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Radiographic Recurrence of Deformity After Hallux Valgus Surgery in Patients With Metatarsus Adductus

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Abstract

Background: Metatarsus adductus (MA) is a congenital condition that may lead to the development of hallux valgus (HV). The associated anatomic deformities may lead to recurrence of the HV in patients with MA. The goals of the study were to identify radiographic rates of recurrence of HV following surgery for HV in patients with MA.

Methods: Between 2002 and 2013, 587 patients who underwent HV surgery were retrospectively identified. The radiographic parameters recorded included the hallux valgus angle (HVA), the intermetatarsal angle (IMA), and the metatarsus adductus angle (MAA) obtained from initial radiographs and at final follow-up. The MAA was considered abnormal if the value was greater than 20 degrees. Radiographic recurrence was defined as HV deformity >20 degrees.

Results: The rate of radiographic recurrence of HV was 15% in patients without MA and 29.6% in patients with MA ($P < .05$). In the group with MA, rate of deformity recurrence did not differ among the operative procedures performed (Lapidus, 28.5%; distal first metatarsal osteotomy, 29.4%; proximal first metatarsal osteotomy, 28.9%). Patients with severe MA (MAA > 31 degrees) were found to have a recurrence rate of 18%, whereas those with less severe MA (MAA < 31 degrees) were found to have a recurrence rate of 82%. Of the patients with severe MA who did not have radiographic recurrence of HV, 60% had undergone a Lapidus arthrodesis and realignment arthrodesis of the second/third tarsometatarsal joints.

Conclusion: The rate of radiographic recurrence for patients with MA undergoing HV correction was ~30%. This finding was consistent with our hypothesis that MA increases the risk of radiographic recurrence of HV deformity irrespective of the procedure performed. We believe the lower rate of recurrence of HV among patients with severe MA deformities is suggestive that more complete management of the deformity is warranted.

Level of Evidence: Level III, retrospective comparative series.

Keywords: metatarsus adductus, hallux valgus, recurrence

Introduction

One of the most common deformities of the forefoot is hallux valgus. It is frequently seen in adults, although children and adolescents may be affected as well. Hallux valgus develops from imbalances in the dynamic muscular support structures around the first metatarsophalangeal joint. These imbalances are accompanied by structural changes that give the characteristic deformities seen on clinical presentation; on examination, there is lateral deviation of the great toe and medial deviation of the first metatarsal.

Symptomatic hallux valgus that is refractory to conservative measures may be treated with surgery, and osteotomies of the first metatarsal or arthrodesis procedures of the first tarsometatarsal joint are utilized. Recurrence of deformity is, however, a complication, which can occur regardless of the type of procedure used. In a review of more than 200 patients who had failed prior hallux valgus surgery with a distal Mitchell osteotomy, Kilmartin et al found a recurrence rate of 26%.[6] Fokter et al found a 47% recurrence rate with use of the distal Mitchell osteotomy.[5] The recurrence rate following the distal chevron osteotomy has been reported to be 10% in 300 consecutive cases, and in another study a 16% recurrence rate was noted.[1,11] The exact causes for recurrence have been speculative. In a retrospective study of 16 patients with severe hallux valgus, Iyer et al found a

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64.7% (11 of 16 patients) recurrence rate after use of a proximal medial opening wedge osteotomy of the first metatarsal to treat hallux valgus, and recurrence was associated with greater preoperative hallux or articular surface deformity.[10] Raikin and colleagues noted a multifactorial etiology to recurrence after hallux valgus surgery, with rates of deformity recurrence varying between 3% and 16%.[19]

The current authors recently demonstrated a 30% (173 patients) prevalence of MA among 587 patients who underwent hallux valgus surgery over a 10-year period.[2] We propose that the presence of MA may account for radiographic recurrence of deformity in certain cases. The goal of this study was to identify the frequency of recurrent deformity in MA patients who had undergone operative correction for symptomatic hallux valgus and to identify differences in the rate of radiographic recurrence of deformity among commonly performed procedures for hallux valgus correction.

