CHAPTER **34**

MINIMALLY INVASIVE LAPIDUS PROCEDURE

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INTRODUCTION

First metatarsocunieform arthrodesis has been described for patients with hallux valgus and a significant intermetatarsal angle (>15 degrees).[1] Lapidus first described the concept of an atavistic medial cuneiform that promotes separation between the first and second metatarsal.[2] This deformity was remedied by resection and stabilization of the first tarsometatarsal joint (TMTJ). The concept of hypermobility was recognized much later and has evolved into a controversial topic because the definition and identification of patients herewith are difficult to synchronize.[3,4] Irrespective of one's individual identification of hypermobility, the Lapidus fusion has become a common procedure to address a hypermobile first ray.[1]

The operation is typically performed from a longitudinal dorsomedial approach to facilitate correction of the pathology at the first metatarsophalangeal joint (MTPJ), and delivery of fixation. Although most surgeons routinely perform a lateral release in conjunction with the resection of the prominent medial eminence, it is becoming more accepted to simply reduce the intermetatarsal angle to near 0 degrees with the expectation that the first metatarsal head will relocate over the static sesamoid complex with lateralization of the first metatarsal. Although untested, it is axiomatic that this strategy may be more useful in patients that have not had the index deformity for a prolonged period of time. The concomitant hypermobility may contribute to the reducibility of the deformity without formal invasion of the first metatarsophalangeal joint (DiDomenico LA: personal communication).

There are other situations besides hallux valgus where a fusion of the first TMTJ may be indicated. These include idiopathic or post-traumatic arthritis of the first metatarsocuneiform joint, isolated second metatarsal overload syndrome, iatrogenic elevation of the first metatarsal, failed bunion surgery with previously unrecognized hypermobility, and stage I hallux rigidus with dorsal hypermobility of the first ray.[5,6] In all of these situations, it is often unnecessary to invade the first MTPJ. Accordingly, the concomitant extensive surgical exposure can be eliminated by a more focused and minimal approach to the first TMTJ. We hereby present the technique known as the minimally invasive Lapidus fusion.

TECHNIQUE

The operation is executed with the patient in the supine position just as in traditional hallux valgus surgery. The surgical incision is made directly medial, over the first MTCJ in line with the long axis of the first metatarsal (Figure 1). The fascia over the joint overlies the insertion of the tibialis anterior and obscures the visualization of the articular surfaces. Palpation with a blunt instrument will identify the level of the articular surfaces. The joint is entered with a vertical incision through the tibialis anterior tendon and joint capsule. The tendon complex is reflected distally and proximally a short distance to expose the dorsal and plantar ligaments of the joint complex. These ligaments are severed to mobilize the first metatarsal (Figure 2).

The surgeon then places one thumb on the medial aspect of the first metatarsal head and pushes the entire metatarsal toward the second metatarsal head until full resistance is met (Figure 3). This maneuver should open the first MTCJ medially. While the lateral-ward pressure is maintained on the metatarsal, the surgeon uses the other hand to resect the first MTCJ with an oscillating saw. The saw is placed into the medial crevice and advanced to the lateral aspect of the joint. The lateral cortex is penetrated, but not advanced further, in order to avoid the deep plantar artery branch from the dorsalis pedis (Figure 4). This maneuver is repeated 3-4 times so that the cartilage and subchondral bone plate are completely removed.[7]

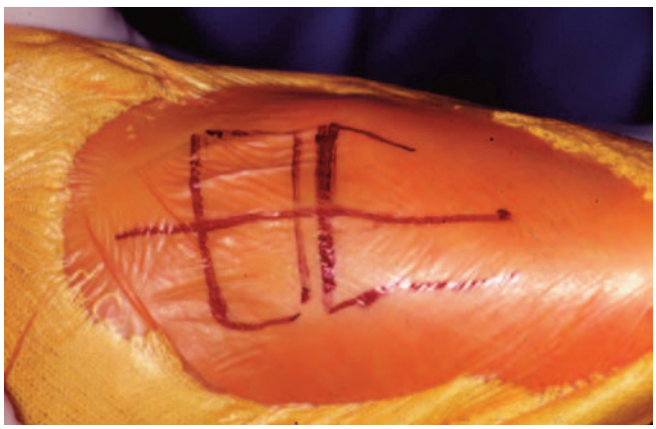

Figure 1. Intraoperative photograph showing the proposed incision along the medial midline.

