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# Can We Abandon Saw Wedge Resection in Lapidus Fusion? A Comparative Study of Joint Preparation Techniques Regarding Correction of Deformity, Union Rate, and Preservation of First Ray Length

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ABSTRACT

The traditional joint preparation technique for Lapidus fusion involves wedge resection using a saw to achieve correction of intermetatarsal angular deformity. The main drawback of this approach is undesirable shortening of the first ray, which can predispose to second ray overload that may preclude the procedure for a subset of patients or may necessitate second metatarsal shortening osteotomy. The goal of this study was to determine whether a first ray length-preserving joint preparation technique (curette and bur) achieves equivalent correction of deformity and fusion rate without first ray shortening compared with the standard saw wedge resection technique. A retrospective review of consecutive cases from January 2007 to August 2014 identified 62 patients who underwent 65 Lapidus fusions for hallux valgus correction with crossed-screw fixation. All patients treated from 2007 to 2010 had saw wedge resection, whereas all patients treated from 2011 to 2014 had curette and bur joint preparation without use of a saw. The mean intermetatarsal angle correction was 9.06° (range 5° to 14.7°) in the saw wedge resection group and 8.11° (range 2.8° to 15.5°) in the curette and bur group, a difference that was not statistically significant. The mean amount of first ray shortening was −3.14 (range −6.1 to 0) mm in the saw wedge resection group and −0.86 (range −2.3 to 4.2) mm in the curette and bur group, a result that was statistically significant. Osseous union was confirmed radiographically at 10 weeks postoperatively in all cases. These findings suggest that first ray length can be preserved using a more conservative joint preparation technique regardless of preoperative deformity, without compromising correction of deformity or union rate.



First metatarsocuneiform joint (MCJ) fusion was popularized by Lapidus in 1934 for hallux valgus correction in patients with a first intermetatarsal angle (IMA) >15° (1,2). Lapidus advocated for correction of hallux valgus at the apex of the deformity, which he believed was the first MCJ (2). Commonly, Lapidus fusion is recommended with a moderate to severe hallux valgus deformity and has been the procedure of choice when first ray hypermobility is present (3-9). The traditional joint preparation approach for Lapidus fusion involves resection of the articular cartilage, often including some form of wedge resection using a saw to obtain desired IMA correction. Fixation is typically achieved with crossing screw fixation, but there is a trend toward locking plate fixation owing to a desire to allow early weightbearing or improve the union rate (10-15).

The Lapidus procedure is avoided by some surgeons because of a real or perceived high complication rate related to nonunion and loss of first ray length (2-7,9,10,12,16-19). Nonunion rates up to 12% with varying types of fixation and joint preparation have been reported (3). A previous meta-analysis found a 5% nonunion rate in 537 patients who underwent Lapidus fusion using a consistent surgical technique including screw fixation (4). Loss of metatarsal protrusion distance (MPD) ranges from 3 to 7 mm in current studies (3,4,19,20). The primary concern with loss of first ray length is second ray overload, which is often a component of preoperative symptoms. A second metatarsal shortening osteotomy is often performed adjunctively when there is a preexisting short first ray or preexisting second ray overload, or when the surgeon is concerned about loss of first ray length when viewing intraoperative images.

A number of procedure modifications have been described to address loss of first ray length when performing Lapidus fusion, including placement of autograft within the fusion site, joint curettage instead of saw wedge resection, and plantar transposition of the first metatarsal through the fusion site. A study performed in 2011 attempted to quantify the amount of shortening both with and without the use of the medial eminence as an autograft placed within the first MCJ (21). Joint preparation

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**Fig. 1.** Comparison of atavistic (A) versus curved (B) medial cuneiform anatomy. Lapidus believed that an atavistic medial cuneiform predisposed the first ray to varus deformation, which led to the development of hallux valgus (2,24).

was performed using a saw to resect the cartilage and subchondral bone plate. The authors reported a mean standard deviation loss of 5.3 ± 1.66 mm of first ray length when no autograft was used, and 2.69 ± 1.56 mm of shortening with use of autograft, a result that was significantly different. The autograft was successful in helping to preserve first ray length; however, a 4.3% rate of bone healing complications was noted in the autograft group, including 1 malunion and 1 delayed union. There were no bone healing complications in the nonautograft group.

Joint curettage is a common method used to prepare the first MCJ for fusion (3,4,6,9,17,22,23). However, surgeons tend to avoid this technique in patients who have rigid midfoot deformity, high IMA, or what Lapidus described as atavistic cuneiform anatomy (Fig. 1) (2,24). When one or more of these factors are present, surgeons fear that they will not achieve desired correction of transverse plane deformity without saw wedge resection. Patients who present with concomitant high IMA and a preexisting short first ray may not be considered for Lapidus fusion by some surgeons because of a lack of confidence regarding ability to preserve first ray length with saw wedge resection. The tendency is to push the limits of deformity correction with more distal procedures for this challenging patient population, including distal metatarsal osteotomy, base wedge osteotomy, or first metatarsophalangeal joint fusion, despite knowing that Lapidus fusion would be optimal if not for concerns about first ray length.