Methods

This retrospective study was conducted after obtaining approval from the Institutional Review Board. We examined the weightbearing radiographs of 750 patients who underwent hallux valgus surgery between 2002 and 2013 with either a distal or proximal first metatarsal osteotomy or a Lapidus procedure. This database included clinical data from 4 fellowship-trained, orthopedic foot and ankle surgeons. The attending surgeon performed surgeries, with the assistance of a fellowship trainee. One hundred sixty-three patients were missing adequate pre- or postoperative radiographs and were excluded and a total of 587 patients formed our study cohort.

The presence of first ray instability (transverse or sagittal plane) or tarsometatarsal (TMT) arthritis was treated with a modified Lapidus arthrodesis. Instability of the medial ray was defined as excessive motion of the first metatarsal in the coronal and sagittal planes. It was assessed both clinically and radiographically as previously described by the senior author.[17] Clinical evaluation of first TMT instability involved firmly supporting the lateral column/midfoot and gently manipulating the first metatarsal between the thumb and index finger of the examiner's contralateral hand. This was compared to the contralateral foot. Radiographically, hypermobility was defined as periosteal thickening of the second metatarsal diaphysis, plantar gapping of the first TMT on the lateral radiograph or dorsal/plantar subluxation of the first metatarsal relative to the medial cuneiform.[17] If the intermetatarsal angle (IMA) was less than 16 degrees, a distal first metatarsal osteotomy was performed (chevron), and if greater than 16 degrees, a proximal first metatarsal osteotomy was performed (Scarf or Ludloff). Patients were included in this study if there was adequate radiographic and clinical follow-up contained within the institutional and electronic medical record. Minimum radiographic parameters that were collected from weight-bearing views of the feet to include pre- and postoperative hallux valgus angles (HVA), the 1-2 IMA and the MAA at a minimum of 1 year of follow-up. Measurement of the HVA and the IMA was completed as previously described.[4]

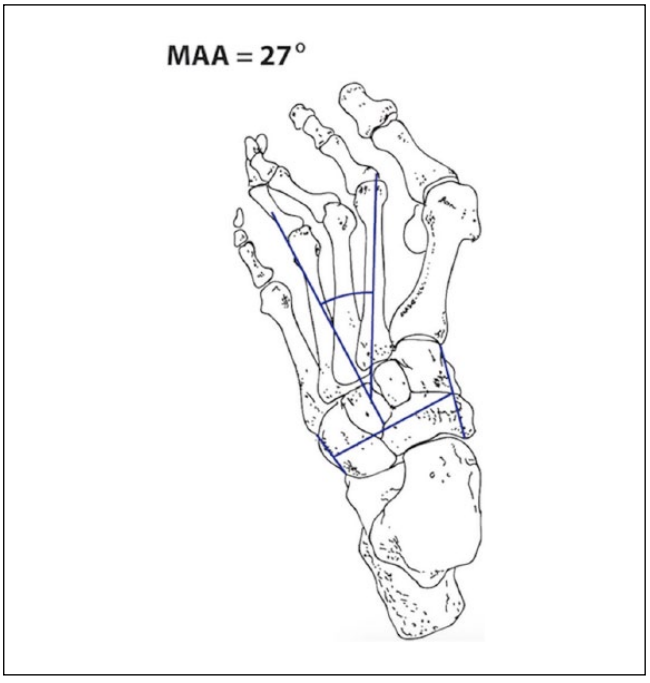

Figure 1. Procedure for measurement of the metatarsus adductus angle (MAA). MAA was measured as follows: a straight line connecting the distal aspect of the medial cuneiform to the most proximal aspect of the navicular was drawn; a line was drawn connecting the most proximal and distal aspects of the cuboid (at the lateral aspect of the fifth TMT); a third line connecting the midpoint of these first 2 lines was drawn; a fourth line perpendicular to the third one was drawn; a fifth line was drawn along the long axis of the second metatarsal, and the angle measured between lines 4 and 5 was defined as the MAA.