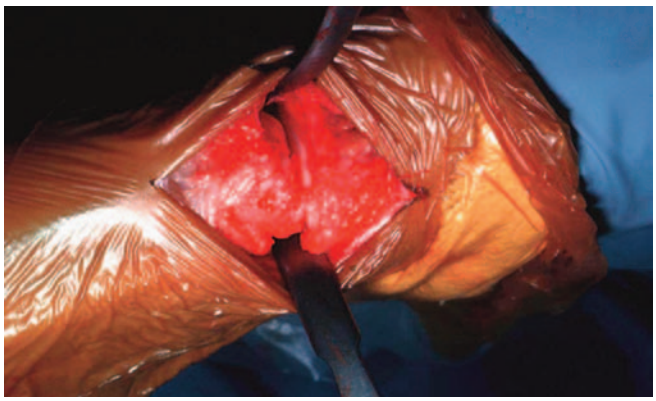

Figure 2. Intraoperative exposure of a different patient with full visualization of the joint.

Figure 3. Note the displacement of the joint as the metatarsal is pushed laterally. In this patient resection of the medial eminence was required so the incision was extended.

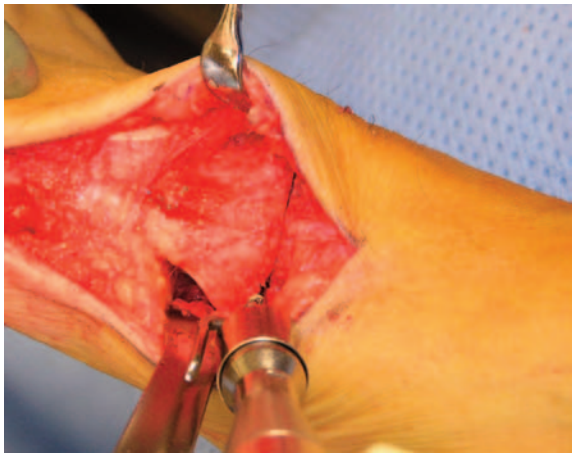

Figure 4. Same patient as Figure 3 showing the maneuver to resect the articular cartilage while the correction is being maintained manually.

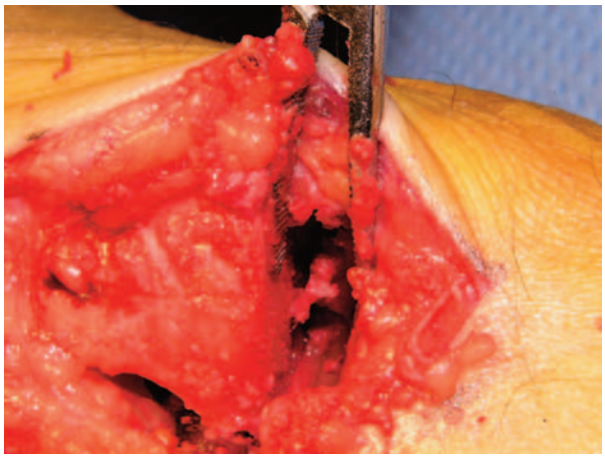

Figure 5. Final joint preparation

Occasionally the remaining articular components on the medial aspect of the joint are removed by reciprocal planning. However there is always less bone removed medially. As such, the subchondral plate may be partially visible at the medial most aspect of the joint. This is acceptable provided that there is ample cancellous substrate throughout the rest of the joint.

It is important during each of the sequential resection maneuvers to allow the excursion of the saw blade to pass dorsal and plantar to the cubic content of the bone so that the saw blade does not bind up. If the saw blade excursion is dampened, the surgeon will be unable to determine penetration of the lateral boundary of the bone mass and risk injury to the deep plantar vessel. This will also ensure a flat planar surface of resection and avoid spurious dorsal or plantar flexion of the metatarsal. Furthermore, saline lavage is utilized to avoid excessive heat build-up during the joint preparation technique. The resected surfaces are carefully inspected to assure exposure of raw cancellous bone (Figure 5). Intraoperative fluoroscopy is utilized to determine the adequacy of correction and quality of apposition of the resected surfaces. If further refinements are necessary they are performed with a rotating burr or saw. Once the preparation is deemed satisfactory, temporary fixation is provided with a Kirschner-wire, strategically placed to avoid collision with the permanent fixatives (Figure 6).

