Modified Mitchell osteotomy alone does not have higher rate of residual metatarsalgia than combined first and lesser metatarsal osteotomy

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Abstract Transfer metatarsalgia (TM) is a common forefoot disorder secondary to hallux valgus (HV). Some authors suggest that a combined lesser metatarsal osteotomy while undergoing HV surgery improves metatarsalgia, whereas others concluded that isolated HV corrective osteotomy can improve symptomatic metatarsalgia. The main purpose of this retrospective study was to compare clinical outcomes in patients with and without combined lesser metatarsal osteotomy while receiving HV correction surgery. We retrospectively reviewed the patients who underwent osteotomy for HV correction between January 2000 and December 2010. All patients underwent HV correction with modified Mitchell osteotomy. Clinical evaluations including the American Orthopaedic Foot and Ankle Society score and residual metatarsalgia were assessed, and radiographic measurements were carried out. Sixty-five patients (83 feet) meeting the selection criteria were enrolled. Thirty feet receiving a combined lesser metatarsal osteotomy were classified as the combined surgery (CS) group, and the others were classified as the control (CN) group (53 feet). The overall rate of persistent symptomatic metatarsalgia was 19.28% after operative treatment. There were six feet with residual metatarsalgia in the CS group, and 10 feet in the CN group. There was no significant difference in the rate of persistent symptoms between the two groups (p = 0.9). According to this result, modified Mitchell osteotomy alone did not have a higher rate of residual metatarsalgia than CS. We also found that the average recovery rate of TM was about 80.7% and those patients

Conflicts of interest: All authors declare no conflicts of interest.

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whose preoperative HV angle was > 30° had the higher risk of residual metatarsalgia after surgery.

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Introduction

Transfer metatarsalgia (TM) is a common forefoot disorder secondary to hallux valgus (HV) because decreased loading on the first metatarsal head leads to lateral shift of weight to lesser toes [1]. Although corrective osteotomy for HV is common, the best treatment option for symptomatic TM combined with HV remains controversial. Some authors suggest that a combined lesser toe osteotomy during HV surgery decreases postoperative metatarsalgia or improves preoperative painful plantar callosity [2–4]. However, other authors suggested that isolated HV corrective osteotomy alone improved symptomatic plantar callosity on lesser toes [5,6].

Because of the different viewpoints concerning treatment of HV with TM, the main purpose of this retrospective study was to compare clinical outcomes in patients with HV and TM who received combined osteotomy with those who underwent corrective osteotomy for HV alone. We also evaluated several parameters to find the predictive factors of residual metatarsalgia after surgery, which were not included in previous studies.

Methods

We retrospectively reviewed the medical records and radiographs of patients who underwent osteotomy for HV correction between January 2000 and December 2010 at the Department of Orthopaedics, Kaohsiung Medical University Chung-Ho Memorial Hospital (Kaohsiung, Taiwan). We included patients who were scheduled to undergo surgery for HV correction combined with lesser toe metatarsalgia. Patients with hallux rigidus, rheumatoid arthritis, gouty arthritis, a previous surgery on the affected toe, or psychologic diseases were excluded.

All patients underwent HV correction with modified Mitchell osteotomy. The surgical procedures carried out are described elsewhere [7]. The modified Mitchell osteotomy was performed by double step-cut osteotomy through the neck of the first metatarsal, leaving a lateral piece of cortex. Some patients received operative correction for TM simultaneously. We used a sliding oblique metatarsal osteotomy [8] to treat the metatarsalgia in patients who received a combined lesser metatarsal surgery. In all cases, the surgeries were performed by two experienced surgeons.

All patients consented to participation in this study, and all aspects of the study were approved by the Institutional Review Board of kaohsiung Medical University Hospital. Regular follow-up (at 2 weeks, 6 weeks, 3 months, 6 months, and 1 year) was scheduled for each patient after discharge. Nonweight-bearing on the first metatarsal head for 6 weeks was instructed. We removed sutures at the 2-week follow-up and removed the pin for lesser toe metatarsal osteotomy at the 6-week follow-up. Partial weight-bearing was instructed after the 6-week follow-up, and full weight-bearing was allowed after the osteotomy site was confirmed to be stable at the 3-month follow-up.

