ABSTRACT

Background: Multiple reports are found in the literature about the surgical treatment of hallux valgus deformities. Few, however, are prospective outcome studies. The purpose of this study was to prospectively look at the functional outcome of patients with moderate and severe hallux valgus deformities (intermetatarsal angle of more than 14 degrees and a hallux valgus angle of more than 30 degrees) after the Lapidus procedure. Methods: Indication for surgery and inclusion into the study was failure of nonoperative management for metatarsus primus varus and painful hallux valgus deformities. Data was collected using the AOFAS Hallux Metatarsophalangeal Interphalangeal Scale, Visual Analog Pain Scale, clinical examination, weightbearing radiographs, and a patient satisfaction questionnaire. Data was collected preoperatively, 6 weeks after surgery, 6 months after surgery, and then yearly. One hundred and five feet in 91 patients were followed for an average of 3.7 years (range, 18 months to 6.2 years). Sixty-two patients were female and 29 were male. The average age at surgery was 41 years (range, 20 years to 71 years). Results: The AOFAS Hallux Metatarsophalangeal Interphalangeal Scale scores increased from 52 preoperatively to 87 points at most recent follow-up (p < .001). The average intermetatarsal angle preoperatively was 18 degrees and 8.2 degrees at most recent follow-up. Between the 1-year and 3.7-year follow-up visits, only 3-degree increase of the intermetatarsal angle was noted. The average hallux valgus angle preoperatively was 37 degrees and 16 degrees at most recent follow-up. Less than 1-degree increase in the hallux valgus angle was noted between the 1-year to 3.7-year follow-up visits. Complications included tarsometatarsal nonunion in seven patients. Five patients lost correction and all seven patients had a revision procedure done for pain. Removal of hardware was necessary in eight patients, minor wound problems occurred in two patients, superficial neuroma in two patients, and transfer metatarsalgia in four. Conclusions: The Lapidus procedure obviously is not the answer to all bunion deformities, but with proper technique and attention to detail it is an excellent alternative treatment for moderate to severe metatarsus primus varus and hallux valgus deformities.

Key Words: Bunion; Hallux Valgus; Lapidus; Metatarsus Primus Varus

INTRODUCTION

The treatment of hallux valgus deformities continues to evolve. Multiple reports are available in the literature but very few are prospective studies.2,3,4,5,8 Anecdotal reports prior to this study suggest that the Lapidus procedure allows a very secure way of preventing recurrence of the intermetatarsal angular malalignment, but the complication rate might outweigh the potential benefits.

The purpose of this study was to prospectively evaluate the functional outcome of patients who underwent the Lapidus procedure as a treatment for moderate to severe metatarsus primus varus and hallux valgus deformities. Less severe deformities were treated with other methods.

MATERIALS AND METHODS

Patients with symptomatic metatarsus primus varus and hallux valgus were assessed. Indication for surgery and inclusion into the study was failure of nonsurgical management for metatarsus primus varus and painful hallux valgus deformities (Fig. 1, A and B). The deformity had to be moderate or severe (intermetatarsal angle of more than 14 degrees and a hallux valgus angle more than 30 degrees). The mobility of the medial ray was assessed but not recorded and was not an
inclusion or exclusion factor in the study. Bilateral Lapidus procedures were done at least 6 months apart. Patients with previous hallux valgus procedures, insulin-dependent diabetes, previous ankle or subtalar fusions, peripheral vascular disease, or peripheral neuropathy were not entered into the study.

One hundred and one patients (118 feet) were included in the study. Ten patients (13 feet) were lost to follow-up, which left 91 patients (105 feet) that were followed for an average of 3.7 years (range, 18 months to 6.2 years). Sixty-two patients were female and 29 were males. The average age at surgery was 41 years (range, 20 years to 71 years). Approval was obtained from the Institutional Review Board, and informed consent was obtained from each patient before the study.