Historically, fusion procedures of the foot and ankle involved joint surface preparation using a saw. Wedge resection effectively corrects deformity but results in excessive loss of essential bone structure. In essence, saw wedge resection corrects one deformity while creating a new deformity. For example, saw wedge resection for fusion of the subtalar or ankle joint effectively corrects rearfoot valgus deformity while creating undesirable limb length shortening. Surgeons have largely abandoned saw wedge resection in lieu of joint curettage for fusion of the ankle, subtalar, talonavicular, calcaneocuboid, naviculocuneiform, and first metatarsophalangeal joints. Why, then, is saw wedge resection still commonly used in Lapidus fusion when preservation of first ray length is a primary goal of the procedure? The obvious lingering question is whether across-the-board abandonment of saw wedge resection would allow surgeons to successfully achieve desired IMA correction, equivalent union rates, and preservation of first ray length with exclusive use of the curette and bur technique for Lapidus fusion, regardless of preoperative IMA or joint anatomy.

Donnenwerth et al (22) published a systematic review in 2011 evaluating the rate of nonunion after first MCJ fusion with joint curettage and crossed compression screw fixation with a minimum of 2 weeks of postoperative non-weightbearing. They identified 5 studies with a total of 537 patients with 599 first MCJ arthrodesis procedures. The nonunion rate was 5% (30/599), 17 (57%) of which were symptomatic. The authors believed that this was a relatively high nonunion rate and recommended further prospective studies to evaluate fixation constructs and postoperative management protocols.

The purpose of this retrospective study was to compare the joint curettage and bur technique to saw wedge resection in Lapidus fusion regarding preservation of first ray length, correction of IMA, and union rate. Based on personal experience, our hypothesis was that the joint curettage and bur technique maintains preoperative first ray length yet achieves an equivalent union rate and IMA correction compared with saw wedge resection, allowing surgeons to abandon the use of a saw in Lapidus fusion, regardless of joint anatomy or preoperative IMA deformity.

## Patients and Methods

After institutional review board approval was obtained, a retrospective review of consecutive cases from January 2007 to August 2014 identified patients who underwent Lapidus fusion for hallux valgus correction with crossed-screw fixation. Patients were classified into 2 groups depending on joint preparation technique. The primary author (T.J.B.) made an intentional change in surgical technique at the end of 2010 based on a desire to avoid loss of first ray length. This change of practice pattern created 2 distinct groups of consecutive patients for comparison. Operative reports and radiographs were evaluated to confirm joint preparation technique in each case. Preoperative and postoperative radiographic measurements included IMA and MPD (25,26), which were used to calculate the mean degree of IMA correction obtained as well as the mean amount of first ray shortening. A 2-sided Student's *t* test was used to determine statistical significance between preoperative and postoperative measurements. Radiographic union was determined to be present or delayed at 10 weeks postoperatively by both investigators. Patients were excluded because of concomitant second metatarsal osteotomy, previous bunion surgery, use of a bone graft (including allograft and autograft), intercuneiform fixation, plate fixation, or midfoot fusion for other conditions including degenerative joint disease, pes planus, or Lisfranc injury.

All procedures were performed by the primary author (T.J.B.). The operative technique was exactly the same in both groups, with the exception of joint preparation. A single dorsal medial incision was used, and all cases involved standard McBride bunionectomy. Lateral release of the first metatarsal phalangeal joint was consistently performed to include release of the lateral sesamoid suspensory ligament and the lateral fibers of the flexor hallucis brevis tendon distal to the fibular sesamoid, but the lateral collateral ligament was left intact to minimize the risk of hallux varus.

The saw wedge resection technique is shown in Fig. 2. Osteotomy guide wires were used to guide the saw cuts on the proximal and distal joint surfaces, with the goal to remove a predictable wedge that achieves ~8° of postoperative IMA (Fig. 2*A*). Patients with metatarsus adductus were aggressively corrected to nearly 0° of IMA in an effort to achieve optimal correction of combined deformity. The osteotomy guide wire across the base of the first metatarsal was angled perpendicular to the long axis of the first metatarsal. The osteotomy guide wire through the medial cuneiform was roughly perpendicular to the long axis of the second metatarsal. The wedge is typically removed from the cuneiform depending on individual patient anatomy. The goal is to remove the least amount of bone possible and avoid multiple cuts, which contribute to undesired loss of first ray length. It is important to note that planar resection creates 2 flat surfaces, and therefore all IMA correction is achieved through wedge resection. Preoperative wedge resection templates were routinely used to determine the size of wedge necessary to correct the IMA.

