The Use of the Lapidus Procedure for Recurrent Hallux Valgus

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ABSTRACT

Background: The objective of this study was to evaluate the Lapidus procedure or its modifications for treatment of recurrent hallux valgus (HV). Our hypothesis was that the Lapidus procedure would achieve good correction of recurrent HV and patients would be satisfied. Materials and Methods: A retrospective review of 32 feet (30 patients) treated with the Lapidus procedure for recurrent HV with at least 1-year followup was performed. Evaluation included radiographs, examination, and chart review. Outcomes were assessed with a pain visual analog scale (VAS), American Orthopaedic Foot and Ankle Society (AOFAS) hallux score, SF-12, Revised Foot Function Index (RFFI), and a survey. Twenty-three of 30 patients (25 feet) met the criteria for inclusion in the study and were available for followup evaluation. The average followup was 31.6 months. Results: Arthrodesis was present in 24 out of 25 feet (96%). The time from initial HV correction to revision surgery was 91 months. The initial surgery performed was a distal osteotomy (15), proximal osteotomy (five), exostectomy (two), diaphyseal osteotomy (two), and proximal/distal osteotomy (one). Preoperative evaluation revealed 96% of patients had clinical hypermobility of the first TMT joint and 52% had radiographic findings of instability. The average postoperative AOFAS hallux score was 82.8, SF-12 score was 94.5, and RFFI was 101. The average preoperative hallux valgus angle (HVA), intermetatarsal angle (IMA), and distal metatarsal articular angle (DMAA) were 36.2, 13.6, 18.6 degrees, respectively, which corrected to an average of 15.2, 7.5, 11.7 degrees postoperatively (p < 0.001). The average shortening of the first ray was 2.9 mm. Average pain VAS was 2.4. Eighty-seven percent reported good to excellent results. Using a multivariable linear regression analysis, postoperative HVA along with change in length of the first ray were significant predictors of quality of life based on SF-12 (p < 0.05). Conclusion: The Lapidus procedure corrected recurrent HV with a low nonunion rate and excellent radiographic correction and patients were satisfied with their outcome.

Level of Evidence: IV, Retrospective Case Series

Key Words: Hallux Valgus; Recurrence; Bunion; Lapidus

INTRODUCTION

Recurrent hallux valgus (HV) can be a difficult problem for both the patient and surgeon. Many options exist to address recurrent HV which include various first metatarsal osteotomies, hallux metatarsophalangeal (MP) arthrodesis, or the Lapidus procedure. There are several absolute and relative indications for choosing one option over another. In addition, each of these options has their own advantages and disadvantages. The Lapidus procedure reliably corrects primary HV,1 2, 4, 6, 9, 14, 18, 19, 23, 28, 29, 32, 35, 38 The Lapidus procedure has also been described for correction of recurrent HV.10, 11

Hypermobility of the first ray was initially introduced by Morton in 1928.52 However, in 1934 Lapidus first described his procedure and later suggested that increased mobility at the first tarsometatarsal (TMT) joint leads to HV.20–22 The original Lapidus procedure was performed by first excising the lateral surface of the cuneiform and the lateral condylar base of the first metatarsal and then a MP joint capsulorrhaphy to straighten the great toe on the metatarsal and simultaneously reposition the first metatarsal parallel to the second. Fixation consisted of securing the first metatarsal to the second with heavy chromic suture, which has been replaced with screw fixation across the first TMT joint and a screw from the first to the second metatarsal.20 There have been many described modified Lapidus procedures including different operative approaches, amount of bone resection, positioning techniques, types of fixation, and postoperative protocol.5, 6, 8, 13, 17, 26, 31, 33

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Treatment of HV recurrence is based upon the magnitude of the deformity, presence of arthritis at the MP joint, the distal metatarsal articular angle (DMAA), and the presence of arthritis and instability at the first and second TMT joint(s). The objective of this study was to evaluate the result of the Lapidus procedure or its modifications in appropriately selected patients with recurrent HV. Our hypothesis was that the Lapidus procedure would achieve good correction of recurrent HV with a low nonunion rate and patients would be satisfied with their outcome.

