Combination of First Metatarsophalangeal Joint Arthrodesis and Proximal Correction for Severe Hallux Valgus Deformity

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ABSTRACT

Background: Arthrodesis of the first metatarsal-phalangeal (MTP-1) joint is a widely accepted procedure for the treatment of hallux valgus in patients with MTP-1 degeneration, severe or recurrent deformity, or inflammatory arthritis. This study aimed to evaluate if an additional more proximal correction was beneficial in cases with a severely increased intermetatarsal 1-2 angle (IMA 1-2). Methods: A consecutive series of 18 feet (4 bilateral, all females; mean age, 61 years) with severe hallux valgus and an increased IMA 1-2 treated by MTP-1 fusion and an additional more proximal correction (Mau osteotomy or modified Lapidus procedure) was evaluated. Radiographs were analyzed for IMA 1-2 and hallux valgus angles (HVA), and for the position of the tibial sesamoid according to the AOFAS guidelines. Results: At a mean followup of 14 months, all patients were satisfied or very satisfied with the results of surgery. There were no intraoperative complications. The IMA 1-2 significantly improved from a mean of 18.8 degrees before surgery to 4.6 degrees at followup ($p < 0.001$) and the HVA from a mean of 49.9 degrees to 9.7 degrees ($p < 0.001$), respectively. Sesamoid position improved two grades on average. We found no difference between the Mau osteotomy and the modified Lapidus procedure. Conclusion: The present results indicate that the combination of a more proximal procedure with a MTP-1 arthrodesis in cases of hallux valgus with severely increased IMA 1-2 has a high correction capability and achieved normal HVAs as well as normal IMAs 1-2. This technique appeared to be safe and clinically successful.

Level of Evidence: IV, Retrospective Case Series

Key Words: Hallux Valgus; First Metatarsophalangeal Joint; Arthrodesis; Mau Osteotomy; Lapidus Procedure; Intermetatarsal Angle; Metatarsus Primus Varus

INTRODUCTION

First metatarsophalangeal (MTP-1) joint arthrodesis is a widely accepted method for the treatment of hallux valgus deformity in patients with MTP-1 joint degeneration. In addition, this procedure can be used for patients with more severe deformities, recurrent hallux valgus, or with a deformity secondary to inflammatory arthritis of the joint. MTP-1 arthrodesis allows for an effective correction of both the hallux valgus angle (HVA) and the intermetatarsal 1-2 angle (IMA 1-2). However, in feet with a severely increased IMA 1-2, MTP-1 arthrodesis alone might not be sufficient to adequately address the metatarsus primus varus deformity. Undercorrection of a wide IMA 1-2 after correction of the HVA alone will result in a persistently wide forefoot with potential problems wearing normal footwear and a cosmetically unaesthetic gap between the first and the second toes.

While it has been suggested that an additional basal metatarsal osteotomy might be required in such cases, some authors reported that the degree of IMA 1-2 correction appeared to be sufficient after a MTP-1 fusion performed with a corrected HVA and that they did not advocate an additional more proximal correction. However, these previous reports included a significant proportion of feet with a normal or only mildly increased IMA 1-2.

This study therefore investigated the correction capability of a MTP-1 arthrodesis combined with a proximal correction (Mau osteotomy or modified Lapidus procedure) for the treatment of severe hallux valgus deformity (HVA $\geq$ 40 degrees) and concomitant severe metatarsus primus varus.
MATERIALS AND METHODS

A consecutive series of 18 feet (14 patients, all females) treated for severe hallux valgus deformity by MTP-1 arthrodesis and additional more proximal correction was retrospectively evaluated. Proximal corrections were a modified Lapidus procedure in 12 feet and a metatarsal Mau osteotomy in six feet. All surgeries were performed at our clinic by one single senior surgeon (P.R.) between 2003 and 2009. The mean age at the time of surgery was 61.3 (range, 31 to 83) years. All cases had both a severe hallux valgus deformity (HVA ≥ 40 degrees; mean, 49.9 degrees) with varying degrees of joint degeneration and a severe metatarsus primus varus deformity (IMA 1-2 ≥ 15 degrees; mean, 18.8 degrees). Five of the 18 cases (28%) had a history of rheumatoid arthritis. Four had previous hallux valgus surgery or surgery on the MTP-1 joint. One had flat foot deformity and one had subtalar arthritis due to hemochromatosis.