Joint preparation with the curettage and bur technique is outlined in Fig. 3. A cadaver study by Johnson et al (23) histologically examined the medial cuneiform before and after joint curettage. Their findings identified 2 layers of cartilage overlying the subchondral bone plate, a noncalcified or visible layer and a calcified layer that was only visible microscopically (23). Our consistent technique included removing the visible articular cartilage initially with a sharp osteotome, followed by a curette. A rotary bur was then used to remove the calcified cartilage layer to expose pinpoint bleeding at the subchondral bone plate. It is important to note that the curved nature of the joint was preserved, which allowed correction of IMA without wedge resection (much like subtalar or talonavicular joint fusion). Correction of IMA was then assessed before fixation. A second pass with the bur was typically needed to remove additional bone at the lateral aspect of the joint (most often the lateral aspect of an atavistic cuneiform as shown in Fig. 1) to achieve desired IMA correction. The focus of the second pass was to enhance the curved nature of the joint to allow IMA correction without excessive first ray shortening. Final joint irrigation and suction were performed before fenestration of the subchondral bone plate using a 2.0-mm drill. Autograft shards were extracted from the medullary canal during the drilling process and were left in the fusion site to promote bone healing.

Screw fixation and postoperative care was consistent between the 2 groups. Two crossing screws were placed to compress the joint fusion site. Plate fixation is not part of our standard approach and is reserved for patients with advanced osteoporosis or who are not physically

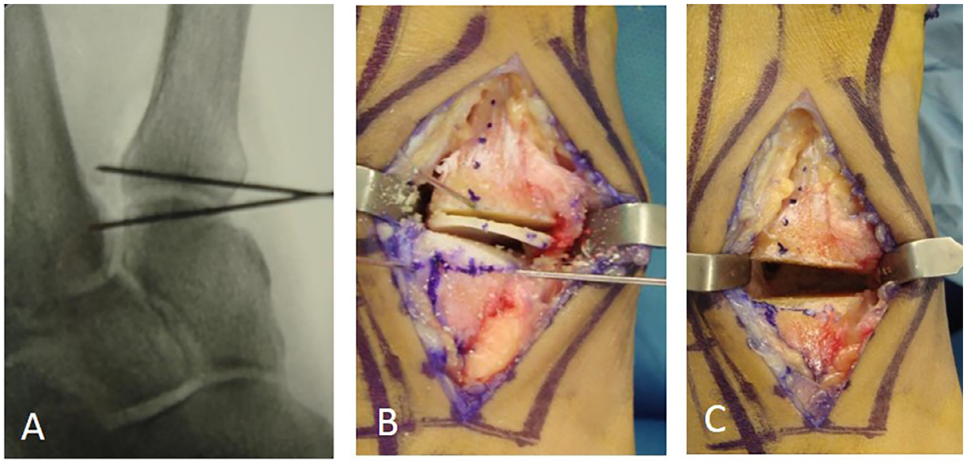


**Fig. 2.** Lapidus fusion joint preparation technique with saw wedge resection. (A) Osteotomy guide wires are shown here on intraoperative imaging before joint resection. The first metatarsal pin is placed ~90° to the long axis of the first metatarsal. The medial cuneiform pin is placed ~90° to the long axis of the second metatarsal. This technique creates a predictable degree of intermetatarsal angle (IMA) correction and avoids excessive shortening associated with serial cuts and repeated feathering commonly associated with freehand cuts. Paper templates can be made preoperatively. (B) Thin wedge cuts are made with a saw following the guide pins. (C) Note that saw wedge resection creates 2 flat surfaces for a tight fit but does not take advantage of the naturally curved surface of the joint when correcting IMA.

capable of being non-weightbearing after surgery. Permanent screws were placed with the intention to remove only if problematic. It is not our routine to place an intercuneiform screw unless intraoperative findings suggest gross instability between the first and second rays after fixation of the fusion site (27). Patients were kept completely non-weightbearing for 6 weeks, followed by progressive weightbearing in a below-knee walking boot from weeks 7 through 10. All patients were placed in a removable below-knee brace, and patients were instructed to remove the brace for first toe and ankle range of motion exercises and to sleep without the brace to minimize the extent of immobilization. No patient was cast immobilized. Patients were allowed to resume walking in regular shoes provided radiographic healing was confirmed at the 10-week postoperative visit.

## Results

A total of 62 consecutive patients (65 feet) who met the inclusion and exclusion criteria were included in the analyses. Patients treated with Lapidus fusion from 2007 to 2010 received joint preparation using saw wedge resection (n = 27), and patients treated from 2011 to 2014 had joint preparation using the curettage and bur technique (n = 38). Patient characteristics are listed in Table 1. Ten patients with Lapidus fusion for hallux valgus

