BACK PAIN FROM THE GROUND UP: “THE WINDLASS EFFECT”

Dr. Marcus A. Kampfe, CCEP, FAKTR, PSC, PES, CES, GFS
WINDLASS EFFECT

• Mech of Gait — Heel raise to toe off

• Supination of the foot, Ext rot of contact leg

• Involuntary movement that normally raises the LTA as foot moves up and over the toes.
WINDLASS EFFECT

Neutral

Flexion of hallucis muscle

plantar fascia
WINDLASS TEST

• Pt stands in front of you w/ feet shoulder width apart and toes straight ahead

• Grasp the big toe and raise it as high as it will comfortably move

• WATCH—— What happens to the foot, knee and leg???
DEMONSTRATION

• Raising the big toe — whole limb EXT rotates and arch of the foot raises into supination.

This is the Windlass Effect
QUESTIONS TO ASK YOURSELF

• Compare both sides
• What if not equal?
• What percent had inequality?
WINDLASS EFFECT/FHL

• Missing glide in medial foot

• Called Functional Hallux Limitus (FHL)

• Big to Normally
  • Dorsiflexion w/o load = 70-90°
  • Weight Bearing = 35°
BREAK DOWNS

• +/- Neutral (calcaneal, talus, navicular, cuboid, FHL)

• Navicular arch drop - Plantar Fascitis
CLOSER LOOK

• BRKDWN in Windlass effect can increase foot Pronation.

• Plastic Deformation- w/in 3-6 month time period caused by INC stretch.

• No longer able to activate inhibitory response.
SHOCK ABSORBERS

• 1° Pronation of Foot— Post Tibialis, L5 nerve root

• 2° Knee Flexion— Popliteus flexes knee first 15° from full Ext (internal rotation of Tibia)

• What Nerve root controls the popliteus?
FORCES INTO THE FEET

- Walking 1-3x
- Running 3-5x
- Jumping 5-7x

some sources will even say 7-11x
KEY CONCEPT

Shock Absorption can not occur at heel strike unless subtalar joint pronation can occur to allow for knee Flexion
QUESTION

• Could inadequate pronation and knee flexion transmit increase shock and/or create abnormal motion in the pelvis and lumbar spine?
TREATMENT OPTIONS

• Adjustments/mobilization

• navicular/arch support taping

• Stretch/Exercises to strengthen Plantar Fascia and Kinetic chain (FMS)

• Modalities: US, IASTM, IFC, Russian
Objective: Abnormal foot posture and function have been proposed as possible risk factors for low back pain, but this has not been examined in detail. The objective of this study was to explore the associations of foot posture and foot function with low back pain in 1930 members of the Framingham Study (2002-05).

Conclusion: These findings suggest that pronated foot function may contribute to low back symptoms in women. Interventions that modify foot function, such as orthoses, may therefore have a role in the prevention and treatment of low back pain.
A systematic review: the effects of podiatrical deviations on nonspecific chronic low back pain.
O'Leary CB1, Cahill CR, Robinson AW, Barnes MJ, Hong J.

Abstract
Lower back pain (LBP) is a widespread, expensive, and debilitating problem in Western industrialized countries. Though LBP can be caused by acute injuries, biomechanical discrepancies have also been indicated to cause chronic LBP. A possible link between podiatrical deviations and LBP has been established in the literature; yet, no comprehensive review investigating the effects of foot and ankle deviations on low back pain has been published. The aim of this study was to assess the relevant literature concerning the effects of foot and ankle deviations on LBP. After review, it was determined that there is limited research regarding ankle and foot deviations and their connection to LBP. Reviewed studies have linked flat feet, ankle instability, sagittal plane blockage and excessive pronation to LBP. Specifically, excessive pronation has been shown to cause leg length discrepancies leading to pelvic tilts and LBP. Based on these results, ankle and foot deviations can be considered a potential cause for LBP due to the disruption of the kinetic chain from the foot to the back. Clinicians should consider the foot and ankle when addressing LBP, especially if more conventional etiologies fail to describe the condition.
Low back pain and its relation to the hip and foot.
Cibulka MT.

Abstract
STUDY DESIGN:
Case study.
OBJECTIVE:
To describe a treatment approach for a patient with recurrent low back pain who also had asymmetry in hip rotation between the left and right sides.
BACKGROUND:
The patient's chief complaint was dull, intermittent unilateral low back pain during the past 3 years.
METHODS AND MEASURES:
The patient was a 35-year-old man with recurrent unilateral low back pain. The findings of the physical therapy examination suggested sacroiliac joint dysfunction. Also, evaluation later showed evidence of unilateral excessive foot pronation on the same side of the excessive hip lateral rotation. The finding of excessive hip lateral rotation and excessive foot pronation on the same side of the unilateral low back pain suggested a possible connection between low back symptoms, hip, and lower extremity dysfunction.
RESULTS:
The treatment of the hip and the subtalar joint of the foot eliminated the reoccurrence of the patient's signs and symptoms of sacroiliac joint dysfunction.
CONCLUSIONS:
This case report demonstrates the successful treatment of a patient with low back pain who exhibited multiple impairments in the sacroiliac, hip, and subtalar joints.
Bilateral and unilateral increases in calcaneal eversion affect pelvic alignment in standing position. Pinto RZ1, Souza TR, Trede RG, Kirkwood RN, Figueiredo EM, Fonseca ST.

