Safe Zone for the Plantar Portal: A Cadaveric Study

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Disclosure

No conflict to disclose

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We have no potential conflicts with this presentation.
Open surgery on the sole requires extensive dissection of soft tissue and is accompanied by the risk of plantar nerve injury.

Endoscopic surgery of the sole dynamically evaluates and treats lesions in the sole in a minimally invasive manner.

If the characteristics of the course of the plantar nerve were to be clarified, new portals could be created, possibility leading to the further development in endoscopic surgery of the sole.

We observed the soles of cadaveric feet and investigated the safe zone for plantar portals.
Materials

✓ 36 feet from 24 preserved cadavers (excluding cases with clear foot deformity)
✓ Males: 12 feet; females: 24 feet
✓ Mean age: 86.5 years (71 - 96 years)

Methods

① Anatomical resection

✓ We amputated the ankle of the cadavers.
✓ Layer by layer from the sole, we dissected the subcutaneous tissue, plantar fascia, flexor digitorum brevis, abductor hallucis, and abductor digiti minimi.
✓ Next, we observed the course of the medial plantar nerve (MPN) and lateral plantar nerve (LPN).
We observed the relationship between the plantar nerve and the flexor digitorum longus (FHL) tendon, flexor hallucis longus (FDL) tendon and peroneus longus (PL) tendon.
Methods ② The course of the plantar nerve

✓ A digital camera placed on a tripod directly above the sole was used to take photographs, which were subsequently uploaded into Image J software (NIH, Thesda, MD) such that each parameter could be measured.

(A) The back of the calcaneus (B) the medial side of the base of the first metatarsal bone (C) the medial side of the head of the first metatarsal bone (D) the lateral side of the head of the fifth metatarsal bone (E) the proximal tip of the base of the fifth metatarsal bone were plotted.
✓ The nerve courses were plotted (red points) on AB, CE, and CD, and the percentage at which they were positioned on the line segment was calculated.
✓ The bifurcation positions of each nerve were plotted (blue points); a perpendicular line was drawn from each line segment defined from the bifurcation region, and the distances were measured.
## Result

✓ **Nerve course on the line segment**

<table>
<thead>
<tr>
<th>Nerve Course</th>
<th>AB (from A)</th>
<th>BE (from B)</th>
<th>CD (from C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plantar nerve</td>
<td>MPN</td>
<td>LPN</td>
<td>MPHN</td>
</tr>
<tr>
<td>Mean ± S.D. (%)</td>
<td>55.8 ± 4.8</td>
<td>44.5 ± 3.9</td>
<td>13.6 ± 6.3</td>
</tr>
<tr>
<td>(Range)</td>
<td>(43.8-69.2)</td>
<td>(34.9-57.7)</td>
<td>(2.5-28.9)</td>
</tr>
</tbody>
</table>

MPHN, medial plantar hallucal nerve; CPDN 1st/2nd/3rd/4th, common plantar digital nerve that run toward the first, second, third, or fourth web space; LPDMN, lateral plantar digiti minimi nerve

✓ **Position of nerve bifurcations of the plantar nerve**

<table>
<thead>
<tr>
<th>Divided nerve (defined line segment)</th>
<th>MPHN (AB)</th>
<th>CPDN 1st (BE)</th>
<th><strong>CPDN 2nd (3rd) (CD)</strong></th>
<th>CPDN 4th (LPDMN) (BE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of the perpendicular line *1 (%)</td>
<td>6.2 ± 3.1 (0-14.5)</td>
<td>10.9 ± 8.6 (0-35.1)</td>
<td><strong>31.3 ± 8.6 (4.98-43.6)</strong></td>
<td>4.7 ± 5.3 (0-18.4)</td>
</tr>
<tr>
<td>Position of the intersection point *2 (%)</td>
<td>72.8 ± 6.2 (62.5-84.5) from A</td>
<td>28.5 ± 6.5 (10.8-36) from B</td>
<td><strong>48.4 ± 4.6 (39-57.3) from C</strong></td>
<td>60.6 ± 5.5 (49.6-69) from B</td>
</tr>
</tbody>
</table>

*1 Length from the nerve bifurcation site to each defined line segment  
*2 Position of the intersection point between the perpendicular line and defined line segment
No major differences were noted in the course of the MPN and the LPN.
✓ Plantar nerve course was calculated from mean nerve positions on the line segment and mean positions of the nerve bifurcation (solid line).
✓ Based on mean values and standard deviation, the range of the course of the nerve was calculated (highlighted line).

No nerves ran between B and E, at 36.4% - 56.1% from B
(approximately 11.4 mm)

A safe zone was present on the center of the sole
The plantar central portal (PCP, highlighted circle) enables approaching the FDL, FHL, and PL.

PCP can be combined with other portals to facilitate endoscopic treatment.
The plantar nerve was absent from the central region of the sole, thereby allowing for a safe creation of a PCP.

Conventional endoscopy and treatment ranges of the sole could be expanded if FDL, FHL, and PL of the sole are approached from the PCP.

References