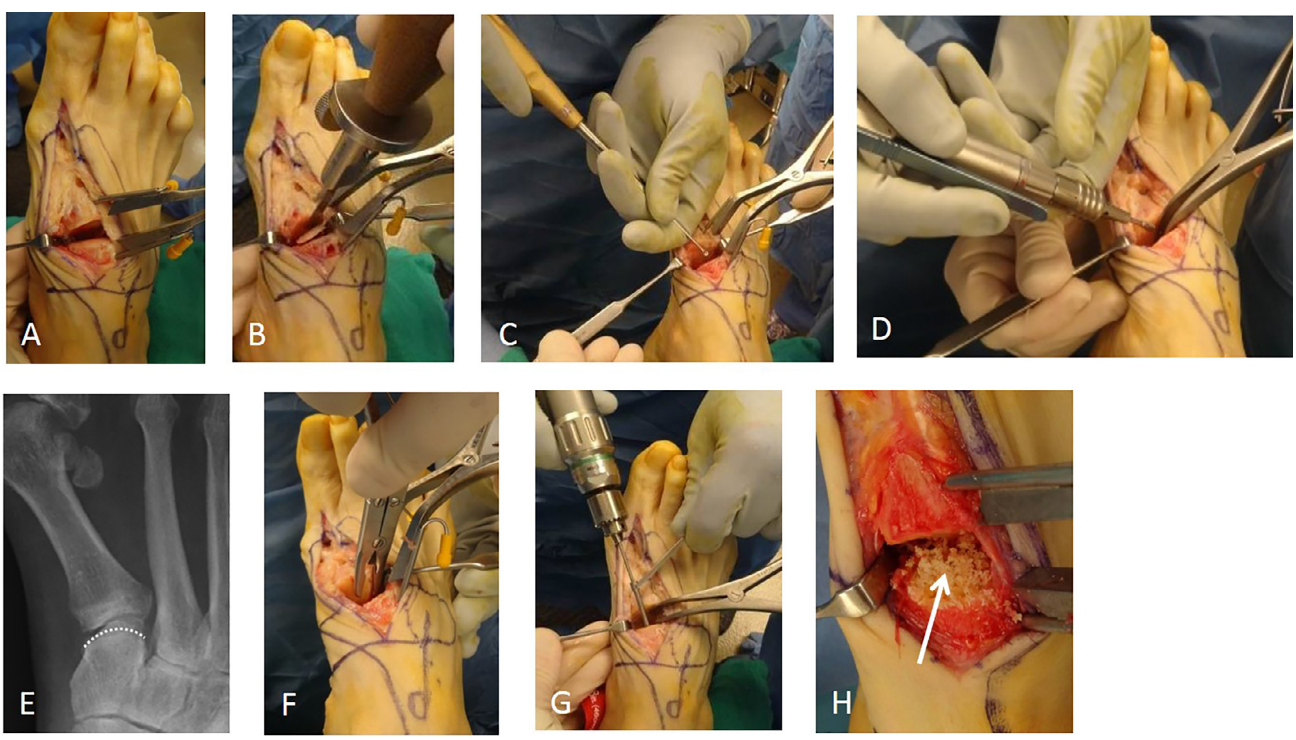


**Fig. 3.** Lapidus fusion joint preparation technique with curette and bur. (A) An invasive joint distractor provides wide exposure to the first metatarsocuneiform joint. (B) A sharp osteotome is initially used to remove the majority of visible articular cartilage on both joint surfaces. (C) The remaining cartilage is then removed with a bone curette. (D) The rotary bur is lightly passed over all joint surfaces, ensuring removal of the calcified cartilage layer in an effort to expose the subchondral bone plate. Additional burring is performed along the plantar lateral flare on the base of the metatarsal or the lateral aspect of an atavistic cuneiform to augment intermetatarsal angle (IMA) correction if needed. (E) Note how the dotted line indicates where an atavistic cuneiform is rounded off laterally to maintain a curved joint contour. (F) The metatarsal flare can also be nipped with a rongeur. (G and H) A 2.0-mm drill is then used to fenestrate the subchondral bone plate (G), which also extracts cancellous autograft (white arrow) from the medullary canal that is left within the joint to augment healing (H).

