Back to the foot: Foot Based Gait Dysfunction and Lower Back Pain?

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THE PODIATRY CENTRE

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the research


- Up to October 2008, There is strong evidence that insoles are not effective for the prevention of back pain. The current evidence on insoles as treatment for existing low back pain does not allow any conclusions.
This study showed improvement in back pain and disability with the use of shoe orthotics for 6 weeks compared with a wait-list control group. It appears that improvement was maintained through the 12-week visit, but the subjects did not continue to improve further during this time.
Since October 2008....


• Foot orthoses (physical component) can be successful in the management of people with low back pain if their expectations and information needs are met (psychosocial component) which in turn can lead to a change in their preconceived beliefs in this area.

• Interviews revealed that for these participants, the foot orthoses did improve back pain. This result is supported with the results of the Roland-Morris Disability Questionnaire which was completed as a standard ‘clinical’ outcome measure
the research


- The study design was a randomized, double-blinded, clinical trial with two groups: experimental, treated with the custom-made foot orthoses, and control, treated with a placebo. Low back pain was evaluated by a visual analog scale for pain and Oswestry's Disability Index Questionnaire for lower back pain at two moments—on the day of inclusion in the study and after 4 weeks of treatment.

- In the sample studied, the use of custom-made foot orthoses to control foot pronation led to a reduction of perceived low back pain within the time scale of their study ("short term").

• Sixty-two consecutive patients presenting with chronic (>3 months), nonspecific, low back pain following work-related low back injury were included in the study. A total of 30 patients in the UC group were given a 6-week exercise therapy program along with prescription analgesics. The intervention group, composed of 32 patients, received UC in addition to customized foot orthotics (orthotics group). All subjects completed the Oswestry Disability Index at the initiation of the study and at 8-week follow-up. Work disability, as defined by working at usual, preinjury job labor level, was recorded at baseline and 8-week follow-up.

• The findings showed that patients in this study with chronic, nonspecific low back pain following work-related low back injury had greater improvement in short-term outcomes with orthotics and UC than with UC alone.

- Sixty-six consecutive patients referred from primary care medical physicians for the complaint of chronic (> 3 months) low back pain following a motor vehicle collision were included. Thirty patients received "usual care" that included prescription of an exercise therapy program in addition to analgesics. Thirty-four patients received the same therapy along with customized foot orthotics. All patients completed the Oswestry Disability Index at the initiation of the study and at 8-week follow-up. The number of participants using any type of prescription analgesic for their back pain at baseline and at 8 weeks was also recorded.

- In this study, patients with chronic low back pain following a motor vehicle collision who used orthotics in addition to usual care had improved short-term outcomes compared with usual care alone.
So when should we?

Before understanding abnormal, we must understand normal.
Confusing and conflicting podiatric (foot function) theory....

<table>
<thead>
<tr>
<th>Theoretical Perspective</th>
<th>Foot Morphology Theory</th>
<th>Sagittal Plane Facilitation Theory</th>
<th>Tissue Stress Theory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criteria for Normalcy</td>
<td>The STJ passes through neutral at key stages of the gait cycle</td>
<td>The foot functions as a pivot allowing adequate hip extension and correct posture</td>
<td>The foot functions in a way that does not result in abnormal tissue stress and injury</td>
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<tr>
<td>Casting Methodology</td>
<td>The foot is cast in STJN, unless large deformity contraindicates this.</td>
<td>Casting methods are not documented, although recent non-custom orthoses from this theory may mean casting is not required</td>
<td>The positive cast is modified when taken to supply the shell shape required to apply the correct forces to the foot</td>
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<tr>
<td>Orthoses aim</td>
<td>To prevent abnormal joint compensation and place the foot into its normal position for key stages of the gait cycle</td>
<td>To allow the foot to work successfully as a pivot and facilitate Sagittal plane motion</td>
<td>To reduce abnormal stress upon symptomatic structures</td>
</tr>
</tbody>
</table>

Harradine and Bevan, JAPMA, 2009.
But, rather than spend the day focussing on the way theories disagree and be incredibly negative (again), lets look at what we all tend to actually agree on.
Agreed Basics of normal foot function....