Abstract
Excessive foot pronation has been associated with the occurrence of low back pain, possibly for generating changes in the lumbopelvic alignment. However, the influence of foot pronation (measured as calcaneal eversion) on pelvic alignment during standing has not been well established. Fourteen young healthy subjects participated in the study. A Motion Analysis System was used to obtain pelvic positions in sagittal and frontal planes and calcaneal position in the frontal plane. Volunteers were filmed in relaxed standing position during three trials, in three conditions: control; unilateral experimental with increased right calcaneal eversion and bilateral experimental with increased bilateral calcaneal eversion. Increased calcaneal eversion was obtained using wedges tilted 10 degrees medially, unilaterally and bilaterally. Repeated measures ANOVAs with Bonferroni corrections were used for statistical analysis. Unilateral and bilateral use of medially tilted wedges produced a significant increase of calcaneal eversion (P<or=0.01), on the right and left sides. Bilateral and unilateral increases of the calcaneal eversion caused average pelvic anteversion of 1.57 degrees (P=0.003) and 1.41 degrees (P=0.021), respectively. Unilaterally increased everted position generated an average pelvic lateral tilt of 1.46 degrees (P<0.001). Excessive calcaneal eversion during standing changes pelvic alignment and should be considered, associated with other relevant factors, when assessing pelvic misalignments.
RESEARCH

Function of the windlass mechanism in excessively pronated feet.
Aquino A1, Payne C.
Author information

Abstract
The foot postures of 39 subjects were evaluated for excessive pronation by means of six static weightbearing and five nonweightbearing measurements, and two types of footprint indexes. Visual evidence of windlass function was recorded by video. Chi-square analysis revealed that excessive pronation does not affect the establishment of the windlass mechanism. The position of the forefoot relative to the rearfoot, subtalar joint axis position, and navicular drift/foot length ratio were significantly associated with dynamic windlass function. These results suggest that selected static measurements may have value in predicting some aspects of dynamic foot function during the propulsive phase of the gait cycle.
Changes in windlass effect in response to different shoe and insole designs during walking.
Lin SC1, Chen CP, Tang SF, Wong AM, Hsieh JH, Chen WP.

Abstract
Windlass effect occurs during the pre-swing phase of gait cycle in which the peak tensile strain and force of the plantar aponeurosis (PA) is reached. The increased dorsiflexion angle of the 1st metatarsophalangeal (MTP) joint is the main causing factor. The aim of this study was to investigate thoroughly in finding the appropriate shoe and insole combination that can effectively decrease the windlass effect. Foot kinematic analyses of 10 normal volunteers (aged 25.2±2.1 years, height of 167.4±9.1 cm, and weight of 66.2±18.1 kg) were performed during gait under the conditions of barefoot, standard shoe (SS) with flat insole (FI) or carbon fiber insole (CFI), and rocker sole shoe (RSS) with FI or CFI. The shoe cover consisting of transparent polymer was used for accurate measurement of kinematic data as specific areas on the cover can be cut away for direct placement of reflective markers onto the skin. Under barefoot condition, the mean of maximum dorsiflexion angle of the 1st MTP joint was measured to be 48.0±7.3°, and decreased significantly to 28.2±5.7° when wearing SS with FI, and 24.1±5.7° when wearing SS with CFI. This angle was further decreased to around 13° when wearing RSS with FI or CFI. Subjects wearing footwear alone can increase the minimum medial longitudinal angle and decrease the maximum plantarflexion angle of metatarsus related to the calcaneus as compared with barefoot condition, resulting in flatter medial foot arch. Results suggested that RSS is the effective footwear in reducing the windlass effect regardless the type of insole inserted. The findings in this study provided us with the evidences in finding the appropriate footwear for treating foot disorders such as plantar fasciitis by effectively reducing the windlass effect.
Foot lengthening and shortening during gait: a parameter to investigate foot function?
Stolwijk NM1, Koenraadt KL2, Louwerens JW3, Grim D2, Duysens J4, Keijsers NL2.

Abstract
INTRODUCTION:
Based on the windlass mechanism theory of Hicks, the medial longitudinal arch (MLA) flattens during weight bearing. Simultaneously, foot lengthening is expected. However, changes in foot length during gait and the influence of walking speed has not been investigated yet.

METHODS:
The foot length and MLA angle of 34 healthy subjects (18 males, 16 females) at 3 velocities (preferred, low (preferred -0.4 m/s) and fast (preferred +0.4 m/s) speed were investigated with a 3D motion analysis system (VICON®)). The MLA angle was calculated as the angle between the second metatarsal head, the navicular tuberculum and the heel in the local sagittal plane. Foot length was calculated as the distance between the marker at the heel and the 2nd metatarsal head. A General Linear Model for repeated measures was used to indicate significant differences in MLA angle and foot length between different walking speeds.

RESULTS:
The foot lengthened during the weight acceptance phase of gait and shortened during propulsion. With increased walking speed, the foot elongated less after heel strike and shortened more during push off. The MLA angle and foot length curve were similar, except between 50% and 80% of the stance phase in which the MLA increases whereas the foot length showed a slight decrease.

CONCLUSION:
Foot length seems to represent the Hicks mechanism in the foot and the ability of the foot to bear weight. At higher speeds, the foot becomes relatively stiffer, presumably to act as a lever arm to provide extra propulsion.
Thank You