**Table 1**
Patient characteristics (N = 65 feet in 62 patients)

| Patient No. | Sex | Age (years) | Laterality | Joint Preparation | Preoperative IMA (°) | Postoperative IMA (°) | Preoperative MPD (mm) | Postoperative MPD (mm) | Fusion (Y/N) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Female | 63 | Right | Bur | 12.6 | 5.1 | −2.8 | −3.7 | Y |
| 2 | Female | 18 | Right | Bur | 13.9 | 6.6 | −2.8 | −4.6 | Y |
| 3 | Female | 45 | Left | Bur | 16.8 | 5.2 | −0.6 | −2.1 | Y |
| 4 | Female | 61 | Left | Bur | 16.5 | 8 | −2.7 | −2.7 | Y |
| 5 | Female | 58 | Right | Bur | 11.3 | 4.6 | 1.4 | 0.5 | Y |
| 6 | Female | 45 | Right | Bur | 18.6 | 7.2 | −3.1 | −2.5 | Y |
| 7 | Male | 20 | Left | Bur | 13.1 | 6.5 | 1.4 | −1.1 | Y |
| 8 | Female | 67 | Left | Bur | 17.3 | 7.2 | −6.6 | −8 | Y |
| 9 | Female | 36 | Right | Bur | 13.9 | 7.4 | 1.5 | 0 | Y |
| 10 | Female | 50 | Right | Bur | 15.6 | 8.3 | −3.7 | −3.6 | Y |
| 11 | Female | 59 | Right | Bur | 15 | 6.9 | −2.3 | −0.9 | Y |
| 12 | Female | 53 | Right | Bur | 13.9 | 7.9 | 0 | −2 | Y |
| 13 | Male | 51 | Right | Bur | 11.1 | 8.3 | 3.3 | −0.9 | Y |
| | | | Left | Bur | 11.4 | 7.3 | 1.7 | −1.7 | Y |
| 14 | Female | 77 | Left | Bur | 20.9 | 8.4 | −6.9 | −6.5 | Y |
| 15 | Female | 63 | Left | Bur | 19.3 | 10.9 | −7.3 | −5.7 | Y |
| 16 | Female | 50 | Left | Bur | 15 | 7.8 | −4.2 | −4.4 | Y |
| 17 | Female | 43 | Right | Bur | 16.9 | 8.7 | −6.8 | −6.3 | Y |
| 18 | Female | 16 | Right | Bur | 12.3 | 6.9 | −1.1 | −0.2 | Y |
| 19 | Male | 46 | Right | Bur | 12.4 | 6.7 | −6 | −5.6 | Y |
| 20 | Female | 43 | Right | Bur | 17.3 | 6 | −1.8 | −2.8 | Y |
| 21 | Female | 44 | Left | Bur | 11.9 | 5.1 | −2.1 | −4.1 | Y |
| 22 | Female | 52 | Right | Bur | 18.9 | 6.3 | −5.9 | −7.1 | Y |
| 23 | Female | 16 | Left | Bur | 14.5 | 5.4 | 0 | −3 | Y |
| 24 | Female | 63 | Right | Bur | 16.2 | 6.4 | −4.7 | −5.2 | Y |
| 25 | Male | 57 | Right | Bur | 18 | 5.4 | −3.6 | −4.1 | Y |
| 26 | Female | 66 | Left | Bur | 14.9 | 8 | −3.8 | −4.6 | Y |
| | | | Right | Bur | 11.8 | 7.1 | −0.9 | −4.1 | Y |
| 27 | Female | 59 | Right | Bur | 14.4 | 6.7 | −3.2 | −3 | Y |
| 28 | Female | 53 | Right | Bur | 17 | 5.6 | −4.1 | −5.2 | Y |
| 29 | Male | 54 | Left | Bur | 14 | 5.7 | −3 | −4.8 | Y |
| 30 | Female | 67 | Right | Bur | 13.7 | 6.8 | −5.7 | −6.7 | Y |
| 31 | Female | 43 | Left | Bur | 16.2 | 8.4 | −0.4 | −2 | Y |
| 32 | Female | 52 | Left | Bur | 16 | 8.6 | −5.4 | −4.9 | Y |
| 33 | Female | 21 | Left | Bur | 11.6 | 7.4 | 1.8 | 1.3 | Y |
| 34 | Female | 51 | Left | Bur | 10.3 | 4.3 | −4.8 | −7.5 | Y |
| 35 | Female | 66 | Right | Bur | 14.2 | 7.1 | −2.7 | −3.2 | Y |
| 36 | Male | 62 | Right | Bur | 23.2 | 7.7 | −5.2 | −2.9 | Y |
| 37 | Female | 58 | Left | Saw | 14.7 | 5.5 | −5.1 | −9.9 | Y |
| 38 | Female | 60 | Right | Saw | 17 | 9.8 | −1.6 | −3.9 | Y |
| 39 | Female | 70 | Right | Saw | 23.9 | 9.2 | −5.9 | −10.6 | Y |
| 40 | Female | 46 | Right | Saw | 17.2 | 6.3 | 5.4 | 0.6 | Y |
| 41 | Female | 56 | Right | Saw | 16.8 | 8.7 | −4 | −5.8 | Y |
| | | | Left | Saw | 13.7 | 7.7 | −1.7 | −7.8 | Y |
| 42 | Female | 60 | Right | Saw | 16.8 | 8.3 | −6.9 | −9.5 | Y |
| 43 | Female | 20 | Right | Saw | 19.7 | 9.6 | −3.5 | −5.1 | Y |
| 44 | Female | 70 | Right | Saw | 19 | 7.3 | −5 | −5 | Y |
| 45 | Female | 24 | Left | Saw | 14.6 | 9.3 | 0.6 | −0.5 | Y |
| 46 | Female | 60 | Right | Saw | 14.6 | 8.3 | 0 | −1 | Y |
| 47 | Female | 65 | Right | Saw | 16.9 | 6.5 | 0.4 | −1.1 | Y |
| 48 | Female | 54 | Right | Saw | 23.1 | 10.9 | −5 | −9.7 | Y |
| 49 | Female | 24 | Right | Saw | 13.8 | 8.7 | −1.3 | −3.1 | Y |
| 50 | Female | 60 | Left | Saw | 17.1 | 8.7 | 4.2 | 2 | Y |
| 51 | Female | 58 | Right | Saw | 15.5 | 8.9 | −3 | −5.8 | Y |
| 52 | Female | 53 | Left | Saw | 17.4 | 6.8 | 2 | −3.7 | Y |
| 53 | Female | 50 | Right | Saw | 15.8 | 7.8 | −3.4 | −6.2 | Y |
| 54 | Female | 60 | Left | Saw | 13.5 | 6.4 | 3.7 | −1.9 | Y |
| 55 | Female | 68 | Right | Saw | 23.4 | 8.2 | −7.1 | −11.6 | Y |
| 56 | Female | 75 | Right | Saw | 19.2 | 6.5 | −6.3 | −7.2 | Y |
| 57 | Female | 75 | Left | Saw | 14.9 | 6 | −1.8 | −8.5 | Y |
| 58 | Female | 53 | Right | Saw | 16.4 | 7.9 | −8.2 | −9.6 | Y |
| 59 | Female | 59 | Left | Saw | 13 | 8 | −1.5 | −3.6 | Y |
| 60 | Female | 58 | Left | Saw | 17.2 | 7.4 | −2.1 | −7.4 | Y |
| 61 | Female | 59 | Right | Saw | 15.3 | 3 | −4.1 | −8.1 | Y |
| 62 | Female | 51 | Right | Saw | 15.8 | 7.4 | −1.3 | −4 | Y |
| 63 | Female | 59 | Right | Saw | 19.3 | 14.1 | −7.1 | −9.5 | Y |

