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Clinical Research

Utilization of the Modified Lapidus Procedure for Correction of Moderate to Severe Hallux Valgus Deformity With Increased Distal Metatarsal Articular Angle

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Abstract: *Background: Hallux valgus, a common deformity treated by orthopaedic foot and ankle surgeons, can frequently present with an increased distal metatarsal articular angle (DMAA), which may require correction in addition to the hallux valgus deformity. Thus, we investigated the efficacy of the modified Lapidus procedure, a triplanar correction, in correcting the DMAA in hallux valgus surgery. Methods: A retrospective chart review was performed on patients who underwent the hallux valgus reconstruction with a modified Lapidus procedure between April 26, 2018, and November 19, 2020. Exclusion criteria included patients with inadequate follow-up. Hallux valgus angle (HVA), intermetatarsal angle (IMA), and DMAA were measured on preoperative weight-bearing, 2-week postoperative non-weight-bearing, and at final follow-up weight-bearing radiographs. Results: The study included a total of 99 cases of modified Lapidus procedure for hallux valgus on 85 subjects. On radiologic assessment, the average DMAA decreased from 17.72 ± 6.18 degrees preoperatively to 9.19 ± 5.19 degrees 2 weeks postoperatively ($P < .0001$) and 9.79 ± 4.62 degrees at the final follow-up ($P < .0001$). The average HVA decreased from 31.34 ± 10.39 degrees preoperatively to 13.34 ± 6.16 degrees 2 weeks postoperatively ($P < .0001$) and 15.05 ± 7.43 degrees at final follow-up ($P < .0001$). Last, the IMA decreased from 14.99 ± 3.82 degrees preoperatively ($P < .0001$) to 4.66 ± 2.59 degrees 2 weeks postoperatively and 6.62 ± 3.46 degrees at final follow-up ($P < .0001$). The recurrence rate was 3.03%. Conclusion: The modified Lapidus procedure is an effective procedure in correcting the HVA, IMA, and DMAA in hallux valgus surgery without the need for additional distal or proximal metatarsal osteotomies. Surgeons should consider this technique in patients with moderate to severe hallux valgus deformity who may require correction of their DMAA.*

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Level of Evidence: *Level IV- Retrospective comparative study.*

Keywords: forefoot disorders; hallux disorders; hallux valgus; hallux valgus surgery; DMAA; Lapidus; modified Lapidus; triplanar correction; hallux valgus deformity; modified Lapidus procedure; distal metatarsal articular angle; DMAA correction

Introduction

Hallux valgus is a common deformity of the forefoot that presents with pain, stiffness, shoe wear problems, and swelling of the great toe. While conservative treatment may alleviate symptoms, definitive correction of hallux valgus is surgical. Over 100 different surgical procedures, including the McBride procedure, distal metatarsal osteotomies, metatarsal shaft osteotomies, the Akin osteotomy, Metatarsophalangeal (MTP) fusions, and first tarsometatarsal (TMT) fusions, have been utilized in the treatment of hallux valgus with varying levels of success.[1,2]

The angles that are commonly corrected in the treatment of hallux valgus are the hallux valgus angle (HVA), intermetatarsal angle (IMA), hallux valgus interphalangeal angle (HVIA), and the distal metatarsal articular angle (DMAA). The DMAA is the angle between a perpendicular line to the first metatarsal anatomic axis and a line delineating the distal articular surface and can frequently be increased in cases of hallux valgus.[3] The DMAA not only represents a deformity of the hallux, but it is also associated with the postoperative recurrence of hallux valgus.[4-6] Specific procedures such as the double and triple first ray osteotomies, biplanar chevron osteotomy, and revolving scarf osteotomy have been shown to successfully treat hallux valgus with an increased DMAA.[7-9] Despite their effectiveness, double and triple osteotomies require the combination of multiple osteotomies and procedures to correct the DMAA with their associated complications.[10,11]

The modified Lapidus procedure (MLP) is a surgical procedure that utilizes a triplanar correction of the first ray at the first TMT joint to correct the IMA and HVA. Although it is established as a treatment for hallux valgus, the impact of the MLP on hallux valgus with an increased DMAA is not well described.[12-14] Given the 3-dimensional nature of this deformity, it is possible that through correcting the deformity at the first TMT joint, the MLP may also correct the DMAA. Thus, we investigated the efficacy of the MLP in correcting the DMAA.

