Addressing The Impact Of Frontal Plane Rotation On Bunion Repair

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Emphasizing frontal plane correction with the modified Lapidus arthrodesis reportedly offers an array of benefits including the restoration of normal or near normal anatomic alignment, improved first MPJ range of motion, and a reduced risk of complications. These authors share pearls from their experience with this approach and discuss key insights from the literature.

When a foot and ankle surgeon faces a preoperative hallux abducto valgus correction, he or she must decide which surgical procedure would be most beneficial to perform. In the podiatric and orthopedic literature, there have been more than 130 different surgical procedures to choose from.

The modified Lapidus arthrodesis is a powerful procedure that enables surgeons to address a multitude of first ray pathologic entities for hallux abducto valgus correction. The procedure is capable of correcting a hallux abducto valgus deformity in three planes.[1-3] The Lapidus arthrodesis has also been known to affect the medial longitudinal arch height.[4] By performing the modified Lapidus arthrodesis, one can easily measure transverse and sagittal plane correction radiographically using the metatarsus primus adductus angle, the first metatarsal declination angle, the lateral talo-first metatarsal angle and the Seiberg index. The frontal plane correction is not as easy to measure.

With an emphasis on the frontal plane during surgical correction, we are able to correct all three planes of the deformity adequately with good reduction, which is identifiable clinically as well as radiographically. The reduction of the frontal plane will in turn assist in restoring near normal or normal anatomic alignment in three planes without having to perform any surgery on the first metatarsophalangeal joint (MPJ).

Indications for the Lapidus procedure include hallux abducto valgus deformities, arthritis, hypermobility, ligamentous laxity and recurrent hallux valgus.[5] Researchers have also described the procedure for use in patients with hallux limitus as it can decompress the joint in combination with a cheilectomy.[4] Contraindications of the procedure may include concurrent arthritis of the first MPJ and an open physes.[6] Potential benefits include the procedure's ability to address the deformity at its apex as well as allowing for a more efficient peroneus longus tendon.[4] Avino and colleagues have also shown the Lapidus procedure to be an effective stabilizer of the medial column.[7] There are a variety of fixation constructs including plates, screws, pins and a combination thereof.

Emphasizing Triplane Correction

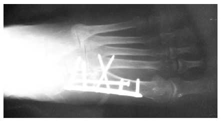
However, preoperative clinical as well as radiographic assessment typically center around the transverse and the sagittal plane while surgeons pay the least attention to the frontal plane deformity.

The traditional decision making process for the correction of hallux abducto valgus deformities has been based on static anterior-posterior radiographs and multiple radiograph-measured parameters. Often, there is a lack of identifying that this condition is a dynamic three-plane deformity. In particular, there is typically a significant valgus rotation (pronation) that occurs about the first metatarsal and great toe in the frontal plane. This is typically associated with hypermobility/instability of the first ray, which also results in an increase in deformity in the sagittal and transverse planes, which leads to a hallux abducto valgus deformity.

Based on our experience, the Lapidus bunionectomy is the only surgical procedure that allows for correction in all three planes (transverse, sagittal and frontal) of the deformity. For this article, we will demonstrate the advantages of emphasizing the frontal plane correction while also correcting the transverse and sagittal planes without surgical intervention about the first MPJ while performing a Lapidus bunionectomy. The advantages of this technique are limiting the potential complications such as hallux varus, staking of the medial eminence, neuritis, avascular necrosis of the first metatarsal head, postoperative stiffness at the first MPJ, scar formation and increased morbidity. The advantages are restoring normal or near normal anatomical alignment; repositioning the sesamoids under the first metatarsal; improved range of motion of the first MPJ; better cosmesis; less surgical dissection; and a quicker and friendlier postoperative course for the patient.

When reconstructing the first ray using the Lapidus procedure, one should consider one of the key components to be relocation of the sesamoid bones under the first metatarsal with frontal plane rotation. This technique emphasizes sesamoid reduction through indirect frontal plane manipulation for correction of a hallux abducto valgus deformity.

