a lag screw may be placed from the medial aspect of the metatarsal base into the second metatarsal (Figure 7).



Fig. 6: The distal-to-proximal cortical lag screw is inserted parallel to the sole of the foot to maximize the axial compression. A small Kocher clamp prevents unwanted rotation of the first metatarsal as the screw is tightened.

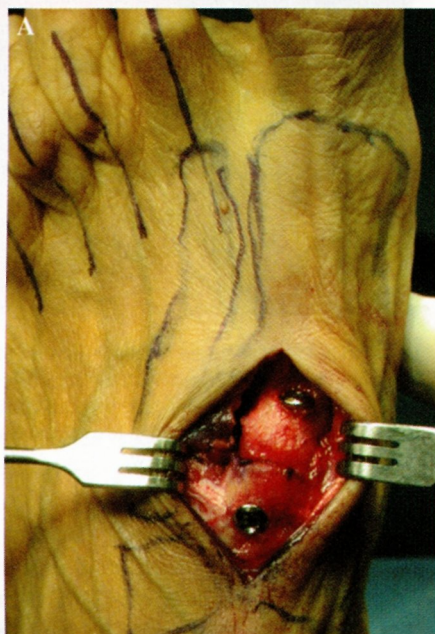


Fig. 7: The second cortical lag screw has been inserted proximal-to-distal and is situated lateral to the first screw (A). This configuration provides additional compression and rotational stability to the arthrodesis and ensures the maximal effect of the closing wedge osteotomy. The metatarsal has been translated 4 mm plantar to the cuneiform to maintain proper weightbearing function of the first ray (B).



Fig. 8: Anteroposterior and lateral radiographs of a 34-year-old woman with metatarsus primus varus and hallux valgus obtained before and 6 months after a Lapidus procedure. The position of the sesamoids, the intermetatarsal, and the hallux valgus angles are markedly improved. In this case, the tip of the distal-to-proximal screw enters the naviculocuneiform joint. When this occurs, it has never been found to produce pain or degeneration of the joint. No screw has ever been removed because of this event.

- The medial capsule of the metatarsophalangeal joint is repaired. True plication of the capsule usually is unnecessary. Aggressive plication of the capsule after full correction of the metatarsus primus varus with the Lapidus procedure could create hallux varus. For the same reason, the hallux is not dressed or taped to produce a varus force on the metatarsophalangeal joint postoperatively.
- Postoperatively, the limb is immobilized in a short-leg splint with medial and lateral side slabs. The splint and sutures are removed 2 weeks after surgery, and the limb is placed into a short leg nonweightbearing cast. At 4 weeks after surgery, radiographs are obtained to confirm union of the arthrodesis. The patient is allowed to progressively bear weight in a commercial walking boot. Physical therapy is prescribed. Modalities to

reduce edema, mobilization of the metatarsophalangeal joint, strengthening of plantarflexion of the first ray and restoration of a heel-to-toe gait are emphasized. The patient transitions to conventional shoes by 8 to 10 weeks after surgery. At 3 months, the patient is encouraged to continue a program of independent exercise at home and is released to full activities (Figure 8).

SUMMARY

The Lapidus procedure is a powerful technique for correcting metatarsus primus varus and hallux valgus. Modification and modernization of the operative technique and the introduction of rigid internal fixation with multiple lag

screws has improved the reliability of healing and correction with this procedure.

The main advantage of the Lapidus procedure is its capacity to correct four deformities in three different planes simultaneously. The biplanar osteotomy of the medial cuneiform corrects the metatarsus primus varus and hallux valgus in the medial plane, allows plantar translation or angulation in the sagittal plane and corrects pronation of the toe in the axial plane when the metatarsal is positioned for arthrodesis. Another advantage is that this procedure can be used to salvage the failed operative correction of hallux valgus with good functional outcomes. Also, the postoperative management is minimal. Frequent painstaking dressing changes, with taping or strapping of the hallux to maintain the correction, are unnecessary.

Disadvantages of the Lapidus procedure include the need for an arthrodesis. However, the tarsometatarsal joint is not an essential articulation for accommodative motion or for the dissipation of the shear forces associated with weightbearing. Finally, the Lapidus procedure is a technically demanding operation. Several pitfalls must be avoided to achieve optimal results. Attention to detail and patience will prevent complications for the patient and frustration for the surgeon.

In conclusion, the Lapidus procedure should be considered for the management of moderate to severe metatarsus primus varus and hallux valgus and hypermobility of the first ray.

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