Methods

After Institutional Review Board, a retrospective chart review was performed on patients who underwent hallux valgus reconstruction with an MLP between April 26, 2018, and November 19, 2020. Surgery was performed by 2 fellowship trained orthopaedic foot and ankle surgeons. A total of 87 patients and 101 feet were included in the initial analysis. Exclusion criteria included any patient undergoing hallux valgus correction who did not receive an MLP and patients with inadequate follow-up or imaging. The final analysis included 85 patients and 99 feet. The average follow-up to the initial postoperative imaging was 13.6 days. The average total follow-up, defined as the time from the surgery until the final postoperative imaging, was 162.2 days.

Surgical Procedure

A standard dorsal medial approach to the patient's first TMT joint was done. An oscillating saw was used to resect the plantar eminence of the joint. Then, a de-rotational pin was placed. A lateral release of the first metatarsophalangeal joint was performed if needed based on the ability to correct the rotation, HVA, and/or IMA. The de-rotational pin along with a joint seeker and C-clamp device (Treace Medical Concepts, Ponte Vedra, FL, USA) was used to de-rotate the first metatarsophalangeal joint and correct the metatarsal primus varus and hallux valgus. At this time, acceptable correction of the HVA and IMA was confirmed with fluoroscopic imaging. Then, a cut guide (Treace Medical Concepts) was placed over the first TMT joint and pinned in place, and the cuts were confirmed fluoroscopically. The distal portion of the medial cuneiform and proximal portion of the first metatarsal base were then resected. Next, one of the pins was removed and a compressor distractor was utilized. The joint was then distracted, the bony cuts were removed, and the joint was compressed. Final fixation was then performed. Finally, acceptable correction across the first TMT joint as well as acceptable correction of the HVA, IMA, and DMAA were confirmed with fluoroscopic imaging. The majority of patients then had a medial approach to the first MTP joint, and a silver bunionectomy along with medial capsulorrhaphy was performed. No distal or proximal metatarsal osteotomies were performed in any patients.

Postoperatively, the patients were non-weight-bearing for 4 to 6 weeks and then progressed to full weight-bearing over an additional 2 weeks in a postoperative shoe or Controlled Ankle Movement (CAM) walking boot. Patients were allowed to return to a regular shoe between 8 and 10 weeks.

Data Collection and Statistical Analysis

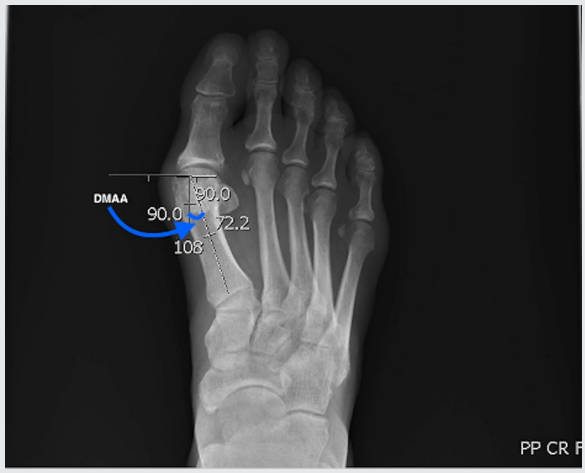
Patient demographic data including gender and age were collected. Recurrence rate was also recorded.

The DMAA was measured as the angle between the long axis of the first metatarsal and a line through the base of the distal articular surface (Figure 1). Radiologic analysis was done on the preoperative, first postoperative non-weight-bearing and final weight-bearing Anteroposterior (AP) foot radiographs to measure the DMAA, HVA, and IMA (Figures 2-4). All radiographic analysis was performed by an independent examiner who was not involved in any of the surgical procedures or patient care.

A paired-comparison *t* test was done to determine the statistical significance between the mean preoperative and mean postoperative values for the DMAA, HVA, and IMA on the 2-week postoperative non-weight-bearing radiographs and at final follow-up weight-bearing radiographs. A *P* value of $<.001$ was used for statistical significance.