MATERIALS AND METHODS

Between January 2004 and May 2009, 32 feet in 30 consecutive patients treated with a Lapidus procedure for recurrent hallux valgus with at least 1-year followup were identified and retrospectively reviewed. Not all patients with recurrent HV were treated with the Lapidus procedure. Patients were treated with the Lapidus procedure when clinical or radiographic evidence demonstrated first TMT instability. The majority of patients with recurrent HV treated by the senior authors were corrected with other surgical procedures depending on the clinical presentation. Institutional review board approval and informed consent were obtained. Patients were contacted and asked to return for clinical and radiographic followup. Five patients (five feet) declined to participate and two patients (two feet) were unable to be located, leaving 23 patients (25 feet) available for clinical and radiographic followup. Patients declined to participate either because they stated over the phone that they were happy with their outcome and/or lived too far away to return for a clinical visit. The procedures were performed by the senior orthopaedic surgeons involved in the study (M.S.M. and C.C.). The operative procedures used in the primary HV cases are listed in Table 1.

The average time between the index surgery and the Lapidus procedure was 91.3 (range, 9 to 232) months. The mean followup was 31.6 (range, 12 to 60) months. Twenty-four of 25 (96%) were female. The average age was 52.1 (20 to 67) years. Concomitant procedures were performed in 23 of 25 (92%); (forefoot procedures in 19 (76%), additional (20 to 67) years. Concomitant procedures were performed in mean followup was 31.6 (range, 12 to 60) months. Twenty-

# Table 1: Procedure Utilized for Initial HV Correction

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Frequency ($n=25$)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distal osteotomy</td>
<td>15</td>
<td>60%</td>
</tr>
<tr>
<td>Proximal osteotomy</td>
<td>5</td>
<td>20%</td>
</tr>
<tr>
<td>Diaphyseal osteotomy</td>
<td>2</td>
<td>8%</td>
</tr>
<tr>
<td>Exostectomy</td>
<td>2</td>
<td>8%</td>
</tr>
<tr>
<td>Proximal/Distal osteotomy</td>
<td>1</td>
<td>4%</td>
</tr>
</tbody>
</table>

The arthrodesis was then appropriately positioned based on gross inspection, fluoroscopy and the use of a foot plate to ensure plantigrade position of the hallux. The hallux MP joint was dorsiflexed in order to manually compress the TMT joint. Bone graft was used in 5 out of 25 (20%) patients (four allograft and one calcaneal autograft) when a
A modified Lapidus procedure (arthrodesis of only the first TMT joint) was routinely used. The addition of fixation extending from the first to second metatarsal was added (the original Lapidus procedure) when the desired clinical or radiographic correction could not be obtained. For these patients, persistent instability was noted between the base of the first and second metatarsal and the middle and medial cuneiform. Following the modified Lapidus procedure, if this transverse plane instability persisted and the IMA was noted under fluoroscopy to be wide, a screw was then inserted from the base of the first metatarsal obliquely to the base of the second metatarsal. A standard medial eminence resection and distal soft tissue release was also performed at the completion of the arthrodesis. Wounds were irrigated, hallux MP joint capsulorrhaphy was performed and following surgical closure a soft compressive dressing was applied.

**Postoperative protocol**

Patients were immobilized in a boot and remained nonweightbearing for 4 weeks. At 4 weeks the patients were allowed to weightbear on the heel in the boot, and at 6 weeks weightbearing in a postoperative shoe with a heel wedge was used for an additional 2 weeks. Dressing changes were performed weekly to maintain correction and evaluate for hallux varus or recurrence.

**Statistics**

Standard descriptive statistics were calculated including means, ranges, frequency and percentages. A Wilcoxon Signed Rank test was used to determine the statistical differences between preoperative and postoperative values since the values were not normally distributed. Spearman correlation coefficient was also calculated. All tests were performed at an *a priori* significance level of 0.05.

**RESULTS**

Preoperative evaluation revealed 24 out of 25 (96%) of feet had hypermobility of the first TMT joint and 13 out of 25 (52%) had radiographic findings of instability. Radiographic evidence of instability was defined as plantar gapping or coronal translation of the first TMT joint (Figure 1, A and B).

The average postoperative AOFAS hallux score was 82.8 (range, 59-100), SF-12 score was 94.5 (range, 75 to 113), RFFI was 101 (range, 57 to 186), and VAS was 2.4 (range, 0 to 6) (Table 2). Twenty of 23 patients (87%) reported good to excellent results at final followup (Table 3). Twenty-two of 23 patients (96%) would have the surgery again and were able to return to previous job responsibilities, and 70% (16 out of 23) were able to return to previous level of activity (Table 4).