1. The foot must coordinate the effect of lower extremity internal rotation with the impact at heel strike.

2. It must then reverse the direction of rotation by midstep and accommodate lower extremity external rotation

3. While simultaneously stabilizing itself to forces that can reach multiples of body weight prior to toe off

4. And permitting the entire body to pivot over it.
1.&2. The foot must coordinate the effect of lower extremity internal and then external rotation.

• **1)CONTACT** - The Hip is internally rotating (*in relation to the floor/foot*) and the Foot pronating

• **2)MIDSTANCE & PROPULSIVE** – The Hip is externally rotating (*in relation to the floor/foot*) and the foot supinating
3. While simultaneously stabilising itself to forces that can reach multiples of body weight prior to toe off

- **Stability**
  Stability refers to a condition where an object tends to be less likely to undergo translational or rotational motion when subjected to the effects of externally applied forces

- How does this relate to heel lift?
We don’t really want this to happen....
3. While simultaneously stabilising itself to forces that can reach multiples of body weight prior to toe off

- Stability at loading phase is accomplished via the reverse windlass mechanism

- Simple model demonstrating the reverse windlass mechanism

- As the arch lowers it becomes longer and the plantar structures (in this example the plantar fascia, but also the plantar ligaments) become more taut. This in turn applies a compressive force longitudinally
3. While simultaneously stabilising itself to forces that can reach multiples of body weight prior to toe off

- Stability at propulsive phase is accomplished via the windlass mechanism
- Simple model demonstrating the dynamic windlass

As the foot supinates and the arch raises, tension is maintained in the plantar fascia via the ‘winding’ of the windlass around the 1st MTPJ.
4. And permitting the entire body to pivot over it.

- Our foot is shaped like this:
4. And permitting the entire body to pivot over it.

- Not like this!

But, we need it to work like this....
4. And permitting the entire body to pivot over it. – 3 rockers

- Via the round underside of the heel

- Position to start stance with heel rocker
- Shock absorption
- Weight-bearing stability
- Preservation of progression
4. And permitting the entire body to pivot over it. – 3 rockers

- **Via Ankle Dorsiflexion**

- Progression over stationary foot
- Limb and trunk stability
4. And permitting the entire body to pivot over it. – 3 rockers

• Via dorsiflexion of the digits, preferably the 1st MTPJ due to
  1) The suitability of this joint to pivot under load
  2) Winding the medial band of the plantar fascia

• Progression of body beyond supporting foot, supplying essential hip extension
Recap of normal foot function (although presented ‘in order’, there is an overlap of these segments)

1. The 1st (Heel) Rocker
2. Internal hip rotation with foot pronation
3. The reverse windlass
4. The 2nd (Ankle) Rocker
5. External hip rotation with foot supination
6. The 3rd (Digits) Rocker
7. The Windlass mechanism with medial column propulsion
8. Adequate hip and knee extension for normal posture and swing phase
Principles of Abnormal Foot Function – ‘Over Pronation’

What goes wrong....?
Defining “OVER-PRONATION”

1. Pronating too hard, meaning the foot cannot resupinate.
2. Pronating too far, meaning there is lower limb functional malalignment.
3. Pronating too far, placing too much stress in the plantar fascia

Reduced ability to pivot over the 1\textsuperscript{st} MTPJ (functional hallux limitus)
1. Pronating too hard, meaning the foot cannot resupinate.

- The foot should supinate in midstance, allowing external rotation of the hip at this stage (in relation to the floor). If this does not occur, compensatory gait mechanisms may be employed.

- Examples include:
  1) Abductory twist
  2) Reduced external hip rotation
2. Pronating too far, meaning there is lower limb functional malalignment.