Figure 1.

Calculation of the DMAA.



The DMAA is calculated as the difference between the angle between the long axis of the first metatarsal and a line through the base of the distal articular surface and the angle perpendicular to the line through the base of the distal articular surface of the first metatarsal.
Abbreviation: DMAA, distal metatarsal articular angle.

Figure 2.

The weight-bearing preoperative DMAA in this patient was 18.7 degrees.

Abbreviation: DMAA, distal metatarsal articular angle.

Figure 3.

The 2-week non-weight-bearing postoperative DMAA was 8.2 degrees.

Abbreviation: DMAA, distal metatarsal articular angle.

Figure 4.

At the final weight-bearing postoperative evaluation, the DMAA was measured at 7.3 degrees.

Abbreviation: DMAA, distal metatarsal articular angle.

Results

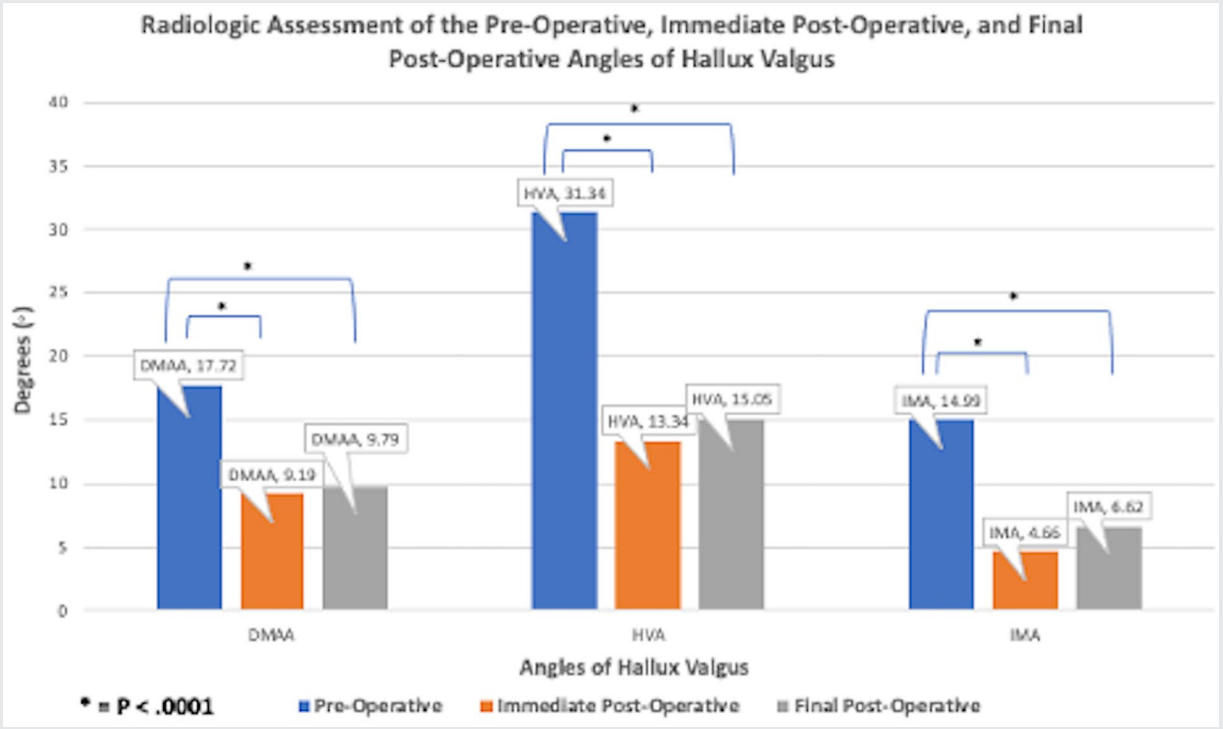
The study included a total of 99 feet or 85 patients. Radiologic assessment showed that the average DMAA decreased from 17.72 ± 6.18 degrees preoperatively to 9.19 ± 5.19 degrees 2 weeks postoperatively on non-weight-bearing radiographs ($P < .00001$). In addition, radiologic assessment of the HVA showed a significant decrease from an average angle of 31.34 ± 10.39 degrees preoperatively to an average angle of 13.34 ± 6.16 degrees 2 weeks postoperatively on non-weight-bearing radiographs ($P < .0000$)1. Last, radiologic assessment showed that the IMA decreased from 14.99 ± 3.82 degrees preoperatively to 4.66 ± 2.59 degrees 2 weeks postoperatively on non-weight-bearing radiographs ($P < .00001$).