The clinical evaluations including the American Orthopaedic Foot and Ankle Society (AOFAS) score [9] and residual metatarsalgia were assessed at each follow-up. Series radiographic examinations including anteroposterior and lateral weight-bearing views were assessed to determine the HV angle (HVA), first to second intermetatarsal angle (IMA), metatarsal shortening (MS), and plantar shifting (PS) of the metatarsal head. All radiographic parameters were measured by two independent investigators who were not involved in the surgery. The values of the measurements at the 1-year follow-up were averaged to produce the radiographic results. HVA is defined as the angle between the longitudinal axis of the first metatarsal and the proximal phalanx, and first to second IMA was measured as the angle formed by the intersection of the axis of the first and second metatarsal [10] (Figs. 1 and 2). The PS was measured on lateral radiograph and defined as the difference in the distance between the dorsal cortex of metatarsal shaft and plantar-displaced metatarsal head related

Figure 1. The preoperative X-ray shows the measurements of hallux valgus angle (A) and 1–2 intermetatarsal angle (A).
to the ground at the osteotomy site (Fig. 3). MS of the first metatarsal was measured in accordance with the procedure described by Tóth et al [11]. The length of metatarsal was obtained from the distance between the midpoint of proximal and distal articular surfaces, and the change in metatarsal length before and after osteotomy was recorded (Fig. 4).

Statistical analysis

We performed statistical analysis using JMP software (SAS Institute Inc., Cary, NC, USA). Data are presented as the mean ± standard deviation. A Chi-square test was performed for comparison of sex and the postoperative TM between patients with and without combined surgery (CS). Student t test was performed for comparison of age, functional score, HVA, IMA, PS, and MS.

Logistic regression analysis of selected variables (sex, age, HVA, IMA, PS, and MS) was performed to identify factors independently associated with persistent TM. A p value < 0.05 was taken to be significant.

Results

Ninety patients (113 feet) met the inclusion criteria, whereas 16 patients (18 feet) were excluded. Nine patients (12 feet) were lost to follow-up and their data were also excluded. Finally, 65 patients (83 feet) were enrolled in this study. All patients had at least 12 months’ follow-up (mean, 3.17 years; range, 1–9.75 years). The majority of participants were female [n = 77 feet (93%)], and the mean age of participants was 46.99 (range, 18–71) years. Thirty feet [including 3 feet with 2nd metatarsophalangeal joint (MTPJ) subluxation and 1 foot with 2nd MTPJ dislocation] receiving a combined sliding oblique metatarsal osteotomy to treat symptomatic metatarsalgia were classified as the CS group, and the others were classified as the control (CN) group (53 feet). No significant difference in sex, age, preoperative AOFAS score, HVA, or IMA was observed between the CS and CN groups (Table 1).

The preoperative HVA and IMA were 29.61 ± 1.26° and 13.64 ± 0.65°, respectively, in the CS group, whereas the preoperative HVA and IMA in the CN group HVA were 28.08 ± 0.96° and 12.86 ± 0.50°, respectively. The AOFAS score was 61.00 ± 2.68 points in the CS group and 58.07 ± 2.35 points in the CN group. There was no significant difference between the two groups (Table 1).

After surgical treatment, no complication, such as infection or nonunion, was found in either group. The mean
AOFAS score in the CS group was 80.76 ± 2.21 points compared with 83.39 ± 1.67 points in the CN group. No significant difference was noted. In the radiographic assessments, there was also no significant difference in HVA, IMA, MS, or PS. The HVA was corrected to 10.44 ± 1.20° in the CS group and to 11.00 ± 0.92° in the CN group, whereas the IMA was corrected to 6.33 ± 0.52° in the CS group and to 6.63 ± 0.40° in the CN group. The MS was 4.23 ± 0.52 mm and PS was 1.73 ± 0.20 mm in the CS group. The MS was 4.38 ± 0.39 mm and PS was 1.70 ± 0.15 mm in the CN group.

The overall rate of persistent symptomatic metatarsalgia was 19.28%. There were six feet with residual metatarsalgia in the CS group (20%), and 10 feet in the CN group (18.87%). There was no significant difference in the rate of persistent symptoms between the two groups (p = 0.9; Table 2).

To find the important factors related to residual metatarsalgia, logistic regression analysis was used. Logistic regression analysis indicated that the predictor of residual metatarsalgia in HV patients was a preoperative HVA > 30° [odds ratio (OR), 14.65; 95% confidence interval, 1.8–403.8; p = 0.0084] (Table 3). Age, preoperative IMA, postoperative HVA, IMA, MS, and PS showed no significant correlation with persistent metatarsalgia.