For the purposes of this study, the MAA was considered abnormal if greater than 20 degrees.[14,20] The measurement technique of the MAA was standardized for the study. A straight line connecting the distal aspect of the medial cuneiform to the most proximal aspect of the navicular was drawn. Similarly, a line was drawn connecting the most proximal and distal aspects of the cuboid (at the lateral aspect of the fifth TMT). A third line connecting the midpoint of these first 2 lines was drawn. A fourth line perpendicular to the third one was drawn. A fifth line was drawn along the long axis of the second metatarsal. The angle measured between lines 4 and 5 was defined as the MAA[2,6,7] (Figure 1). Multiple radiographic techniques exist to evaluate the MAA, with high interobserver and intraobserver reliabilities,[6] but in a previous publication, the current authors demonstrated high inter- and intraclass coefficients for this technique.[2]

Table 1. Impact of Metatarsus Adductus on the Hallux Valgus Angle, Intermetatarsal Angle, and on the Recurrence of Hallux Valgus.

	Preoperative HVA (degrees)	Postoperative HVA (degrees)	Preoperative IMA (degrees)	Postoperative IMA (degrees)	Recurrence of HV (%)
Non-MA	25	12	13.8	6.9	15.2
MA	33.6	16.8	11.8	7.4	28.9

Abbreviations: HV, hallux valgus; HVA, hallux valgus angle; IMA, intermetatarsal angle; MA, metatarsus adductus.

Table 2. Rates of Radiographic Recurrence stratified by Procedure Type.

Procedure	Number of patients with MA	Rate of recurrence (%)
Lapidus	10	28.5
Proximal first metatarsal osteotomy	5	28.9
Distal first metatarsal osteotomy	35	29.4

The patients were divided into those with and without MA ("MA group" and "non-MA group," respectively). The type of surgery did not influence whether patients were placed into one group or another because the presence of MA did not affect operative decision making with regard to the procedure completed. The most recent postoperative follow-up radiograph was used to measure the HVA. Radiographic recurrence was defined as an HVA greater than 20 degrees at the most recent follow-up after initial weight-bearing postoperative radiographs (average of 4-6 weeks postoperation) showed an HVA of less than 20 degrees. The minimum follow-up was of 1 year. The objectives of this study were as follows:

1. Compare the rates of recurrence of HV between the MA and non-MA group.
2. Stratify the rates of deformity recurrence by the procedure performed.
3. Assess the influence of the severity of the MA deformity on the incidence of recurrence of hallux valgus

Statistical analysis was completed with Excel (Microsoft, Seattle, WA). A level of significance was set at $P < .05$

Results

Rate of Deformity Recurrence

One hundred seventy-three of the 587 were found to have MA (29.5%). In the non-MA group the preoperative IMA was found to be an average of 13.8 degrees, and in this group the postoperative IMA averaged 6.9 degrees. In the MA group, the preoperative IMA averaged 11.8 degrees and postoperatively averaged 7.4 degrees. Radiographic recurrence of hallux valgus in the MA group was identified in 50 patients (28.9%) (Table 1). On average, radiographic signs of deformity recurrence were observed 32 weeks (range 3–488 weeks) postoperatively in patients with MA. The rates of recurrence delineated by procedure are presented in Table 2. An illustration depicting radiographic recurrence after each type of procedure included in the study is shown in Figures 2, 3, and 4.

Of the 414 patients who did not have MA, radiographic recurrence of hallux valgus was found in 63 patients (15.2%). The difference between recurrence rates in the MA group versus the non-MA group was evaluated with a chi-squared test and was statistically significant ($P < .0001$).

Impact of Severity on Deformity Recurrence

Of the 50 patients with MA who had recurrent HV, we stratified the results by severity of the deformity. A severe MA deformity was defined as MAA >31 degrees , whereas a less severe MA deformity was defined as an MAA <31 degrees. Those with severe MA had a recurrence rate of 20% (10 of 50 patients). In contrast, those with less severe MA (MAA <31 degrees) were found to have a recurrence rate of 80% (40 of 50).

Severe MA. A total of 19 patients were found to have severe MA deformity (Table 3). As noted, the rate of deformity recurrence was 20% in this group. Of the 10 patients with deformity recurrence, 2 patients (20%) underwent more aggressive corrective procedures with a closing wedge realignment arthrodesis of the first, second, and third TMT joints. In contrast, of the 9 patients who did not have recurrence of the deformity, 6 (66%) underwent a realignment arthrodesis of the first, second, and third TMT joints.