Abbreviations: IMA, intermetatarsal angle; MPD, metatarsal protrusion distance.

**Table 2**
Comparison of preoperative patient characteristics (N = 65 feet in 62 patients)

| Variable | Lapidus Bur (n = 38) | Lapidus Saw (n = 27) | *p* Value |
|---|---|---|---|
| Age (years) | 50 (16 to 77) | 56 (20 to 75) | .13 |
| Sex (M, F) | 6, 30 | 0, 26 | .12 |
| Laterality (R, L) | 22, 16 | 18, 9 | .17 |
| Mean preoperative IMA (°) | 15.1 (10.3 to 23.2) | 17 (13 to 23.9) | .01 |
| Mean preoperative MPD (mm) | −2.7 (−7.3 to 3.3) | −2.5 (−8.2 to 5.4) | .51 |

Abbreviations: M, male; F, female; R, right; L, left; IMA, intermetatarsal angle; MPD, metatarsal protrusion distance.
Data are mean (range) unless noted otherwise.

**Table 3**
Postoperative results (N = 65 feet in 62 patients)

| Variable | Lapidus Bur (n = 38) | Lapidus Saw (n = 27) | *p* Value |
|---|---|---|---|
| Postoperative IMA (°) | 7.0 ± 1.3 | 7.9 ± 2.0 | .07 |
| Mean IMA correction (°) | 8.11 ± 2.7 | 9.06 ± 2.8 | .21 |
| Postoperative MPD (mm) | −3.6 ± 2.3 | −5.6 ± 3.8 | .01 |
| Mean shortening (mm) | −0.86 ± 1.4 | −3.14 ± 1.9 | <.0001 |
| Nonunion | 0 | 0 | |
| Complication | 1 (pain at screw) | 1 (neuritis) | .83 |

Abbreviations: IMA, intermetatarsal angle; MPD, metatarsal protrusion distance.
Data are mean (standard deviation) unless noted otherwise.

(5 from each group) were excluded owing to concomitant second metatarsal shortening osteotomy. Another 29 patients had Lapidus fusion for conditions other than hallux valgus during the study time frame and were excluded (19 patients undergoing flatfoot surgery and 10 patients with midfoot fusion for Lisfranc injury). Joint preparation with saw wedge resection was used in 26 patients (27 feet) from 2007 to 2010, and joint preparation with the curettage and bur technique was performed in 36 patients (38 feet) from 2011 to 2014. The 2 groups were comparable in regard to baseline characteristics as demonstrated by *p* values .13, .12, .17, and .51 (Table 2). The mean preoperative IMA of the 2 groups had a *p* value of .01, likely because of a larger sample size in the bur group. No patients were excluded for use of bone grafts, intercunieform fixation, or plate fixation.

Table 3 provides a comparison of postoperative results for the 2 groups. The mean IMA correction was 9.06° (range 5° to 14.7°) in the saw wedge resection group and 8.11° (range 2.8° to 15.5°) in the curette and bur group, a difference that was not statistically significant. The mean amount of first ray shortening was −3.14 (range −6.1 to 0) mm in the saw wedge resection group and −0.86 (range −2.3 to 4.2) mm in the curette and bur group, a result that was statistically significant. Osseous union was confirmed radiographically at 10 weeks postoperatively in all cases. Figures 4 and 5 demonstrate typical outcome for each group. Each group had 1 documented minor complication (e.g., hardware pain, neuritis).