Fixation of the construct is typically with lag screws. Although we prefer the use of solid core screws, cannulated screws can be employed. The most commonly used construct for fixation of the Lapidus fusion is based on preservation of the intact subchondral bone plates on either side of the fusion.[8,9] Yet delivery of the screws in this fashion requires an extensive and dorsal exposure, not afforded by the minimally invasive technique. Furthermore, the removal of the subchondral plate may make this construct less mechanically stable. Accordingly, the minimally invasive, medial exposure allows for the insertion of a plantar medial screw in an oblique fashion across the fusion interface. Either

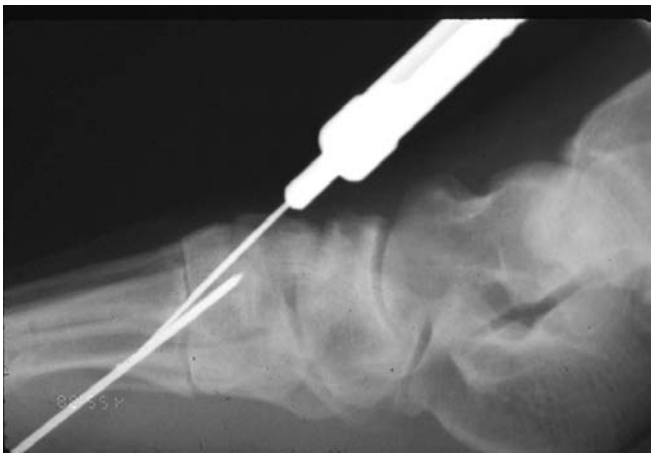

Figure 6. Intraoperative radiograph with temporary fixation. The plantar K-wire will be replaced by a partially threaded cancellous screw.

a partially or fully threaded screw can be utilized. The insertion point is the medial plantar metaphyseal flare and the target is the dorsal lateral corner of the first cuneiform. The second screw is delivered in a percutaneous fashion from the most proximal aspect of the dorsal midline of the cuneiform and directed toward the plantar surface of the first metatarsal base (Figure 7).

The percutaneous technique may require flurosocopy to assure the proper insertion point as the proximal joint line may not be palpable through the skin. A small stab incision is placed over the joint line and a 3.5 mm drill sleeve is inserted in an oblique fashion onto the dorsal surface of the cuneiform. The sleeve should either avoid or brush aside the tendon sheath of the extensor hallucis longus tendon. The drill is directed towards the plantar metatarsal base and advanced until it penetrates the distal pole of the cuneiform. A 2.5 mm drill is then inserted into the channel and further advanced to penetrate the plantar surface of the first metatarsal. Countersinking is not recommended, as the bone usually succumbs to the pressure generated by tightening of the screw. Once the proper length of screw is determined, the distal channel is tapped and the screw is inserted (Figure 7). Final apposition and stability are checked visually and fluorscopically.

Closure is rather routine except for the re-approximation of the fascial expansion of the insertion of the tibialis anterior. Unless inadvertent detachment of the insertion of the tendon from overzealous dissection has occurred, the chance of dorsiflexion dysfunction is almost nil (Figure 8).

POSTOPERATIVE CARE

The postoperative regimen for the minimally invasive Lapidus is identical to that for the traditional technique. Although historically many surgeons have advocated a

Figure 7A. Dorsoplantar radiograph demonstrating the optimal position of the screws. Note the medial eminence was not resected and the sesamoids have been relocated.

Figure 7B. Lateral view of same patient.

period of non-weight bearing up to 6 weeks, some have lessened this period of time, contending that the stability of the construct enables such a policy. However the effect on the union rate with less than 6 weeks of non-weight bearing has not been established. As such, we still recommend the obligate period of non-weight bearing. Early range of motion of the first MTPJ can be initiated during the period of convalescence.

DISCUSSION

The use of the minimally invasive technique from an intuitive standpoint is appealing. Even with modern techniques of anatomic dissection, each surgical maneuver of altering the tissue such as periosteal elevation or division of the fascial planes, requires a healing response by the patient. If one can minimize the absolute surgical trauma by far less dissection,

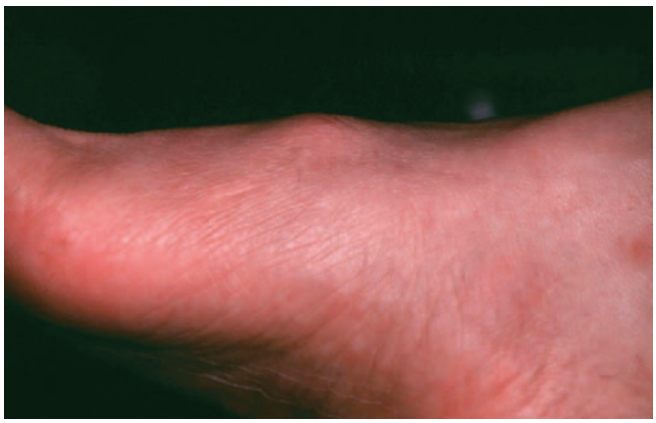

Figure 8A. Preoperative photograph of patient with post-traumatic arthritis of the first TMTJ.