Although there were a high percentage of lesser toes deformities (53%) in the severe MA group, only 2 patients (11%) had valgus deformities of the lesser toes preoperatively. Both patients underwent a realignment arthrodesis of the first, second, and third TMT joints. Neither patient had

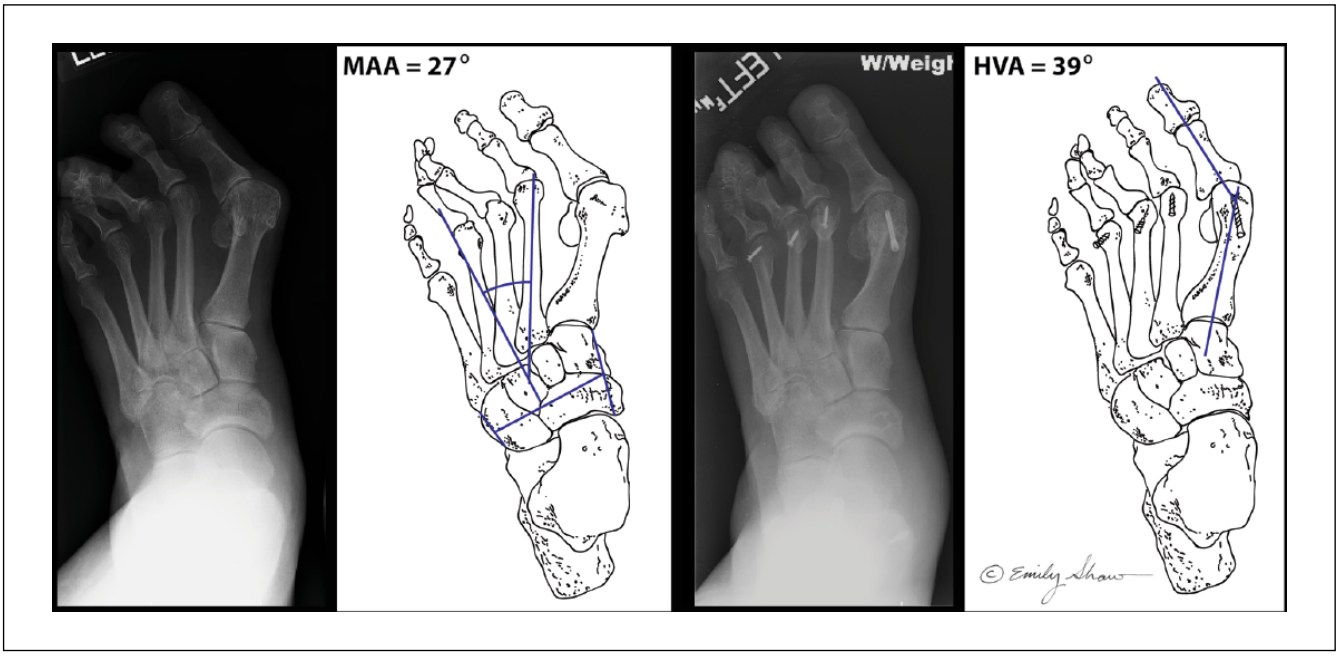

Figure 2. Recurrence of deformity after a distal first metatarsal (chevron) osteotomy in the setting of metatarsus adductus (MA). The second, third, and fourth lesser metatarsals have been shortened via Weil osteotomies for the lesser toe deformities. Note the increased preoperative metatarsus adductus angle (MAA) and the elevated postoperative hallux valgus angle (HVA) at the most recent follow-up.