### Discussion

Metatarsalgia is a common disorder of the forefoot, and one of the contributory factors is HV. HV is a disorder in which the first metatarsal head drifts medially, slips off the sesamoid apparatus and rotates with pronation. The first metatarsal head elevation with medial motion leads to lateral transfer of plantar pressure [1]. According to a previous study, unloaded first metatarsal bone (especially a peak load reduction of 20–30%) leading to transfer of lateral pressure to lesser toes is a risk factor to induce symptomatic metatarsalgia. Therefore, TM over the lesser toe was not uncommon among the patients with HV, and these patients often complained about pain over the plantar side of forefoot, and callosity was often found over the second and third metatarsal heads.

Several previous studies have mentioned that isolated corrective osteotomy for metatarsalgia was successful [8, 12, 13], and some authors found that a combined metastral osteotomy with HV correction surgery was helpful for HV-related TM. Wang et al [2] studied 17 HV feet that received CS (oblique sliding osteotomy) for metatarsalgia while receiving HV surgery. They concluded that the surgical technique is effective for patients suffering from moderate-to-severe HV with metatarsalgia. Okuda et al [3] found a 57% recovery rate of TM after HV correction with lesser toe shortening osteotomy. They suggested that the combined procedure for HV with painful plantar calllosities was successful. Yamamoto et al [4] reported that the recovery rate of painful calllosity was 84% in the feet treated by HV correction with lesser metatarsal osteotomy, and 48% in the feet treated by HV correction alone. The recovery rate was much better in patients who received CS. According to these studies, the combined procedures were successful for HV-related TM.

However, additional surgery means additional surgical time and may also lead to increased risk of infection or nonunion, and may create TM at the toe next to the operated one. HV-related TM may be improved theoretically if we correct HV and bring the first metatarsal head to its optimal position. Opsomer et al [14] seemed to support this hypothesis. They studied 13 patients who had received surgery for isolated HV and measured the pre- and postoperative cortical thickness of the second and fourth metatarsal bones. They concluded that isolated cortical variations of the second metatarsal bone implied that isolated HV correction led to a redistribution of the stresses on to the first ray [14], and the decreased cortical thickness of the second metatarsal bone proved that lesser toe unloaded after HV correction. Some authors supported this conclusion.

### Table 1 Demographic data and the results of preoperative evaluations.

<table>
<thead>
<tr>
<th></th>
<th>CS group</th>
<th>CN group</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>n (n = 30)</td>
<td>53</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female (%)</td>
<td>27 (90%)</td>
<td>50 (94%)</td>
<td>0.46</td>
</tr>
<tr>
<td>Age (y)</td>
<td>49.97</td>
<td>45.85</td>
<td>0.23</td>
</tr>
<tr>
<td>Preoperative AOFAS score</td>
<td>61.00</td>
<td>58.07</td>
<td>0.41</td>
</tr>
<tr>
<td>Preoperative HVA (degree)</td>
<td>29.61</td>
<td>28.08</td>
<td>0.34</td>
</tr>
<tr>
<td>Preoperative IMA (degree)</td>
<td>13.64</td>
<td>12.86</td>
<td>0.35</td>
</tr>
</tbody>
</table>

AOFAS = American Orthopaedic Foot and Ankle Society; CN = control group; CS = combined surgery; HVA = hallux valgus angle; IMA = 1–2 intermetatarsal angle; MS = metatarsal shortening; PS = plantar shifting of the metatarsal head; TM = transfer metatarsalgia.

### Table 2 Results of postoperative assessments.

<table>
<thead>
<tr>
<th></th>
<th>CS group</th>
<th>CN group</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>n (n = 30)</td>
<td>53</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Postoperative AOFAS score</td>
<td>80.76</td>
<td>83.39</td>
<td>0.35</td>
</tr>
<tr>
<td>Postoperative HVA (°)</td>
<td>10.44</td>
<td>11.00</td>
<td>0.71</td>
</tr>
<tr>
<td>Postoperative IMA (°)</td>
<td>6.33</td>
<td>6.63</td>
<td>0.65</td>
</tr>
<tr>
<td>MS (mm)</td>
<td>4.23</td>
<td>4.38</td>
<td>0.83</td>
</tr>
<tr>
<td>PS (mm)</td>
<td>1.73</td>
<td>1.70</td>
<td>0.90</td>
</tr>
<tr>
<td>Residual TM</td>
<td>6 (20%)</td>
<td>10 (18.87%)</td>
<td>0.90</td>
</tr>
</tbody>
</table>

AOFAS = American Orthopaedic Foot and Ankle Society; CN = control group; CS = combined surgery; HVA = hallux valgus angle; IMA = 1–2 intermetatarsal angle; MS = metatarsal shortening; PS = plantar shifting of the metatarsal head; TM = transfer metatarsalgia.