Figure 8B. Postoperative photograph with the minimally invasive technique and the resultant incisional scar.

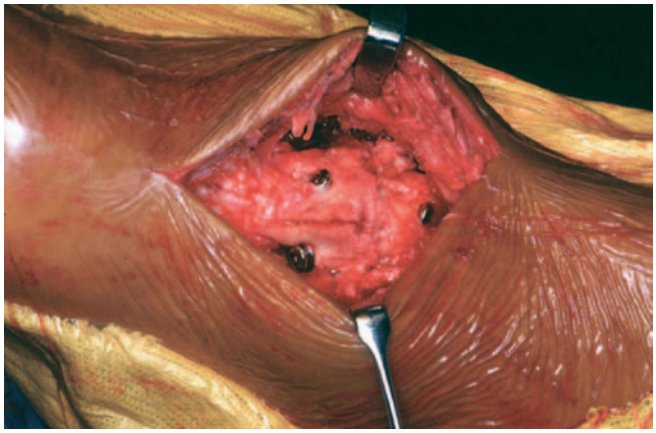

Figure 9. Intraoperative photograph showing the final construct with an additional screw. Note the short lever arm with placement of the screws. In this arrangement, the bending at the fusion interface is dampened.

then the overall healing process will be lessened in both intensity and duration. This technique affords the surgeon the opportunity to impart stability to the first metatarsocuneiform joint without the extensive exposure that many authors advocate,[9-12] and is consistent with the increasing utility of minimally invasive approaches. Although large planar deviations are probably best addressed through the more extensive approach, with experience, the lateral side of the joint can be sculpted to correct larger intermetatarsal angles.

The published union rate for the Lapidus procedure ranges from 3.3-2%.[10-15] Although there are many variables that may account for this wide range of non-unions, the rates are determined from the standard extensive approach. The most pertinent variables are the joint preparation technique and the fixation construct. The union rate deserves further study and perhaps modifications of the techniques to lower the incidence of same. The minimally invasive approach may be one such modification for 3 fundamental reasons. First the effect of a more extensive exposure logically increases the probability that blood supply to the fusion mass will be compromised. Second, the stability of the modern fixation construct is predicated on "long" screws.[8] Upon examination of simple lever arm mechanics, the enhanced stability afforded by longer screws applies only if there is preservation of the subchondral plate, because the stress on the screw decreases precipitously with 2 cortical bone fixation points in close juxtaposition to the potential point of failure (the fusion interface). Shorter screws inserted closer to the flexure point, without subchondral bone interposition, lessens the stress on the screws as the fusion mass is subjected to cyclical load (weight bearing) (Figure 9). Lastly, the plantar anchor point for one of the screws is more capable of resisting plantar gapping with cyclical load. Mechanical testing with cyclical loading rather than load to failure, with each of these philosophies, may resolve the issue, and in effect determine the capacity for early weight bearing.

The third factor that may impact the union rate is the preservation of the subchondral bone plate. It has been shown that simple curettage may leave cartilaginous remnants at the fusion interface. Further the vascularity of cortical bone is decidedly less than raw exposed cancellous bone. It follows that union is more favorable with a more vascular substrate. The minimal stripping of the soft tissues, shorter screws inserted closer to the flexure point, and resection of the subchondral bone plate may increase the overall union rate.

The technique presented herein also offers a distinct advantage in determining the ultimate position of the first ray. With the curettage technique, preservation of the surface contour is an integral part of joint preparation. As such, the intermetatarsal angle is reduced by a lateral shift of the metatarsal on the cuneiform. If the joint has excessive medial deviation, the intermetatarsal correction may be less than

desired. The surgeon then must further refine the lateral side of the joint to improve correction. With our technique, the lateral aspect of the joint is removed by subsequent and incremental passes of the saw blade from medial to lateral. Furthermore, the manual positioning of the first metatarsal head against the second metatarsal prior to joint resection typically results in an intermetatarsal angle at or near zero degrees. The degree of shortening of the first ray is probably comparable to the curettage technique but currently there is no data to support this contention. Lastly the medial exposure allows for excellent access and visualization of the plantar confines of the joint, which is often obscured from a dorsal exposure. With the dorsal exposure, wide distraction of the joint is often needed to facilitate passage of the surgical instruments to the plantar aspect of the joint. In some cases, inadequate preparation leads to spurious elevation of the metatarsal.

Although this technique is not suitable for all conditions that require fusion of the first TMTJ, the fundamental concepts of minimal stripping of the soft tissues, rigid fixation and adequate joint preparation are upheld. Further study and experience is necessary to determine the overall union rate and expansion of the indications.

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