The average DMAA of the final weight-bearing postoperative imaging was 9.79 ± 4.62 degrees. When compared with the average DMAA preoperatively, the final postoperative DMAA average was significantly different ($P < .0001$). The average HVA of the final weight-bearing postoperative imaging was 15.05 ± 7.43 degrees. When compared with the average HVA preoperatively, the final postoperative HVA average was significantly different ($P < 0.0001$). The average IMA of the final weight-bearing postoperative imaging was 6.62 ± 3.46 degrees. When compared with the average IMA preoperatively, the final postoperative IMA average was significantly different ($P < .0001$; Figure 5).

The rate of recurrence, which was defined as the clinical recurrence of deformity, was 3.03% or 3 out of the 99 total cases. For the 3 cases of recurrence of hallux valgus, the average preoperative DMAA was 17.2 degrees,

Figure 5.

The pre-, 2-week post-non-weight-bearing, and final postoperative weight-bearing radiographic means of the DMAA, HVA, and IMA, respectively.



Abbreviations: DMAA, distal metatarsal articular angle; HVA, hallux valgus angle; IMA, intermetatarsal angle.

the HVA was 33.1 degrees, and the IMA was 16.3 degrees. The 2-week postoperative non-weight-bearing average DMAA was 13.1 degrees, the HVA was 19.0 degrees, and the IMA was 5.6 degrees. The final weight-bearing postoperative average DMAA was 9.8 degrees, the HVA was 25.1 degrees, and the IMA was 13.8 degrees.

Discussion

Our study demonstrated the MLP to be an effective procedure for the correction of increased DMAA in hallux valgus surgery without the need for additional distal or proximal osteotomies. Radiological assessment showed the mean DMAA of the patients decreased from 17.72 degrees preoperatively to 9.19 degrees 2 weeks postoperatively but maintained their correction at 9.79 degrees at an average of 5.4 months. In addition, the MLP showed appropriate correction of the HVA and IMA with a very low rate of recurrence of 3.03%.

Correction of hallux valgus deformity continues to be studied and explored, as many procedures are still described with a relatively high recurrence rate.[15] When considering correction of hallux valgus deformity, the surgeon must consider the size of the HVA, IMA, DMAA, and HVIA and if there is first TMT instability. Not every type of hallux valgus correction can accomplish the tasks of addressing these 5 components.

When considering correction of the DMAA, several techniques have been described to accomplish correction of the DMAA, HVA, and IMA. For mild to moderate hallux valgus deformity with no first TMT instability, the biplanar chevron has shown to be effective.[8] Nery et al showed that 94% of patients with increased DMAA who underwent biplanar chevron had maintained correction at 2 years.[8] However, again this osteotomy has its limitation and often only can be used in patients with mild to moderate deformity.

The first double metatarsal osteotomy (DMO) is another procedure that can be utilized when treating hallux valgus with an increased DMAA. Johnson et al looked at 9 adolescent patients and 14 feet with severe hallux valgus deformity and increased DMAA who underwent a DMO. They showed 90% of patients had good to excellent results, and the complication rate was 14%.[16] In addition, Park et al looked at 16 cases of DMO done in 14 adult patients with mild to moderate hallux valgus deformity and an increased DMAA. Although there was substantial improvement in the DMAA with a DMO, they showed a high recurrence rate and complication rate.[17] The DMO is limited

in the treatment of hallux valgus with an increased DMAA by a high complication rate, as seen in the cases of both adolescents and adults.[16,17]