### Table 3 Logistic regression analysis of factors influencing the residual transfer metatarsalgia.

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>p</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.265</td>
<td></td>
</tr>
<tr>
<td>Preoperative IMA</td>
<td>0.594</td>
<td></td>
</tr>
<tr>
<td>Postoperative HVA</td>
<td>0.095</td>
<td></td>
</tr>
<tr>
<td>Postoperative IMA</td>
<td>0.567</td>
<td></td>
</tr>
<tr>
<td>MS</td>
<td>0.299</td>
<td></td>
</tr>
<tr>
<td>PS</td>
<td>0.553</td>
<td></td>
</tr>
<tr>
<td>Preoperative HVA &gt; 30°</td>
<td>0.0084*</td>
<td>14.65 (1.8–403.8)</td>
</tr>
</tbody>
</table>

* Statistically significant difference (p < 0.05).

CI = confidence interval; HVA = hallux valgus angle; IMA = 1–2 intermetatarsal angle; MS = metatarsal shortening; OR = odds ratio; PS = plantar shifting of the metatarsal head.
and suggested that isolated HV corrective osteotomy was helpful for HV-related TM. Mann et al [5] studied 48 HV feet with metatarsalgia that received HV corrective osteotomy without lesser toe surgery, and reported no further symptomatic metatarsalgia in 30 feet. This means the recovery rate of TM was 63% [5]. Lee et al [6] mentioned that 80% of painful plantar callosity in 40 HV feet disappeared after HV surgery alone, and they implied that painful plantar callosities under lesser metatarsal could be improved after HV correction alone without lesser metatarsal osteotomy.

Another study also found that the most common complication of Mitchell osteotomy was TM (incidence rate, 12.4%) [15]. It seemed more important for surgeons to decide whether to perform lesser metatarsal osteotomy while performing Mitchell osteotomy. Therefore, we aimed to determine whether a combined lesser metatarsal surgery was necessary for HV-related TM, while undergoing HV corrective osteotomy. We retrospectively reviewed the HV patients with TM and compared the clinical outcomes in the patients receiving combined lesser metatarsal osteotomy with those who underwent Mitchell osteotomy alone. The most important finding of the present study was that there was no significant difference in the incidence of residual metatarsalgia between combined corrective osteotomy and Mitchell osteotomy alone for patients with HV and TM. The conclusion was consistent with some of the previous related studies. The recovery rate was 80% in the CS group and 81% in the CN group. The recovery rate in the present study was similar to previous studies, and even better than some. The difference between the CS and CN groups was not statistically significant (p = 0.9), which implied that combined lesser metatarsal osteotomy did not influence the incidence of residual metatarsalgia after HV corrective osteotomy. In other words, modified Mitchell osteotomy alone did not have a higher rate of residual metatarsalgia than CS.

No previous studies focused on the predictive factors of residual metatarsalgia after HV correction alone or after combined lesser metatarsal surgery. Some previous studies mentioned that first MS or distal fragment dorsal angulation was correlated with metatarsalgia resulting from HV osteotomy, but others disagree with this conclusion. We evaluated several parameters, including first MS and distal fragment PS, to find the predictor of residual metatarsalgia after surgery. There was no significant difference in most parameters except for preoperative HVA between feet with and without residual metatarsalgia. Therefore, we used logistic regression analysis for further evaluation. We found that patients with preoperative HVA > 30° had the higher risk of persistent TM after surgery (OR = 14.65).

Although we believed that our study included several advances, there were also potential limitations. One major limitation was that this was a retrospective study and all patients who had subluxation or dislocation of the second MTPJ underwent CS. Although the combined surgeries on the second metatarsal were necessary for these cases, this factor could cause some statistical bias and this is the major weakness of this retrospective study. We believed that a well-controlled prospective study should be conducted to decrease the potential bias in evaluation of treatment for HV with metatarsalgia. The other limitation was that the sample size was not large. Because this was a long-term retrospective study, some patients were lost to follow-up. However, compared with previous studies, the case numbers in this study still represent a relatively large series.

### Conclusion

In this retrospective study, we concluded that combined lesser metatarsal osteotomy did not influence the incidence of residual metatarsalgia after HV corrective osteotomy. In other words, modified Mitchell osteotomy alone did not have a higher rate of residual metatarsalgia than CS. We also found that the average recovery rate of TM was about 80.7%, which was similar to previous studies. Moreover, we analyzed predictive factors of residual metatarsalgia, which were not included in previous studies. We found that the patients whose preoperative HVA was > 30° had the higher risk of residual metatarsalgia after surgery.

### References