The average HVA decreased from 36.2 (range, 18 to 53) degrees preoperatively to 15.2 (range, 0 to 25) degrees postoperatively (*p* < 0.001). The average IMA decreased from 13.6 (range, 1 to 30) degrees preoperatively to 7.5

### Table 2: Postoperative Clinical Outcome Scores

<table>
<thead>
<tr>
<th>Outcome measure</th>
<th>Postoperative score (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AOFAS Hallux Score</td>
<td>82.8 (59–100)</td>
</tr>
<tr>
<td>SF-12</td>
<td>94.5 (75–113)</td>
</tr>
<tr>
<td>RFFI</td>
<td>101 (57–186)</td>
</tr>
<tr>
<td>VAS</td>
<td>2.4 (0–6)</td>
</tr>
</tbody>
</table>
Table 3: Postoperative Patient Satisfaction Survey

<table>
<thead>
<tr>
<th>Response</th>
<th>Frequency (n = 23)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>13</td>
<td>57%</td>
</tr>
<tr>
<td>Very good</td>
<td>2</td>
<td>9%</td>
</tr>
<tr>
<td>Good</td>
<td>5</td>
<td>22%</td>
</tr>
<tr>
<td>Fair</td>
<td>3</td>
<td>13%</td>
</tr>
<tr>
<td>Poor</td>
<td>2</td>
<td>9%</td>
</tr>
</tbody>
</table>

Table 4: Questionnaire Response

<table>
<thead>
<tr>
<th>Question</th>
<th>% Yes (frequency, n = 23)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return to previous job?</td>
<td>96% (22)</td>
</tr>
<tr>
<td>Would you have the surgery again?</td>
<td>96% (22)</td>
</tr>
<tr>
<td>Return to previous activity?</td>
<td>70% (16)</td>
</tr>
</tbody>
</table>

(range, 1 to 16) degrees postoperatively (p < 0.001). The average DMAA decreased from 18.6 (range, 7 to 46) degrees preoperatively to 11.7 (range, 0 to 30) degrees postoperatively (p < 0.001) (Figure 2). The average medial cuneiform height increased 4.1 (range, 1 to 10.6) mm and the average Meary’s angle improved 3.1 degrees (range, 0 to 10) degrees (p < 0.01) (Figure 3 and 4). Postoperative hallux length decreased 2.9 (range, 0.5 to 9.5) mm (Table 5). The nonunion rate was one out of 25 (4%) of feet. This was successfully managed with a revision Lapidus procedure and calcaneal autograft.

In order to identify possible predictors of success, correlation between SF-12 scores and all postoperative radiographic and clinical measurements was assessed using Spearman correlation coefficients. Using a multivariable linear regression analysis, postoperative HVA along with change in length of the first ray were significant predictors of quality of life based on SF-12 (p < 0.05).

Discomfort related to implants occurred in five out of 25 (20%), resulting in implant removal. Nonunion occurred in
one out of 25 (4%). One patient had recurrent HV 13 months postoperatively which was successfully managed with hallux MP arthrodesis. Although this patient had successful union of both sites and excellent improvement in radiographic alignment, she rated her satisfaction as poor and had the lowest AOFAS hallux score (59) and the highest RFFI score (186) in the cohort.

**DISCUSSION**

Recurrent HV presents multiple challenges to the treating surgeon. The initial question one should ask is why did the original surgery fail? In our series, the initial surgery performed was a distal osteotomy (15), proximal osteotomy (five), exostectomy (two), diaphyseal osteotomy (two), and proximal/distal osteotomy (one). Revision correction should be centered on the cause of failure to reduce the likelihood of a second recurrence. Cause of failure may include choosing an osteotomy in the original surgery that was not powerful enough to maintain correction of a large deformity (e.g., using a distal chevron osteotomy for an IMA of 20 degrees). Failure may also be due to lack of recognition of a hypermobile first TMT joint on physical exam, or subtle radiographic findings demonstrating the same. Recurrence may also be due to not correcting the deformity at all in the original surgery (e.g., only performing a medial eminence excision). Regardless of the cause, one must critique why the original surgery did not maintain long-term correction.