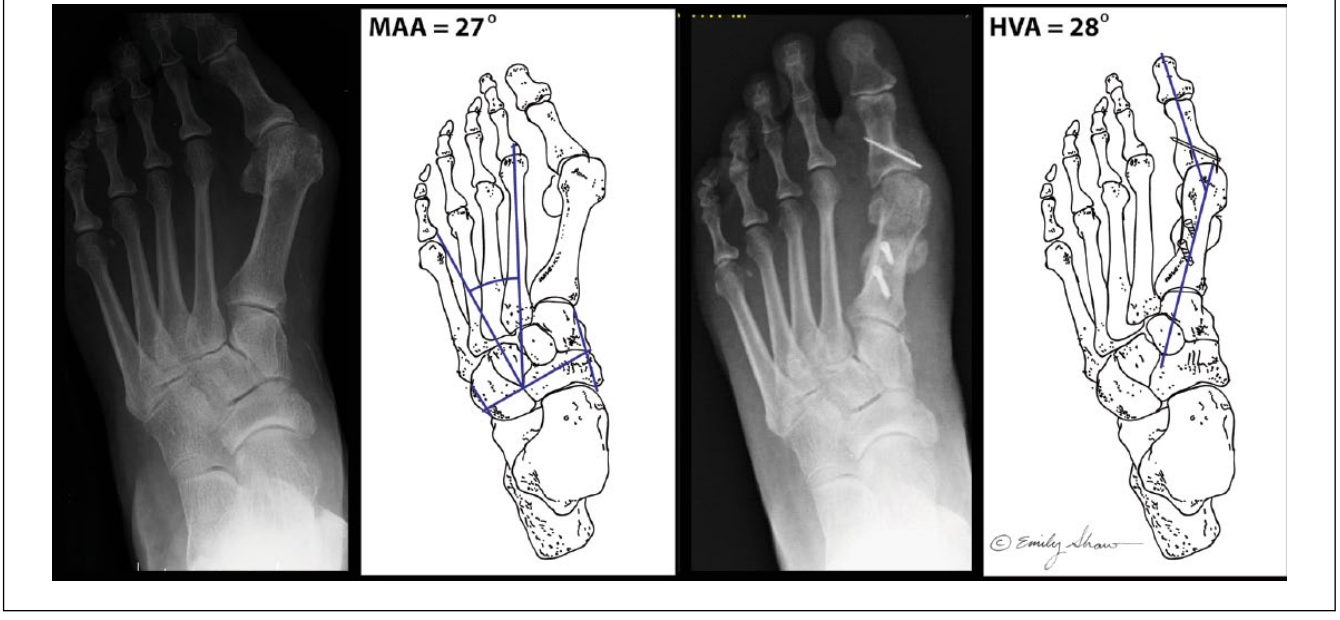

Figure 3. Recurrence of deformity after a proximal first metatarsal osteotomy (Ludloff) in the setting of metatarsus adductus (MA). An Akin osteotomy has been performed to aid in correction of the deformity. Note the increased preoperative metatarsus adductus angle (MAA) and the elevated postoperative hallux valgus angle (HVA) at the most recent follow-up.

recurrence of hallux valgus. This is suggestive that in the setting of severe MA, realignment of the lesser TMTs is necessary to prevent HV deformity.

Nonsevere MA. A total of 154 patients were found to have nonsevere MA. Forty patients with nonsevere MA had recurrence of hallux valgus, making the recurrence rate in this