The scarf osteotomy has been described as a single osteotomy to correct the HVA, IMA, and DMAA in hallux valgus. A study by George et al investigated the treatment of moderate to severe hallux valgus with an increased DMAA by scarf osteotomy in 19 feet of 13 adolescent patients. The mean DMAA was successfully reduced from 17.1 weeks preoperatively to 8.06 weeks postoperatively, but the rate of recurrence was 36.8%.[18] In addition, Wang et al looked at the revolving scarf procedure in the correction of the DMAA in 32 feet with severe hallux valgus deformity. They showed good functional outcomes with no metatarsal shortening or Avascular necrosis (AVN) of the metatarsal head.[9]

The Lapidus procedure is a very common procedure done for hallux valgus correction in severe deformity and those with first TMT instability. It is not technically demanding and has a relatively low complication rate reported as ranging from 7.6% to 13.1%.[19,20] In addition, the nonunion rate with this procedure has overall been reported to be low with studies showing a range of 0% to 5.3%.[20,21]

Over the years, the Lapidus procedure has been modified to include a triplanar correction addressing the 3-dimensional deformity of hallux valgus. Several studies have looked at outcomes and nonunion rates of the MLP. Ray et al looked at the correction of hallux valgus by triplanar first TMT arthrodesis, also known as an MLP, in 62 feet of 57 patients and found an overall nonunion rate of 1.6% and a recurrence rate of 3.2%.[22]

Many studies have also looked at the functional outcomes of the Lapidus procedure for correction of hallux valgus deformity. McInnes and Bouché examined the postoperative functional outcomes of 25 patients with hallux valgus who underwent treatment with an MLP. They showed that 86% of active patients and 75% of sedentary patients were able to return to their preoperative activity levels, and 78% of patients subjectively rated their surgery as "completely" or "very" effective.[23] In addition, Bednarz et al evaluated the functional outcomes of 26 patients who underwent an MLP for the treatment of hallux valgus and found that 100% of the 19 working patients were able to return to full-time work, and it took an average of 8 months for patients to return to unlimited activity. They also found that 96% of patients were satisfied with the procedure and postoperative pain relief.[24]

Our study demonstrates that the MLP can correct the DMAA along with the HVA and IMA without additional metatarsal osteotomies and maintain this correction on average up to 5.4 months with a very low recurrence rate. The MLP is a triplanar correction that provides the benefit of not only being able to correct mild to severe HVA and IMA, but, additionally, the authors have shown it can also correct the DMAA and be used in cases of first TMT instability. This makes the MLP more versatile and able to be used in a large range of hallux valgus correction. Moreover, it is a fairly standardized technique, not requiring an additional osteotomy to correct the DMAA, which may potentially lower the morbidity of patients.

Our study has several limitations including a relatively small sample size. While the data showed a statistically significant change in DMAA, a larger sample size would increase the strength of the results. No inter- and intraobserver reliability was performed as several other studies have already investigated this and we felt it was out of the scope of this study. Additional research in this area can be performed in future studies. In addition, this study focused on the procedures of 2 surgeons with significant experience doing the MLP. A multisurgeon/multicenter study would allow for more generalizable results regarding outcomes and recurrence rate after correction. Furthermore, we had a relatively short follow-up of, on average, 6 months. The goal of the article was to assess the ability of the MLP to correct the DMAA which we were able to show. In addition, we were able to show that with weight-bearing, the DMAA, HVA, and IMA were maintained at almost 6 months follow-up. Long-term studies are needed to assess the ability of the surgery to maintain correction, which was outside the scope of this study. We did not look at functional outcomes in our study, and further research is needed to see the effect of this procedure on outcomes. Despite these limitations of our study, we demonstrated the effectiveness of the MLP in correcting the DMAA along with the HVA and IMA in hallux valgus surgery.

Conclusion

The MLP, a triplanar hallux valgus procedure, seems to be an effective procedure in correcting the DMAA along with the HVA and IMA in hallux valgus surgery without the need for additional distal or proximal metatarsal osteotomies. Surgeons may consider utilizing this surgical technique when patients require correction of their DMAA with moderate to severe hallux valgus deformity.

Declaration of Conflicting Interests

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Ethical Approval

Not applicable, because this article does not contain any studies with human or animal subjects.

Informed Consent

The patient written informed consent has been obtained prior to the case submission.

Trial Registration

Not applicable, because this article does not contain any clinical trials.

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