For this technique, we utilize the intact soft tissues about the first MPJ to reduce subluxed/displaced sesamoids. The sesamoid apparatus of the first MPJ consists of the two sesamoid bones enclosed with a thick plantar plate and connected by an interosseous ligament. The sesamoids are attached to the distal first metatarsal by medial and lateral metatarsosesamoid ligaments. The suspensory ligaments are connected to the proximal phalanx of the great toe by medial and lateral sesamophalangeal ligaments. The sesamoid apparatus is also encased by a nonarticular plantar surface of the flexor hallucis brevis, transverse and oblique segments of the adductor hallucis, the deep transverse metatarsal ligament, and fibers of the plantar aponeurosis. The tibial and fibular sesamoids are synovial joints with hyaline cartilage interfaces.[8,9]



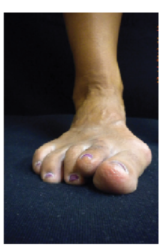
Due to this natural anatomic apparatus, manual reduction of the frontal plane rotation of the first ray can reliably reduce the sesamoids under the first metatarsal head, leaving the soft tissues intact. This differs from the translational approach, which relies on resection of the lateral soft tissue structures to translate into the transverse plane. The lateral release destabilizes the joint, making it more vulnerable to complications. Additionally, the standard techniques using typical AP radiographs provide static views of the deformity and do not foster consideration of the dynamic effects of the soft tissue around the osseous structures.

Key Insights On Surgical Technique

Make an approximate 4 cm incision over the first tarsometatarsal joint. Resect the tarsometatarsal ligaments. There is no need for periosteal stripping. After ensuring adequate joint exposure, destabilize and distract the joint. Prepare the joint for arthrodesis using a combination of a power saw, osteotome, mallet, drills and picks to ensure good subchondral bone exposure. There is no dissection of the first MPJ, eliminating the need for a medial eminence resection or a lateral release. This also reduces the risks of potential complications as we described earlier.

Perform the reduction by derotating the hallux and first metatarsal out of the valgus position into a varus direction. Following the reduction, the great toe should maintain a neutral position. (If there is callus tissue on the medial condyle of the great toe, once one reduces this to a neutral position, it will offload the condyle and the nail plate should be parallel with the ground.) The surgeon then dorsiflexes the great toe while maintaining frontal plane alignment, enabling correction of the sagittal plane. Additionally, the first metatarsal goes into adduction, thus correcting the transverse plane. This is one maneuver that occurs at the same time in all three planes.

If additional transverse plane correction is needed to close down the intermetatarsal angle, use a large Weber clamp to assist in reducing the intermetatarsal angle. This maneuver should allow for the entire great toe, sesamoid and first metatarsal complex to rotate into a neutral position as one unit. One can view the sesamoid correction via fluoroscopy.



Temporarily pin the first tarsometatarsal joint with a K-wire from dorsally and distally to plantarly and proximally, and from the first metatarsal into the second metatarsal. If additional frontal plane rotation is needed, back out the K-wires and place a 2.0 K-wire in the shaft of the first metatarsal perpendicular to the weightbearing surface, using the K-wires as a "joystick." Reintroduce the original K-wires for temporary stabilization.

Proceed to check the anatomic alignment via fluoroscopy to ascertain if there is adequate reduction. If this is the case, achieve definitive fixation with a 3.5 mm cortical screw, introducing it with a lag technique in a "home run" fashion as Hansen described.[3] The screw should be as long as possible from anteriorly to posteriorly and should engage the posterior cortex of the medial cuneiform. One should also apply a medial based plate. This plate can function as a “large washer” in reducing the intermetatarsal angle with the insertion of a lag screw from the base of the first metatarsal into the second metatarsal base.

Contrary to the original description of the Lapidus procedure, the senior author does not perform distal soft tissue or bony procedures. The senior author has found that adequate frontal plane reduction of the sesamoid apparatus under the metatarsal head can occur with manual manipulation and ligamentotaxis once one has achieved joint resection of the first tarsometatarsal joint. Correcting the rotational, frontal plane component of the deformity can place the sesamoids into anatomic alignment in the sesamoidal grooves. This negates the need for translation via a lateral soft tissue release, which primarily depends on the transverse plane for correction.[10]

Dayton and colleagues noted that abnormalities in the tibial sesamoid position are again partially a reflection of the valgus rotation of the metatarsal in addition to the transverse translation.[11] Avoiding a lateral release with this technique eliminates the potential for scar formation and the possibility for avascular necrosis to the first metatarsal head secondary to disruption of the vascular supply, etc. The senior author also avoids the medial eminence resection. Experience has shown that there is no true “large medial eminence” but rather a rotated first metatarsal head (in valgus) that appears to project on a static AP radiograph as a large medial eminence. Intraoperatively, when the first metatarsal rotates out of valgus into a neutral position, the appearance of the “large medial eminence” is no longer apparent on a static AP radiograph.