The following methods were used for data collection: the AOFAS Hallux Metatarsophalangeal Interphalangeal Scale, Visual Analog Pain Scale, clinical examination, weight bearing radiographs, and a patient satisfaction questionnaire. Data was collected preoperatively, at 6 weeks after surgery, at 6 months, and then yearly thereafter. The GraphPad InStat software was used for statistical analysis. A two-tailed \( t \) value was obtained through a Welch corrected unpaired \( t \) test.

**Surgical Procedure**

The patient was placed supine with a tourniquet around the thigh. A 6-cm incision was made over the dorsum of the foot in line with the extensor hallucis longus tendon. The interval between the extensor hallucis longus and extensor hallucis brevis was used to expose the first and second tarsometatarsal joints. The medial aspect of the second metatarsal was exposed and denuded of soft tissue, and the cortex was perforated to augment the subsequent fusion. The lateral aspect of the base of the first metatarsal was denuded and prepared in a similar fashion. If there was a large prominence at the lateral base of the first metatarsal, it was removed to allow the metatarsal to rotate around the medial cuneiform. The articular cartilage was removed from the opposing surfaces of the first tarsometatarsal joint either with small osteotomes or occasionally with a saw. In patients with a short first metatarsal, only the cartilage was removed to limit further shortening of the ray. Great care was taken to ensure that the cartilage was removed down to the plantar aspect of the joint. The first tarsometatarsal joint is about 30 mm deep. A mini lamina spreader was used to aid exposure and allow complete cartilage removal. If the plantar half of the joint is not adequately prepared, there will be a tendency to fuse the metatarsal in slight dorsiflexion, which is counterproductive. Next, the adductor hallucis tendon was released through a 2-cm incision in the first web space. The lateral first metatarsophalangeal joint capsule was incised longitudinally to allow the sesamoids to reduce. A medial incision was then made over the first metatarsophalangeal joint, and
the capsule was incised longitudinally and any residual bunion prominence removed. The first metatarsal was then reduced parallel to the second, closing the intermetatarsal gap. Bone graft taken from the removed medial eminence was packed in the space between the bases of the first and second metatarsals to aid the fusion. As with a proximal osteotomy, it is possible to internally or externally rotate the metatarsal, and one should ensure that this rotation is correct before and after insertion of the first screw. As mentioned earlier, there is a tendency to overlook the cartilage on the plantar aspect of the tarsometatarsal joint, which will place the first metatarsal in slight dorsiflexion with the fusion. One 3.5-mm cortical screw was then inserted from the cuneiform into the first metatarsal under compression. A second screw was inserted from the medial aspect of the first metatarsal into the base of the second metatarsal to close the intermetatarsal gap securely. With the intermetatarsal gap reduced, the medial capsule was plicated at the first metatarsophalangeal joint to reduce the sesamoids. It is not necessary to overtighten the capsule to maintain the alignment of the hallux. Local bone graft was packed into any bony defects at the bases of the metatarsals.

If hallux valgus was still present with a congruent first metatarsophalangeal joint, an Akin osteotomy of the proximal phalanges was added. The tourniquet was deflated and the wounds closed in layers.

Postoperatively, the foot was immobilized in a slipper cast (fiberglass great toe spica) for 2 weeks, at which time the sutures were removed and a second slipper cast applied for an additional 4 to 6 weeks. The patients were kept heel-touch weight bearing for 6 weeks. If radiographs demonstrated satisfactory progression of the fusion at that time, the cast was removed and physical therapy started. Patients were advised not to return to any vigorous physical activity for at least 3 months, although they could commence swimming and biking at 8 weeks.

RESULTS

At most recent follow-up the AOFAS Hallux Metatarsophalangeal Interphalangeal Scale scores increased from 52 preoperatively to 87 points. A two-tailed t value was obtained through a Welch corrected unpaired t test. The two-tailed p value was <.0001 and considered extremely significant (Table 1).

