Effects on the Tarsal Tunnel Following Malerba Z-Type Osteotomy Compared to Standard Lateralizing Calcaneal Osteotomy

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Introduction/Purpose: Tarsal tunnel syndrome is a known complication of lateralizing calcaneal osteotomy, which is performed to treat cavovarus hindfoot deformities. Lateralizing calcaneal osteotomies have been shown to significantly decrease tarsal tunnel volume, which may be a factor in development of tarsal tunnel syndrome. A Malerba Z-type osteotomy involves a step cut for lateralization and a lateral wedge resection for rotation. Compared with a standard oblique osteotomy, it may preserve more tarsal tunnel volume and decrease risk of neurovascular injury. We investigated two effects on the tarsal tunnel of the Malerba osteotomy compared to a standard osteotomy using a cadaveric model: (1) the effect on tarsal tunnel volume measured by magnetic resonance imaging (MRI), and (2) the proximity of the osteotomy saw cuts to the tibial nerve.

Methods: Five above-knee paired cadaveric specimens underwent MRI of the ankle to obtain a baseline measurement of tarsal tunnel volume. Each right foot was randomized to receive either a standard calcaneal osteotomy or a Malerba osteotomy, with the left foot then receiving the other type of osteotomy. MRIs of each specimen were performed after each of three increasing amounts of lateral displacement: 4 mm, 8 mm, and 12 mm. In the Malerba osteotomy group, each displacement was accompanied by increasing amounts of wedge resection: 2 mm, 4 mm, and 6 mm. Tarsal tunnel volume was measured on oblique coronal images using previously described and validated parameters. Differences in tarsal tunnel volume with osteotomy type (Malerba vs. standard), displacement, and their interaction were assessed with generalized estimating equations (GEEs). After all MRIs were completed, each specimen was dissected and the nearest distance of tibial nerve branches to the osteotomy site was measured.

Results: Baseline tarsal tunnel volume averaged 13,229 ± 2354 mm^3 for all specimens, and did not differ between the two study groups (p = 0.386). Tarsal tunnel volume decreased significantly in all
specimens following each translation (p < 0.001 for each), although the magnitude of the decrease
did not differ between groups (p = 0.578) (Table). Upon dissection of the specimens, tibial nerve
branches crossed the osteotomy site in all specimens (Figure). At least one of the major branches of
the tibial nerve crossed the osteotomy site in 5 out of 5 specimens that received the Malerba
osteotomy, versus 2 out of 5 that received a standard osteotomy. In the remaining 3 specimens, the
lateral plantar nerve was 2 to 8 mm from the osteotomy site.

Conclusion: Tarsal tunnel volume decreased significantly with increasing lateral displacement of a
calcaneal osteotomy, regardless of osteotomy type. There was no difference between standard and
Malerba osteotomies in terms of volume decrease. However, in the clinical setting, a smaller amount
of displacement may be required with a Malerba osteotomy given that some correction is also
achieved by a wedge resection for rotation. In all specimens, the osteotomy was at the level of
branches of the tibial nerve, showing that calcaneal osteotomies must always be performed with
care to avoid direct nerve injury on the unvisualized medial side of the cut.
**Table.** Baseline tarsal tunnel volume and changes in volume are listed for each osteotomy type as well as for all specimens. T1 refers to the MRI scans completed after the first displacement of 4 mm, T2 after 8 mm, and T3 after 12 mm. Units are in mm$^3$.

<table>
<thead>
<tr>
<th></th>
<th>Standard osteotomy (n=5)</th>
<th>Malerba osteotomy (n=5)</th>
<th>All specimens (n=10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline volume</td>
<td>12555 ± 2704</td>
<td>13904 ± 2004</td>
<td>13229 ± 2354</td>
</tr>
<tr>
<td>T1 change in volume from baseline (%)</td>
<td>-835 (-7%)</td>
<td>-1145 (-8%)</td>
<td>-990 (-7%)</td>
</tr>
<tr>
<td>T2 change in volume from baseline (%)</td>
<td>-1411 (-11%)</td>
<td>-2195 (-16%)</td>
<td>-1803 (-14%)</td>
</tr>
<tr>
<td>T3 change in volume from baseline (%)</td>
<td>-3285 (-26%)</td>
<td>-3734 (-27%)</td>
<td>-3510 (-27%)</td>
</tr>
</tbody>
</table>

**Figure.** Images from dissection of the specimens show branches of the tibial nerve (solid arrows) in direct contact with the osteotomy sites (arrow outlines) in specimens that received (A) a standard osteotomy and (B) a Malerba step cut osteotomy.