All but three cases underwent surgery under ankle block anesthesia, two cases were operated under general anesthesia and one under spinal anesthesia. The patient with spinal anesthesia additionally received a knee prosthesis in the same surgical session. All patients underwent a standard primary fusion of the MTP-1 joint using a medial approach and preparation of the MTP joint in a ball and cup shape using a gouge-forceps (luer) and osteotomes. No lateral soft tissue release was performed at the MTP-1 joint. After full correction of the hallux valgus deformity the MTP-1 joint was temporarily fixed by one Kirschner wire. A simulated weightbearing AP radiograph of the foot was then taken under fluoroscopy. If the IMA 1-2 was still increased (10 degrees or more), clinically usually resulting in a remaining increased width of the forefoot and in a gap between the first and the second toe, we decided to add a more proximal procedure for correcting the IMA 1-2. For the Mau osteotomy, the proximal aspect of the first metatarsal was approached by a proximally extended incision and, after identifying the first tarsometatarsal (TMT-1) joint, an oblique osteotomy, situated 1 cm distal to the TMT-1 joint, was made medially from plantar-proximal to dorsal-distal, parallel to the weightbearing surface using a power saw. The osteotomy terminated just proximal to the articular surface of the first metatarsal head and was stabilized using two 2.0-mm lag screws (Figure 1). For the modified Lapidus procedure, a separate dorsomedial incision was made over the TMT-1 joint. A bone wedge was resected within the distal part of the medial cuneiform to allow for the correction of the metatarsus primus varus deformity. Care was taken to remove only as little bone as possible to avoid excessive first ray shortening. The TMT-1 joint was fixed using two crossed 3.5-mm cortical lag screws (Figure 2). Finally, the MTP-1 fusion was stabilized with two crossed 3.5-mm cortical lag screws. Postoperatively, all patients were kept partial weightbearing (15 kg) in a removable walker boot for 6 weeks using crutches.

All patients had weightbearing AP and lateral foot radiographs taken before surgery, at 6 weeks, and at final followup at an average of 14.1 (range, 10 to 39) months after surgery. IMA 1-2s, HVAs, and the position of the
tibial sesamoid relative to the inter-sesamoidal ridge were measured according to the American Orthopaedic Foot and Ankle Society guidelines. All measurements were made on digital radiographs (Jivex software, VISUS Technology, Bochum, Germany). Clinical outcomes were assessed by subjective satisfaction rating of the results of surgery using a Likert-scale (very satisfied, satisfied, neither nor, dissatisfied) and all complications and revisions were recorded. All patients provided written informed consent to participate in this study.

Statistical analyses were performed using SPSS (Version 15, SPSS Inc, Chicago, IL). Paired Student t-tests and Wilcoxon signed rank tests were used to compare HVAs, IMAs, forefoot width and sesamoid position. The Mann Whitney-U test was used to compare differences between the Mau osteotomy group and the modified Lapidus group. *P* values < 0.05 were considered statistically significant.

RESULTS

Mean HVAs significantly (*p* < 0.001) decreased from 49.9 (range, 40.1 to 66.7) degrees preoperatively to 9.7 (range, 4.2 to 17.7) degrees at followup. Mean IMAs significantly (*p* < 0.001) decreased from 18.8 (range, 15.1 to 21.4) degrees to 4.6 (range, 0.7 to 8.0) degrees. Mean sesamoid positions improved from 2.8 (range, 2 to 3) to 0.8 (range, 0 to 2) (Table 1). There were no differences between the Mau group and the modified Lapidus group (Table 2).

Fifteen cases were very satisfied with the results of surgery and three cases were satisfied (Table 1). There were no intra-operative complications. One superficial soft tissue infection was successfully treated with oral antibiotics. All arthrodeses and osteotomies healed uneventfully as confirmed clinically (stable joint) and radiographically (fusion achieved) at final followup. Hardware was removed in one patient with a modified Lapidus because of localized pain that resolved after screw removal.

DISCUSSION

MTP-1 arthrodesis is a successful procedure for the treatment of hallux valgus with degenerative changes of the MTP-1 joint. Previous reports highlighted satisfactory outcomes, also in terms of radiographic results related to the correction of both the HVA and the IMA 1-2. While the HVA can be reliably corrected to normal values with this technique, the correction of increased IMA 1-2 is less predictable. Although previous studies consistently reported improvements in the IMA 1-2, the

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Mean 61.3 14.2 49.9 9.7 18.8 4.6 2.8 0.8

FU, followup; HVA, hallux valgus angle; IMA, intermetatarsal angle; sesamoid, position of the tibial sesamoid.
values of correction differed and ranged from 4.0 degrees to 8.2 degrees.\textsuperscript{5,8,15,16,19} This might be related to the fact that these studies comprised feet with a wide range of deformity severity, also including feet with normal or almost normal IMA 1-2.\textsuperscript{5,8,15,16,19} In feet with severe preoperative metatarsus primus varus, however, the IMA 1-2 could not be sufficiently corrected.

In contrast, all feet in the present series had severe hallux valgus deformities (all HVA \(\geq 40\) degrees) with severe metatarsus primus varus deformities (all but four IMA \(\geq 18\) degrees), therefore representing a more uniform cohort regarding the IMA 1-2 value.