Likewise, if a clear reason cannot be identified, one must carefully examine which revision procedure will reliably correct recurrent HV. The indications for revision HV correction are largely the same as for primary HV correction. In the low demand patient, a resection arthroplasty may be sufficient for recurrent HV. In the other hand, hallux MP fusion and the Lapidus procedure are excellent options to reliably correct primary HV deformity and are indicated in the setting of arthritic changes in the respective joints. Repeat uniplanar or biplanar first metatarsal osteotomies or opening wedge osteotomies are viable options when degenerative joint disease at the hallux MP or TMT do not coexist to address recurrent HV. Also, certain osteotomies may be preferable in the setting of an abnormal DMAA. However, although the Lapidus procedure is a translational osteotomy, we do not believe that an additional distal metatarsal osteotomy is routinely necessary, and indeed found that the DMAA improved from 18.6 degrees preoperatively to 11.7 degrees postoperatively. Thus, the Lapidus procedure may be a viable option in appropriately selected patients with a high DMAA. We hypothesize that rotation of the hallux and first metatarsal may give the appearance of a radiographic increase in the DMAA, thus making some authors alter their treatment options. After proper alignment of the hallux following the Lapidus procedure, the hallux is derotated, which we believe also lowers the DMAA.

The literature is sparse reporting the results of the Lapidus procedure for either primary or recurrent HV. A recent surgical technique was published describing the use of the Lapidus procedure for recurrent HV. To our knowledge, only one series has reported the use of the Lapidus procedure for recurrent HV. The series concluded that in appropriately selected patients, the Lapidus procedure is a reliable and effective operation after failed surgical treatment of hallux valgus. In their series, there was a three out of 26 (11.5%) nonunion rate, all of which occurred in smokers.

In our series, preoperative HVA and IMA were 36.2 and 13.6 degrees, and improved to 15.2 and 7.5 degrees postoperatively (p < 0.001). Although the Lapidus provides a strong correction, it was chosen in our series due to the clinical or radiographic evidence of first TMT instability. Arthrodesis of the first TMT joint (versus MP joint) preserves hallux MP motion and theoretically more normal biomechanics of the first ray, especially during push-off. It has been reported that patients are able to return to their same level of activity following the Lapidus procedure. A large prospective cohort series of 91 patients who had a Lapidus procedure for primary HV demonstrated that 84 patients (92%) were able to return to their previous level of activity. In our series, 16 out of 23 (70%) of patients returned to their previous level of activity. This disparity may be due to the fact that our patients were undergoing revision surgery. However, the majority of our patients (87%) reported good to excellent results at final followup and 96% said they would undergo the surgery again and were able to return to work. Similarly, postoperative VAS was 2.4, indicating good pain relief following surgery.

In our series, preoperative evaluation revealed 24 out of 25 feet (96%) had hypermobility of the first TMT joint and 13 out of 25 feet (52%) had radiographic findings of instability. Clinically, hypermobility

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**Table 5: Pre- and Postoperative Radiographic Comparison**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Preoperative</th>
<th>Postoperative</th>
</tr>
</thead>
<tbody>
<tr>
<td>HVA</td>
<td>36.2 degrees</td>
<td>15.2 degrees*</td>
</tr>
<tr>
<td>IMA</td>
<td>13.6 degrees</td>
<td>7.5 degrees*</td>
</tr>
<tr>
<td>DMAA</td>
<td>18.6 degrees</td>
<td>11.7 degrees*</td>
</tr>
<tr>
<td>Medial cuneiform height</td>
<td>20.4 mm</td>
<td>24.5 mm*</td>
</tr>
<tr>
<td>Meary’s angle</td>
<td>−4.6 degrees</td>
<td>−1.5 degrees*</td>
</tr>
<tr>
<td>Hallux shortening</td>
<td>–</td>
<td>2.9 mm</td>
</tr>
</tbody>
</table>

