Muscle strengthening and stretching exercises

Peter Guy BSc DCh
Private practice Whitby and Peterborough
Professor Chiropody Faculty Michener Institute of Education at UHN
Advisory Board Member Paris Orthotics
Pathology specific exercises
Relationship Between Tightness of the Posterior Muscles of the Lower Limb and Plantar Fasciitis

50 subjects with pl. fasc. and 50 healthy subjects had their ROM of the hamstrings and calf muscles evaluated.
The pl.fasc. group had tighter calf muscles compared to healthy subjects group. The straight leg and dorsiflexion of ankle (knee extended) were most specific and sensitive tests.

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean ± SD</th>
<th>CI 95%</th>
<th>P</th>
<th>IR</th>
<th>Median</th>
<th>Cohen's d</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLET</td>
<td>Experimental</td>
<td>56.8 ± 9.8</td>
<td>54.1, 59.6</td>
<td>&lt;.001</td>
<td>13</td>
<td>58.5</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>85.9 ± 11.5</td>
<td>82.7, 89.2</td>
<td></td>
<td>10</td>
<td>87</td>
</tr>
<tr>
<td>PA</td>
<td>Experimental</td>
<td>34.7 ± 9.3</td>
<td>32.1, 37.3</td>
<td>&lt;.001</td>
<td>11</td>
<td>34.5</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>6.9 ± 8.1</td>
<td>4.6, 9.3</td>
<td></td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>ADFKE</td>
<td>Experimental</td>
<td>4.6 ± 3.1</td>
<td>3.7, 5.5</td>
<td>&lt;.001</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>20.2 ± 4.6</td>
<td>18.9, 21.5</td>
<td></td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>ADFKF</td>
<td>Experimental</td>
<td>9.7 ± 4.2</td>
<td>8.5, 10.9</td>
<td>&lt;.001</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>24.8 ± 4.7</td>
<td>23.5, 26.1</td>
<td></td>
<td>9</td>
<td>25</td>
</tr>
</tbody>
</table>

ADFKE = ankle dorsiflexion with the knee extended; ADFKF = ankle dorsiflexion with the knee flexed; IR = interquartile range; PA = popliteal angle; SLET = straight leg elevation test.
The results of this study suggest if you employ a stretching protocol for plantar fasciitis, your assessment of plantar fasciitis should include testing for both hamstring and triceps surae tightness. Stretching should focus on both muscle groups.
The new paradigm for static measurement of the ankle joint dorsiflexion is keeping the foot supinated.
A pilot investigation into the relationship between static diagnosis of ankle equinus and dynamic ankle and foot dorsiflexion during stance phase of gait: Time to revisit theory?

Alfred Gatt, Stephanie De Giorgio, Nachiappan Chockalingam, Cynthia Formosa

Fig. 2. The Istituto Ortopedico Rizzoli foot model marker placement.

Maximum Ankle vs Foot Dorsiflexion Angle

Group A ( <-5° )

Group B ( between -5° and 0° )

Mean dynamic AJ DF/Foot DF
= 4.4°/8.6°

Mean dynamic AJ DF/Foot DF
= 13.9°/17.13°
Table 1. Weight-Bearing Lunge Dorsiflexion Range of Motion Measurement Averages.

<table>
<thead>
<tr>
<th>Test</th>
<th>Mean±SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tape Measure</td>
<td>9.5 ± 3.1 cm</td>
</tr>
<tr>
<td>Digital Inclinometer</td>
<td>38.8 ± 5.2°</td>
</tr>
<tr>
<td>Goniometer</td>
<td>43.2 ± 5.8°</td>
</tr>
</tbody>
</table>

Averages were determined using data from each side (right and left) during trial 1.

Figure 2. Inclinometer placement at the tibial tuberosity along the anterior tibial crest.
The Lunge test demonstrates the stiffness of the ankle joint

https://www.youtube.com/watch?v=JcpziXgvpMc
Plantar Fasciopathy Treated with Dynamic Splinting

A Randomized Controlled Trial

Multicentre RCT with 30 subjects receiving pl fasc. standard care plus ADD and the 46 control subjects receiving just the standard of care.
High-load strength training improves outcome in patients with plantar fasciitis: A randomized controlled trial with 12-month follow-up


48 patients with U/S verified pl. fasc. Were randomized to FOs / stretching group or FOs / high load progressive strength training. Foot function index was assessed at 1, 3, 6 and 12 months
A simple progressive exercise protocol performed every 2\textsuperscript{nd} day resulted in superior self-reported outcome after 3 months compared to stretch group.
Strengthening the tibialis posterior muscle
6 asymptomatic adults with pes planus performed a resisted foot adduction with plantar flexion exercise. Barefoot and shod with foot orthoses tests (3 sets of 30 repetitions) were separated by a week. MRI signal intensity of the tibialis posterior, tibialis anterior, soleus, medial gastrocnemius, and peroneus longus was measured immediately before and after each exercise.
Wearing the foot orthoses and shoes improved selective activation of the TP in persons with flat feet.
What are the new findings?