The present results highlight that combining the MTP-1 arthrodesis with a proximal correction (either Mau osteotomy or modified Lapidus procedure) offered a very high correction capability for both the HVA and the IMA 1-2. In all feet, normal IMA 1-2 values were achieved (less than 9.0 degrees) and a mean IMA 1-2 improvement of 14.2 degrees is far more than indicated by previous reports.\textsuperscript{5,8,15,16,19} Undercorrection of a preoperatively wide IMA 1-2 will result in a remaining increased width of the forefoot with persistent problems in normal footwear and a cosmetically unaesthetic gap between the first and second toes (Figure 3, A and B; Figure 4, A and B). Furthermore, we postulate that an increased IMA 1-2 after MTP-1 arthrodesis could cause metatarsalgia due to an altered windlass mechanism. In such cases, the addition of a more proximal correction might be required to further reduce the IMA 1-2 to normal values resulting in a radiographically and clinically improved result (Figure 3, C and D; Figure 4, C and D). The position of the tibial sesamoid was improved by at least two grades in this study. This observation also suggests a higher potential for correction than with a MTP-1 arthrodesis alone, considering that Pydah et al.\textsuperscript{15} reported an improvement of the tibial sesamoid position of only one grade.

We could not find differences between the Mau osteotomy and the modified Lapidus procedure, however, the number of patients treated does not offer enough power to show minor differences. While we routinely performed the modified Lapidus procedure for the first 12 cases of this series because we were very familiar with this procedure, we acknowledge there are potential disadvantages of a TMT-1 arthrodesis and advantages of the Mau osteotomy. The modified Lapidus procedure shortens the first metatarsal,

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<td>Mean HVA difference</td>
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<td>Mean IMA difference</td>
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<td>Mean sesamoid position difference ((95% \text{ CI}))</td>
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HVA, hallux valgus angle; IMA, intermetatarsal angle; CI, confidence interval.

\begin{figure}
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\includegraphics[width=\textwidth]{foot_and_ankle_international_vol_33_no_5_may_2012_combined_procedures_for_hallux_valgus_403.png}
\caption{A. Preoperative radiograph of severe hallux valgus deformity and a degenerative MTP-1 joint. B. After temporary fixation of the MTP-1 joint in physiologic valgus, the IMA 1-2 remained increased. C. The incision was therefore extended proximally and a Mau osteotomy was performed. D. The osteotomy was fixed with two 2.0-mm lag screws. The IMA 1-2 was corrected to a normal value following this additional proximal correction.}
\end{figure}
has an increased risk of pseudarthrosis, and requires an additional incision. Although all TMT-1 fusions in this series healed uneventfully, the Mau osteotomy might have a lower pseudarthrosis risk, a very low risk of first metatarsal shortening, and it can be easily performed by extending the incision proximally. We now therefore recommend the Mau osteotomy as proximal correction procedure of first choice when combining with a MTP-1 arthrodesis.

With regard to the modified Lapidus, which is an isolated TMT-1 arthrodesis, one might assume that two fusions (MTP-1 and TMT-1) cause more adverse biomechanical effects on the first ray than a MTP-1 fusion alone. However, the modified Lapidus procedure leaves the joints between the medial cuneiform and the second metatarsal as well as between the medial and intermediate cuneiform intact. It has been demonstrated biomechanically that most of the motion in the medial tarsometatarsal joint complex occurs in the latter joints and not in the TMT-1 itself (maximum displacement of 2.6 mm, or less than 4 degrees of motion in the sagittal plane).12,20 Therefore, the loss of motion related to an additional TMT-1 fusion is minimal. Furthermore, metatarsus primus varus deformity might be associated with increased TMT-1 mobility, and fusion of this joint therefore directly addresses this pathomechanism.12

This study has some limitations. First, this study is retrospective with radiographic followups at about 6 weeks and 1 year postoperatively and we hence cannot present exact data on the time to fusion. Nevertheless, all arthrodeses and osteotomies healed uneventfully and there occurred no pseudarthrosis. Second, we have no matched control group using MTP-1 arthrodesis alone. However, comparing the present results with those reported in the literature, an IMA 1-2 correction of 14.2 degrees appears to be significantly higher than the 4.0 degrees to 8.2 degrees that have been indicated in previous investigations.5,8,15,16,19 Finally, we did not use standardized outcome measure for assessing the clinical results. Nonetheless, we could show that all patients were satisfied or very satisfied, and the study question was focused on the radiographic outcome.

CONCLUSION

The present study offers evidence that MTP-1 fusion combined with a more proximal correction procedure can substantially reduce the IMA 1-2 in hallux valgus deformities with severe metatarsus primus varus. In cases with severe hallux valgus deformity and a preoperative IMA of 15 degrees or more, an additional proximal correction might be considered. Based on potential risks and advantages and also considering similar radiographic outcomes, we favor the Mau osteotomy instead of the modified Lapidus procedure when performing this type of surgery.

EDITOR’S NOTE

The authors have done a nice job showing that adding a proximal procedure will help decrease the IMA angle in this patient population. One reviewer felt that the necessity for a proximal procedure was not proven by this study and therefore it should not be published. Since no clear answer exists, the study has been published to show that it can be successful, at least radiographically. Ideally, a prospective study will be done to determine whether the addition of a proximal procedure improves the patient’s clinical outcome.

REFERENCES