- A commonly used example here is excessive internal hip rotation with excessive pronation. This often presents as a ‘squinting patella’.
3. Too much pronation limits hallux dorsiflexion via the reverse windlass

- Simple model demonstrating the reverse windlass mechanism

- As the arch lowers it becomes longer and the plantar structures (in this example the plantar fascia) become more taut pulling the digits DOWN
3. Too much pronation limits hallux dorsiflexion via the reverse windlass and ALSO...dorsiflexing the first ray

![Diagram showing normal hallux dorsiflexion with first ray plantarflexion and limitation due to pronation]
Too much pronation can cause gait dysfunction by impeding dorsiflexion at the 1st MTPJ (a functional hallux limitus).
So, pronation may lead to gait dysfunction. But does that link to lower back pain

- Lower back pain
  - Facilitating an erect torso
    Lumbar flexion creates disc compression as well as muscular overuse
  - Positioning the limb to initiate swing phase
    Iliopsoas overuse and shear at inter-vertabral discs (Kapandji, 1974)
  - Reduction of angle between leg and ischial tuberocity
  - Lateral Trunk Bending
    Bending from the ipsilateral restricted side to the contralateral side at ipsolateral toe-off. Caused by two groups, Quadratus Lumborum and contralateral glut max / ITB complex. Drags trailing limb. Can lead to: Pain in QL between 12\textsuperscript{th} rib and iliac crest, greater troch bursitis, lateral knee pain, and (owing to QL’s partial insertion into the iliolumbar ligament ) disc compression pain related to rotation of the 5\textsuperscript{th} lumber vertebra
So from a podiatry perspective, how would we reduce these abnormal gait patterns?

1. Reduce dorsiflexion moments on the first ray
2. Reduce pronation moments across the subtalar joint axis (STJA)
1) Shells are cut narrow or positive casts are modified so as not to impinge on first ray function:

- Normal Hallux dorsiflexion with first ray plantarflexion

Functional Limitation of Hallux dorsiflexion due to an increase of dorsiflexory moments on the first ray from an ‘incorrect’ / high medial contour (arch) orthosis

Sagittal view
1) Shells are cut narrow or positive casts are modified so as not to impinge on first ray function:

- Full Width
- **Rootian** width, 25% of first ray covered
1) Shells are cut narrow or positive casts are modified so as not to impinge on first ray function:
1) Shells are cut narrow or positive casts are modified so as not to impinge on first ray function:

- Negative casts are often modified depending upon the required shell shape to apply the correct moments to the foot.
- The first ray can be plantarflexed to reduce dorsiflexory moments on the first ray

Fuller PBG course notes, 1999
2) Reduce pronation moments across the STJA (subtalar joint axis)
2) Reduce pronation moments across the STJA (subtalar joint axis)
2) Reduce pronation moments across the STJA (subtalar joint axis)
2) So we want to reduce pronation moments by applying a ‘push up’ (force) on the medial side of the axis.
But in a ‘pronated foot’ the STJA is often not in the middle of the foot, but is medial.....
But in a ‘pronated foot the STJA is often not in the middle of the foot, but is medial.....

So we only want to ‘push up’ (apply an orthotic reaction force) HERE......
2. Posting applied to the medial side of the STJA at the rearfoot

- The amount of rearfoot post motion to be incorporated into an extrinsic rearfoot post is a most important prescription choice
  
  Anthony 1991 (The modified Root appliance)
2. Posting applied to the medial side of the STJA at the rearfoot

- The rearfoot post is a very important component of a prescription foot orthoses

Kirby, 2002
To improve abnormal foot function we would therefore aim to:

1. Reduce dorsiflexion moments on the first ray
2. Reduce pronation moments across the STJA

Are there any other methods of doing this other than orthotics?
Are there any other methods of doing this other than orthotics?

Aiming to strengthen lateral rotators and so reduce pronation (Snyder et al, 2008)

Aiming to reduce Ankle Equinus and reduce compensatory pronation (Radford et al, 2006)

Aiming to strengthen the Tibialis Anterior and reduce pronation (Galbraith & Lavallee, 2009)
More than one way to improve gait, but which do we do first?
Excepting that:

‘Our present satisfaction with our state of understanding may reflect the paucity of the data rather than the excellence of the theory.’

Conclusion

• The current research shows positive trends on the use of orthotics for Lower Back Pain

• The need and method of orthotic prescription needs to be based upon clinical reasoning and observation of outcomes
Conclusion

• Custom orthotics are often required due to asymmetrical foot function and avoidance of first ray impingement.

• Podiatrists are not back pain specialists. Referral for orthotics / assessment of validity of orthoses use should come from a profession such as physiotherapy.

• More research is required