HVA, hallux valgus angle; IMA, intermetatarsal angle; DMAA, distal metatarsal articular angle; *, p < 0.001; #, p < 0.01.
is evaluated by determining sagittal motion (the grasping test) and transverse motion (the clinical squeeze test) and by identifying signs such as the presence of a dorsal bunion, intractable plantar keratosis beneath the second metatarsal head, and arthritis of the first and second TMT joint. Although we documented objective radiographic evidence of instability, one weakness of the study was the subjective assessment of clinical instability. We did not use any measuring device to assess clinical instability, but rather documented instability based on increased laxity compared to the nonoperative side or greater than 10 mm increased sagittal translation with manipulation of the first ray. Radiographically, hypermobility is evaluated by measurements from the modified Coleman block test (for sagittal motion) and the radiographic squeeze test (for transverse motion) and by the identification of signs, such as cortical hypertrophy along the medial border of the second metatarsal shaft, a cuneiform split, the presence of os intermetatarsaeum, and the round shape and increased medial slope of the first TMT joint.22 Avino et al. reported in 39 feet which underwent the Lapidus procedure for forefoot surgery.1 They demonstrated a statistically significant improvement in Meary’s angle and medial cuneiform height, suggesting that the Lapidus procedure may influence the medial longitudinal arch.1 Thompson et al. reported on 201 feet who underwent the Lapidus procedure in which 21 also had flatfoot reconstruction.37 They reported no nonunions in the flatfoot group and demonstrated successful radiographic and clinical outcomes. Also, a cadaveric model has demonstrated the role of the Lapidus procedure in a flatfoot. The model suggested that arthrodesis at the first TMT joint increases the efficiency of the peroneus longus stabilizing action on the medial column.3 In our series, preoperative medial cuneiform height and Meary’s angle averaged 20.4 mm and −4.6 degrees, and postoperatively it improved to 24.5 mm and −1.5 degrees, respectively (p < 0.01).

However, disadvantages have been reported with use of the Lapidus procedure. The largest concern is the risk of nonunion. The nonunion rate at the first TMT joint is between 2% and 10% for unilateral procedures and up to 33% for bilateral procedures.16,34 In the three largest series, the nonunion rate was eight out of 201 (4%), 12 out of 227 (5.3%) and seven out of 342 (2%).19,28,37 We report a nonunion rate of 4%, which is consistent with the literature. The nonunion rate can be reduced by meticulous technique. Adequate subchondral bone should be exposed, either by multiple subchondral perforations with a small diameter drill or “shingling” of the subchondral plate with an osteotome. It is advisable to keep the patient minimally weightbearing for 8 weeks. Also, due to its superficial location, implant prominence may become an issue following the Lapidus procedure. Twenty percent of our patients elected for implant removal due to prominence or pain. This subgroup of patients had equivalent outcomes to those not requiring implant removal. Another potential disadvantage is the proximity to the dorsalis pedis artery. The dorsalis pedis artery enters the first intermetatarsal space about 1 to 1.5 cm distal to the TMT joint. Overzealous dissection could compromise the artery, but this was not encountered in our study. As with all HV surgery, recurrence, shortening of the first ray, or hallux varus is a possibility. At 32-month followup (range, 12 to 60 months) our cohort had no varus deformity, one recurrence, and shortening averaged 2.9 mm.

Weaknesses of our study include its retrospective design, the lack of preoperative VAS and AOFAS hallux scores, intermediate followup, its small number of patients and patients (eight) lost to followup. Strengths include that it emphasized the need for a thorough preoperative assessment for hypermobility before proceeding with primary hallux valgus correction. It also adds to the literature the role of the Lapidus procedure in concomitant flatfoot deformity. It demonstrates that the Lapidus procedure may be a good choice to address recurrent HV with high patient satisfaction and a low nonunion rate.

There is no single procedure that will work for all recurrent HV deformities. Each individual patient requires careful assessment and each surgical option is weighed with all its potential pitfalls. In our practice, we use the Lapidus procedure or its modifications approximately 20% of the time when correcting recurrent HV. This procedure is contraindicated in patients with an open physes, a short first metatarsal and arthritis of the hallux MP joint. First TMT arthrodesis allows for correction of the first metatarsal in three planes, including adduction, plantarflexion, and rotation. It also increases medial column stability. We identified predictors of success based on SF-12 scores as adequate HVA correction and avoidance of shortening of the first ray. Our average shortening was 2.9 mm and since change in length was directly related to SF-12 scores, we caution to only resect cartilage and not remove any bone. In addition, when appropriate, lesser metatarsal shortening osteotomies were added to create a normal cascade. With proper technique and attention to detail, the Lapidus procedure was an excellent option for recurrent hallux valgus deformities.

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