The average intermetatarsal angle preoperatively was 18 degrees and 8.2 degrees at most recent follow-up. Between the 1-year and 3.7-year follow-up visits, only a .3-degree increase of the intermetatarsal angle was noted. The average hallux valgus angle preoperatively was 37 degrees and 16 degrees at most recent follow-up. There was less than 1-degree increase in the hallux valgus angle from 1 to 3.7 years. It took more than 1 year to regain the preoperative metatarsophalangeal joint range of motion (Table 2). The Visual Analog Pain Scale improved from 5.3 to 1.3 points. The same unpaired t test was used. The two-tailed p value was <.0001 and considered extremely significant (Fig. 2).

At most recent follow-up 85.5% of patients were very satisfied, 5% somewhat satisfied, 8% somewhat dissatisfied, and 1.5% dissatisfied (Figs. 3 and 4).

Complications

Complications included tarsometatarsal nonunion in seven patients. Five patients lost correction and all seven patients had a revision procedure done for pain. Removal of hardware was necessary in 8 patients, minor wound problems occurred in two patients, superficial neuroma in two patients, and transfer metatarsalgia in four. The transfer metatarsalgia was thought to be secondary to a shortened first ray in two patients, and a dorsiflexed first metatarsal in two.

Two patients who were dissatisfied had a nonunion of their tarsometatarsal fusions. One required a single bone grafting procedure and the other required two revisions before solid fusion. Both went on to a stable union but were unhappy with the entire process. The other five patients with a nonunion went on to full recovery.

<table>
<thead>
<tr>
<th>Table 1: AOFAS Hallux MTP-IP Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Pain:</td>
</tr>
<tr>
<td>Activity limitations</td>
</tr>
<tr>
<td>Footwear requirements</td>
</tr>
<tr>
<td>MTPJ motion</td>
</tr>
<tr>
<td>IPJ motion</td>
</tr>
<tr>
<td>MTP-IP stability</td>
</tr>
<tr>
<td>Callous</td>
</tr>
<tr>
<td>Function</td>
</tr>
<tr>
<td>Alignment</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

The average intermetatarsal angle preoperatively was 18 degrees and 8.2 degrees at most recent follow-up. Between the 1-year and 3.7-year follow-up visits, only a .3-degree increase of the intermetatarsal angle was noted. The average hallux valgus angle preoperatively was 37 degrees and 16 degrees at most recent follow-up. There was less than 1-degree increase in the hallux valgus angle from 1 to 3.7 years. It took more than 1 year to regain the preoperative metatarsophalangeal joint range of motion (Table 2). The Visual Analog Pain Scale improved from 5.3 to 1.3 points. The same unpaired t test was used. The two-tailed p value was <.0001 and considered extremely significant (Fig. 2).

At most recent follow-up 85.5% of patients were very satisfied, 5% somewhat satisfied, 8% somewhat dissatisfied, and 1.5% dissatisfied (Figs. 3 and 4).
Table 2: Angle measurements and range of motion

<table>
<thead>
<tr>
<th></th>
<th>Baseline Mean (SD: n = 105)</th>
<th>1 Year Mean (SD: n = 105)</th>
<th>3.7 Years Mean (SD: n = 97)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intermetatarsal angle (degrees)</td>
<td>18.0 (3.2)</td>
<td>7.9 (1.9)</td>
<td>8.2 (1.8)</td>
</tr>
<tr>
<td>Hallux valgus angle (degrees)</td>
<td>37.1 (7.2)</td>
<td>15.7 (2.9)</td>
<td>16.0 (3.1)</td>
</tr>
<tr>
<td>MTPJ dorsiflexion</td>
<td>66.4 (13.0)</td>
<td>59.4 (12.4)</td>
<td>65.0 (11.2)</td>
</tr>
<tr>
<td>MTPJ plantarflexion</td>
<td>29.6 (12.6)</td>
<td>27.2 (10.1)</td>
<td>30.5 (11.4)</td>
</tr>
</tbody>
</table>

(Means ± Standard Deviations)

Fig. 2: Visual Analog Pain Scale.

One was very satisfied, one somewhat satisfied, and two somewhat dissatisfied. Six further patients were somewhat dissatisfied, and five were only somewhat satisfied. The most common reason for this response was unrealized expectations (nine patients). Five were women who mentioned the following problems: inability to wear high-heeled shoes, discomfort over scars, not the desired cosmetic effect, and mild pain with recreational activities.