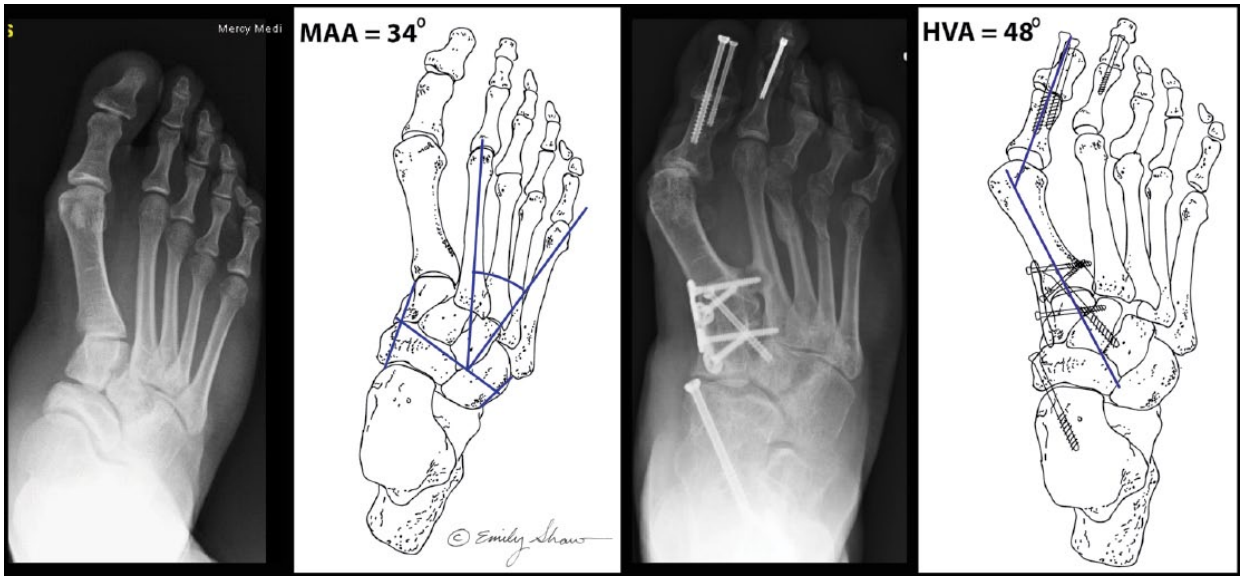

Figure 4. Recurrence of deformity after a Lapidus arthrodesis in the setting of metatarsus adductus (MA). A hallux interphalangeal (IP) arthrodesis has been performed as well. Note the increased preoperative metatarsus adductus angle (MAA) and the elevated postoperative hallux valgus angle (HVA) at the most recent follow-up.

Table 3. Radiographic Evaluation of the Most Severe Metatarsus Adductus Patients (Metatarsus Adductus Angle > 31 degrees, n = 19).

	Hallux valgus angle (degrees)	Intermetatarsal angle (degrees)	MAA (degrees)
Preoperative	42	10.3	36
Postoperative	21	6.3	29

Abbreviation: MAA, metatarsus adductus angle.

group 80% (40 of 50). The majority of nonsevere MA patients underwent distal (Chevron) osteotomies (72%, 111 of 154). Lesser toe deformities were present in 10% of those who underwent distal osteotomies (11 of 111). None of these patients had a valgus deformity of the lesser rays specifically. Furthermore, none of these patients underwent realignment procedures of the lesser toes (ie, lesser metatarsal osteotomies, realignment TMT arthrodeses). Only 1 patient who underwent a Lapidus procedure had lesser toe deformity.

Discussion

MA is a congenital deformity that has a relative incidence of 1:1000 births.[3,14] The etiology is not entirely clear although soft tissue contracture resulting from in utero malpositioning has been postulated.[8,9,13] Structurally speaking, there is adduction of all of the metatarsals[1]; this coincides with the widely held belief that MA precedes the development of a hallux valgus deformity.[18] Aiyer et al have recently reported the prevalence of MA in patients undergoing hallux valgus surgery to be close to 30%.[2] This raises the question of the importance of associated MA in patients undergoing hallux valgus surgery.

To answer this question, it's important to consider the pathoanatomy in hallux valgus. Adduction of the first metatarsal leads to plantarward displacement of the abductor hallucis tendon, thereby losing the medial buttressing effect the abductor hallucis has on the metatarsal head. The thin dorsomedial capsule is not strong enough to restrain medial translation of the metatarsal head.[2,4,16] Additionally, adduction of the first metatarsal leads to a relative tenodesis effect on the adductor hallucis tendon-lateral sesamoid complex, which exacerbates the hallux valgus deformity.[4]

With adduction of the second metatarsal, there is minimal if any first intermetatarsal space, which limits the corrective effect of any first metatarsal osteotomy; there is limited space for the metatarsal head or shaft to translate laterally. Because of this adduction, there may be an underappreciation for the degree of deformity that truly exists within the 1-2 intermetatarsal space. Therefore, a more powerful corrective procedure of the first metatarsal may be required to address this issue. Based on the senior author's experience and the findings of

the study, an arthrodesis of the first TMT would be an appropriate alternative to help address the extent of deformity in the first webspace that exists in the MA patient population.[17]