## Discussion

The Lapidus procedure can provide substantial IMA correction for patients with hallux valgus deformity with or without midfoot instability. Early surgical reports describe the use of wedge resection from the medial cuneiform to obtain correction (28). Modifications have been made to this technique in regard to incisional approaches, amount and area of wedge resection, and types of fixation, but the original approach is still widely used (19). Despite improvements in the technique, the most commonly discussed complications of this procedure include first ray shortening, which can lead to transfer metatarsalgia, and delayed union or nonunion (2,4-7,9,10,12,17-19,29).

Joint preparation with a curette and bur in lieu of saw wedge resection is a commonly used technique intended to minimize first ray shortening (3,4,6,9,17,22,23). The curette technique allows for preservation of the curved contour of the joint without causing significant loss of first ray length (23). However, these benefits may be offset by the potential for increased risk of nonunion. A cadaver study in 2009 was conducted to assess the histologic appearance of the first MCJ after joint curettage in an effort to understand why the curettage technique is prone to nonunion. Results showed a residual layer of calcified cartilage overlying

**Fig. 4.** Case example of saw wedge resection joint preparation technique in Lapidus fusion. Preoperative and 10-week postoperative anteroposterior and lateral x-rays with crossed screw fixation. Note ideal intermetatarsal angle correction and union yet mild loss of first ray length.

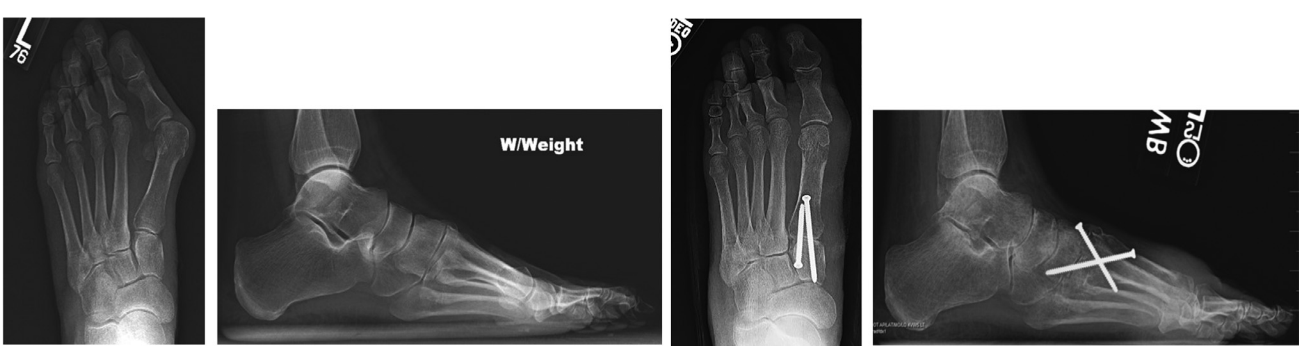


**Fig. 5.** Case example of curette and bur joint preparation technique in Lapidus fusion. Preoperative and 10-week postoperative anteroposterior and lateral x-rays with crossed screw fixation. Note preservation of first ray length without compromise of intermetatarsal correction or union despite severe preoperative deformity and atavistic cuneiform anatomy.

the subchondral bone plate after joint curettage that is not visualized in surgery. The authors concluded that the calcified cartilage layer acts as a histologic barrier that may interfere with joint fusion. That study also discussed the issue of whether to preserve the subchondral bone plate during the Lapidus fusion. Ray et al demonstrated that maintaining the subchondral bone plate in Lapidus fusion enhances stability, increases screw purchase, and helps to maintain first ray length (1). However, Johnsen et al opposed this theory and believed that the subchondral bone plate was acellular and less capable of fusion (23). Many surgeons have adopted the technique of perforating or fenestrating the subchondral bone plate to stimulate osseous healing.

We believe that joint preparation is a significant factor in determining the outcome of the Lapidus procedure. Our preferred surgical approach avoids saw wedge resection and rather uses joint curettage and burring. We believe that saw wedge resection has an increased risk of undesired shortening without improving the union or complication rate. Saw wedge resection relies entirely on the size of the wedge to correct IMA deformity. The saw essentially converts curved joint surfaces into flat surfaces. Wedge resection is necessary for osteotomies used to correct fixed osseous deformities but is not necessary when performing arthrodesis of flexible joints. The joint curettage and bur technique relies on joint mobility around curved subchondral bone surfaces to correct deformity without the need for wedge resection. Selective burring of lateral bone prominence after removal of the calcified cartilage allows for ideal correction of the IMA, and some degree of shortening is inherent to the procedure, since cartilage is removed from both bone surfaces.