DISCUSSION

Almost every report in the literature on hallux valgus surgery present excellent results with a specific procedure. Very few, however, are prospective outcome studies. The best method to truly compare results is to do a prospective, blinded, controlled study that compares two procedures in two demographically similar groups. This study evaluates a single group, and although still not ideal, the prospective nature makes it much more reliable than any retrospective study. In
addition, we had a very high retention rate of the patient group. At an average of 3.7 years, 91 of the original 101 patients were followed. The Lapidus procedure is probably one of the more technically demanding hallux valgus procedures available. Some of the concerns are the difficulty in sagittal and coronal orientation, fusion of the tarsometatarsal joint in dorsiflexion thereby elevating the first ray, shortening of the first ray, and nonunion of the tarsometatarsal joint fusion.9

Nonunion of the first tarsometatarsal joint fusion is the most problematic complication. The nonunion rate at the tarsometatarsal joint is between 2% and 10% for unilateral procedures and up to 33% for bilateral procedures.6,7,9 Therefore, simultaneous bilateral Lapidus procedures are not recommended. The high nonunion rate is believed to be the result of the orientation of the joint perpendicular to the weight-bearing axis of the foot, which results in a shear force across the joint, while most of the shaft osteotomies result in a compression force due to the horizontal plane of the osteotomy. This also requires immobilization and protected weight-bearing after the Lapidus procedure for a much longer time than after most of the other hallux valgus procedures. The non-union rate can be reduced by meticulous technique. Adequate subchondral bone should be exposed, either by multiple subchondral perforations with a small diameter drill or “crushing” of the subchondral plate with an osteotome. It is advisable to keep the patient minimally weight bearing for 8 weeks.10

Further complications include malunion, with dorsal elevation being the most common, and shortening of the first ray. The Lapidus procedure is not indicated if the first ray is more than 1.5 cm shorter than the second, unless the lesser metatarsals are shortened at the time of the procedure with either a Weil or shaft osteotomy.1 In this study only two patients needed a Weil osteotomy of the second metatarsal at the time of their primary procedure. Four patients had moderate transfer metatarsalgia at 3.7 years that was not surgically treated. Two were thought to be secondary to a short first ray and two caused by elevation of the first metatarsal. Dorsal malunion usually is the result of inadequate removal of cartilage or bone from the plantar aspect of the tarsometatarsal joint. The joint is about 30 mm deep and sometimes difficult to see all the way down. It is advisable to use a mini lamina spreader to open the joint to allow proper removal of the plantar cartilage. Plantarflexing the first metatarsal a few degrees should be attempted.

The dorsalis pedis artery enters the first intermetatarsal space about 1 to 1.5 cm distal to the tarsometatarsal joint. Overzealous dissection could compromise the artery, but this was not encountered in the study.

Over the past year, two modifications have been made. Four-millimeter, self-tapping cortical screws are used instead of 3.5-mm screws, and platelet rich concentrate, (Symphony, DePuy, Warsaw, IN) is used at the fusion site in smokers. These two modifications have reduced the nonunion rate, but follow-up is not long enough to be included in this study.

There is no single procedure that will work for all hallux valgus deformities. It is best to have “horses for courses” and plan each individual surgery with all the potential pitfalls of the surgery and the pathology in mind.9 With proper technique and attention to detail, the Lapidus procedure is an excellent alternative for moderate to severe metatarsus primus varus and hallux valgus deformities. This is only an intermediate term study, but the recurrence rate, once the fusion is solid, is extremely low.

REFERENCES

5. **Grace, D; Delmonte, R; Catanzariti, AR; Hofbauer, M:** Modified Lapidus arthrodesis for adolescent hallux abducto valgus. J. Foot Ankle Surg. 38:8–13, 1999.

6. **Kitaoka, HB; Alexander, IJ; Adelaar, RS; Nunley, JA; et al:** Clinical rating systems for the ankle-hindfoot, midfoot, hallux, and lesser toes. Foot Ankle Int. 15:349–353, 1994.