In the current study, the rate of radiographic recurrence of deformity in patients with MA was found to be 28.9%. A significant difference was not identified when the recurrence rate was stratified by procedure type (Table 2). The likely explanation for this is the loss of the buttress mechanism that the lesser metatarsals normally afford in preventing hallux valgus. This is most easily understood in the setting of severe MA. In more severe deformities, adduction of all of the metatarsals collapses the intermetatarsal spaces, causes ligamentous insufficiency and ultimately lesser toe deformity. Based on the results presented here, documented lesser toe deformities were seen in more than 50% of patients with severe MA. Those patients undergoing realignment procedures (ie, realignment arthrodesis of the first, second, or third TMTs) of the lesser metatarsals were less likely to have deformity recurrence in comparison to those who did not (33% vs 80%, respectively).

In contrast, lesser toe deformity may be subtler in patients with less severe MA deformities. The buttress effect of the lesser metatarsals is compromised by the inherent deformity, albeit less clinically pronounced. In these situations, irrespective of the type of procedure performed, recurrence can occur. In those with less severe MA deformity, 80% of patients had a recurrence of hallux valgus.

In the non-MA group, the rate of recurrence of hallux valgus is comparable to rates of recurrence described in the literature.[1,5,8,10,11,12,15,17] Several reports in the literature do not explicitly define recurrence; they imply that recurrence is the clinical development of hallux valgus after intraoperative correction of alignment.[1,11,12] Austin et al reviewed 300 chevron osteotomies completed over a 3-year period and found a 10% recurrence rate. In that study, recurrence was associated with higher IMAs.[1] Johnson et al compared the outcomes of patients undergoing Chevron osteotomies with those undergoing modified McBride procedures. A recurrence rate of 12% was identified in that series.[11] In a review of more than 200 patients undergoing revision foot surgery, more than 25% of patients were found to have had recurrent hallux valgus after undergoing prior corrective surgery.[12] Veri et al found an 11% recurrence rate in a patient cohort undergoing proximal crescentic osteotomy and distal soft tissue release for moderate hallux valgus deformity. In their study, recurrence was clinically evaluated but radiographically defined as a postoperative hallux valgus angle increase of greater than 10 degrees.[21] In a retrospective study of 122 patients undergoing hallux valgus surgery with a lateral release and crescentic osteotomy, Coughlin found a recurrence rate of 5%. Recurrence in their study was defined as a hallux valgus angle of greater than 20 degrees, with angular corrective change of less than 10 degrees.[5] Iyer and colleagues looked at patients with severe hallux valgus who had undergone a proximal medial wedge osteotomy. They found a high rate of recurrence in their patient population, close to 65%. The authors defined recurrence as a change in the HVA of greater than 5 degrees during the postoperative course. There was a significant association between recurrence and severity of the HVA or the DMAA.[10]

For the present study, the hallux valgus deformity was defined to have recurred if the measured HVA was greater than 20 degrees at the most recent follow-up. For this study, 414 patients composed the non-MA group. Of this patient subset, a radiographic recurrence rate of 15.2% was identified. The rate of radiographic recurrence of hallux valgus deformity is close to 2 times higher in patients with MA. We believe that this is the first report to quantify the effect of MA on radiographic recurrence of hallux valgus deformity.

The limitations of this study are that it is retrospective and radiographic in nature. An important caveat to the findings of radiographic recurrence of deformity is the unknown correlation with clinical findings. It is possible that patients with radiographic recurrence did not have clinical symptoms. This may be more applicable in those patients with less severe MA deformities. With more severe MA deformities, the presence of concomitant lesser toe deformities may impact patient satisfaction, leading to pain and difficulty with shoe wear. It should also be noted that there was a higher percentage of distal metatarsal osteotomies performed. This is related in part to selection bias, because these are commonly performed procedures. Additionally, lack of recognition of the MA deformity may have prompted treating surgeons to use this osteotomy more frequently.

Conclusion

Radiographic recurrence of hallux valgus was substantially higher in patients with MA versus those who did not have MA. This is consistent with the widely accepted belief that MA increases the risk of recurrence of the deformity after hallux valgus surgery.

Further research could help to delineate a operative treatment algorithm to minimize risk of recurrence in this subgroup of patients.

Declaration of Conflicting Interests

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