McInnes and Bouche (3) discussed a “medial stress” radiographic maneuver that was first described by Lapidus for evaluating first ray reducibility in the transverse plane. The technique involves manual distraction of the hallux while medial stress is applied to the first metatarsal head. This provides IMA reduction and demonstrates the inherent transverse plane mobility of the first MCJ. Joint preparation with the curette and bur technique allows preservation of the curved joint contour and uses this transverse plane mobility to correct IMA while maintaining first ray length. The ability to preserve first ray length expands the indications for Lapidus fusion to include patients who have second ray overload resulting from an inherently short or unstable medial column. Most other joints of the foot and ankle are fused with the curette and bur approach, and we have not found the need to use a saw with Lapidus fusion in the past 9 years.

The 100% fusion rate observed in both joint preparation groups can likely be attributed to thorough joint preparation, rigid internal fixation with 2 compression screws, and a strict postoperative course of nonweightbearing for 6 weeks. We have not felt compelled to add plate fixation or allow early weightbearing for fear of compromised union rate and increased risk of hardware irritation. Hardware removal after plate fixation in Lapidus fusion is not a benign procedure, since the medial branch of the medial dorsal cutaneous nerve typically crosses the incision at this location. The nerve is easily identified and protected on the index procedure yet is difficult to find when removing a plate through scar tissue. Surgical pearls aimed at avoiding nonunion with joint curettage and burring include joint preparation that removes the calcified cartilage layer, drilling to fenestrate the subchondral bone plate, preservation of autograft within the joint produced from drilling, and strict AO guidelines for proper joint compression. Of note, our study focused only on Lapidus fusion for hallux valgus deformity. Other conditions for which Lapidus fusion is indicated, including degenerative joint disease, Lisfranc fracture/dislocation, and Charcot arthropathy, involve compromised bone quality at the MCJ, which may predispose to a higher risk of nonunion. Patients who undergo elective primary fusion for hallux valgus deformity typically have normal bone quality without prior trauma or degenerative changes.

The saw wedge resection group had a mean preoperative IMA of 17° (range 13° to 23.9°) compared with a mean preoperative IMA of 15.1° (range 10.3° to 23.2°) in the curettage and bur group. The upper range was equivalent in each group, whereas there were several patients in the curette and bur group with combined hallux valgus and significant metatarsus adductus accounting for the lower range of preoperative IMA.

Recognized shortcomings of this study include the retrospective study design, exclusion of 10 patients who had concomitant second metatarsal osteotomy, and lack of long-term follow-up. Study patients were consecutive, and no patient was lost to follow-up. All patients had 10-week postoperative radiographs, and longer follow-up would not be expected to change the results of union rate, IMA correction, or MPD. However, longer follow-up may have revealed other complications not yet obvious at 10 weeks (e.g., sub-second metatarsal pain). The same number of patients were excluded from each group because of lesser metatarsal osteotomy. It is possible that the surgeon’s technique has improved with time, and the saw wedge resection group was at a disadvantage from that respect. This factor would be expected to affect union rate more than IMA or MPD. A prospective study would be beneficial to validate our findings that ideal correction of IMA, low nonunion rate, and minimal first ray shortening are consistently reproducible with the curette and bur joint preparation technique regardless of preoperative IMA or joint anatomy.

There is a trend in the literature toward focus on correction of frontal/coronal plane deformity in hallux valgus surgery (30-33). One proposed technique to allow triplanar correction relies on a jig to make precise cuts and then correct coronal plane deformity (34). The pin-based osteotomy guide technique described here is our rudimentary way of achieving the same predictable cut precision. With regard to coronal plane correction, it is our routine to assess rotational deformity of the first metatarsal intraoperatively during reduction and provisional fixation. This is accomplished by plantarflexing the hallux to allow direct visualization of the plantar surface of the first metatarsal head to ensure neutral position in the coronal plane. This step is more critical in planar resection, since it is possible for the surgeon to create coronal plane deformity if not paying attention to rotational alignment during fixation. The authors acknowledge that preservation of first tarsometatarsal joint curvature with the curette and bur technique may restrict the ability to correct significant coronal plane deformity compared with planar resection, which was not assessed in this study.

In conclusion, the results of this study confirm our initial hypotheses. The curettage and bur joint preparation group demonstrated significantly less first ray shortening than the saw wedge resection group, −0.86 (range −2.3 to 4.2) mm versus −3.14 (range −6.1 to 0) mm, respectively, a result that was significant. As predicted, we found no significant difference in the degree of IMA correction or nonunion rate between the 2 groups. All patients had osseous fusion by 10 weeks postoperatively. Based on these findings, surgeons should not feel compelled to use a saw for Lapidus fusion in patients with high IMA or atavistic cuneiform anatomy. These results also confirm that a preexisting short first ray or preoperative second ray overload are not contraindications of Lapidus fusion, as it is possible to consistently maintain first ray length with careful attention to joint preparation.

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