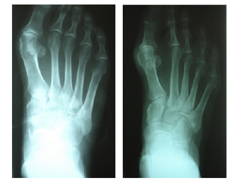
After correcting the frontal plane, there should not be a need to perform a resection of the medial eminence as most of the enlargement is secondary to hypertrophied capsule. Unfortunately, it takes several weeks for the soft tissue adaptation to occur. Therefore, at the time of surgery, the surgeon must rely on experience and intraoperative radiographs in order to avoid habitual training of entering the first MPJ. Also, by rotating the first metatarsal into anatomic position in the frontal plane, the medial eminence, the shape of the first metatarsal head as well as apparent changes in the proximal articular set angle (PASA) are more anatomic. Hence, these “pathologic findings” often appear on a static AP radiographic projection of a malaligned first ray in the valgus position.

Dayton and colleagues also noted that it is the “third plane of deformity,” the frontal plane, which typically alters the appearance of the metatarsal head.[11] Surgeons rarely address the PASA as they feel that the valgus position of the metatarsal is what provides the appearance of an abnormal PASA. Once the metatarsal is in a neutral alignment, this typically eliminates the appearance of PASA.

We also noted that where most distal, midshaft and basilar osteotomies provide mainly transverse plane correction, the Lapidus can provide correction in all three planes at the center of rotation of angulation (CORA) as introduced by Paley and colleagues.[12] When the surgeon does not take the center of rotation of angulation into consideration, one creates a secondary deformity and essentially a new center of rotation of angulation without addressing the apex of the original deformity.[11,13] We feel the modified Lapidus arthrodesis is the treatment of choice for most hallux abducto valgus deformities in which one can achieve triplane correction with predictable long-term outcomes.

What The Literature Reveals

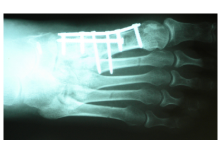
A recent survey of 105 academic foot and ankle surgeons in the United States showed a variation in surgical approaches for a clinical case scenario involving a symptomatic, severe bunion deformity with an intermetatarsal angle greater than 20 degrees.[14] More than 52 percent of the polled surgeons selected a metatarsal osteotomy as their procedure of choice, 26 percent selected MPJ arthrodesis and 24 percent chose a Lapidus arthrodesis. There was also a high likelihood of lateral release with 90 percent of the surgeon respondents incorporating this into their approach.



Why is there such variation with procedure selection? Does it pertain to surgeon experience, the technical aspect of the procedure, concern for nonunion or lack of a predictable construct? In the senior author's experience, the Lapidus arthrodesis is a predictable procedure that is able to correct the deformity at its apex and maintain long-term correction.

Coetzee and Wickum reported on 91 patients who had a Lapidus arthrodesis.[15] In a one- to 3.7-year follow-up period, patients maintained the correction well with an average increase in the intermetatarsal angle of 0.3 degrees. Klemola and coworkers recently reported on 66 patients (84 feet) who had a modified derotational Lapidus technique as outlined by Dayton and DiDomenico without addressing the first MPJ.[10,11,16] They noted that once they achieved correction, the first metatarsal had reduced back over top of the sesamoid apparatus, the hallux abducto valgus angle was reduced, stability of the first ray was visible with congruence at the first MPJ and the prominent medial eminence disappeared.

Dayton and coworkers reported on 25 feet in 24 patients who had a frontal plane rotational Lapidus procedure.[11] Their surgical technique did involve a lateral capsulotomy/lateral sesamoid ligament release through a medial approach but the surgeons performed no other distal soft tissue procedures. The mean change in the intermetatarsal angle was 10.1 degrees, the mean change in the PASA was 18.7 degrees and the mean change in the tibial sesamoid position was 3.8 degrees. Okuda and colleagues reported on 11 patients (12 feet) who had a proximal abduction-supination osteotomy of the proximal first metatarsal. Surgeons performed a distal soft tissue release in addition to the index procedure. There was a significant decrease in the intermetatarsal angle pre- and postoperatively from 14.0 to 6.2 degrees respectively.[17]



As we stated previously, a lateral release is not a routine part of our hallux abducto valgus correction. Lee and coworkers compared hallux abducto valgus patients who had a distal chevron procedure with and without a distal interspace release.[18] They found no difference postoperatively in radiographic assessment or American Orthopedic Foot and Ankle Society (AOFAS) scores, but there was a statistical difference with regard to decreased first MPJ range of motion in the group that had a lateral release.

In Summary

It is the senior author's opinion that hallux abducto valgus is a three-plane deformity with the frontal plane often going overlooked. We have outlined our surgical technique for a modified Lapidus arthrodesis with a focus on the frontal plane for hallux abducto valgus correction. In order to obtain a long-term predictable good surgical result, one must correct the triplane deformity with a primary focus on the frontal plane, which is an essential component of the correction.

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