- The foot core system is comprised of interacting subsystems that provide relevant sensory input and functional stability for accommodating to changing demands during both static and dynamic activities. The interaction of these subsystems is very similar to the lumbopelvic core system.
- The plantar intrinsic foot muscles within the active and neural subsystems play a critical role in the foot core system as local stabilisers and direct sensors of foot deformation.
- Assessment of the foot core system can provide clinical insight into the ability of the foot to cope with changing functional demands.
- Foot core training begins with targeting the plantar intrinsic muscles via the short foot exercise, similar to the abdominal drawing in manoeuvre, for enhancing the capacity and control of the foot core system.
How do you strengthen the plantar intrinsics?
Foot Shortening Exercise

1. Stand on one foot by balancing against wall
2. Raise arch by lifting all toes off the ground
3. Slowly lower toes back to ground and maintain arch without curling toes

1. Raise arch of the foot without curling toes
2. Hold for 10 seconds
3. Relax foot posture
Effect of plantar intrinsic muscle training on medial longitudinal arch morphology and dynamic function

Edward P. Mulligan*, Patrick G. Cook


21 asymptomatic subjects (42 feet) completed a 4-week SFE training program emphasizing recruitment of the plantar intrinsic muscles. The arch height index, navicular drop and a functional reaching test was measured pre and post exercise program.

Figure 7 The short foot manoeuvre is depicted. Note in the relaxed foot (left) the resting length of the foot (top image with solid black line). In the contracted position (right), note the change in foot length (dashed line) due to the short foot contraction drawing in the foot (arrows) from the relaxed condition (solid black line).
IFM training may have an adjunctive role in preventing excessive ND and some balance measures.
Intrinsic foot muscles have the capacity to control deformation of the longitudinal arch


*J. R. Soc. Interface* 2014 11, 20131188, published 29 January 2014

9 healthy subjects had their MLAs loaded at 50%, 100% and 150% body weight as the EMG activity of 3 plantar intrinsic foot muscles were recorded.

Part 2 involved intrinsic muscle stimulation to observe the effect on the MLA height and length.
Intrinsic muscle response to MLA loading

MLA response to muscle stimulation
Intrinsic foot muscles have the capacity to control deformation of the longitudinal arch


• LA deformation and muscle stretch plateaued towards the maximum load of 150% body weight, when muscle activity was greatest.

• Electrical stimulation of the plantar intrinsic muscles countered the deformation that occurred owing to the application of external load by reducing the length and increasing the height of the LA.

• These findings demonstrate that these muscles have the capacity to control foot posture and LA stiffness and may provide a buttressing effect during foot loading.
10 healthy males had their plantar intrinsic muscle activity monitored while sitting, DL standing and SL standing
The results indicated that recruitment of the AH, FDB and QP increases with increasing postural demand.
This study suggests FO + FSE is more beneficial at strengthening abductor hallucis than FO alone or FSE alone.

Effect of foot orthoses and short-foot exercise on the cross-sectional area of the abductor hallucis muscle in subjects with pes planus: A randomized controlled trial

Do-Young Jung, Eun-Kyung Koh and Oh-Yun Kwon

*Department of Physical Therapy, College of Tourism & Health, Joongbu University, Geumsan, Republic of Korea

Department of Physical Therapy, Masan University, Changwon, Republic of Korea

Department of Physical Therapy, College of Health Science, Laboratory of Kinetic Ergoscope Based on Movement Analysis, Yonsei University, Wonju, Republic of Korea

Abstract: Objective: To prevent overuse injuries related to excessively pronated feet, the strengthening of the foot intrinsic muscles has been recommended. The purpose of this study was to examine the effects of foot orthoses and a short-foot exercise intervention on the cross-sectional area (CSA) of the abductor hallucis (AhdH) muscle and strength of the flexor hallucis (FH) in subjects with pes planus.

Methods: Twenty-eight subjects with pes planus were randomly assigned to the foot orthosis (FO) group or the combined foot orthosis and short-foot exercise (FOSF) group for an 8-week intervention. The CSA of the AhdH muscle and the strength of FH were measured before and after intervention. Data were analyzed using a mixed-model ANOVA.

Results: Significant group by intervention interaction effects were observed in CSA of the AhdH (p = 0.009) and strength of the FH (p = 0.015). The results of the post hoc paired t-test showed that the CSA of the AhdH muscle and the strength of the FH significantly increased after the intervention in both groups (p = 0.000). The mean CSA of the AhdH muscle and the strength of FH were significantly greater in subjects in the FOSF group compared with subjects in the FO group (mean difference of FO vs. FOSF = 13.61 mm² in CSA of AhdH muscle; 0.90 kgf in strength of FH; p = 0.008).

Conclusions: Results from this study demonstrate that foot orthoses combined with short-foot exercise is more effective in increasing the CSA of the AhdH muscle and the strength of FH compared with foot orthoses alone. Therefore, foot orthoses combined with short-foot exercise are recommended for improving strength of AhdH muscle in subjects with pes planus.

Keywords: Abductor hallucis, medial longitudinal arch, pes planus, short-foot exercise