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HOW TAPING AFFECTS THE PLANTAR FASCIA AND ITS WINDLASS MECHANISM

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The plantar fascia is a crucial structure in the foot that serves multiple functions beyond simply supporting the arch. It plays a role in optimizing muscle function, shaping movement, and ensuring proper physiological operation of the foot's nerves and blood vessels. One of its most significant mechanical functions is its involvement in the windlass mechanism, which helps maintain foot stability and efficiency during weight-bearing activities. Additionally, understanding the biomechanics of the windlass mechanism allows clinicians to use therapeutic taping to modify the mechanical properties of the plantar fascia, thereby providing relief in cases of dysfunction.

The Plantar Fascia

The plantar fascia is a structure of dense connective tissue that spans from the calcaneus (heel bone) to the phalanges (toes). Mechanically, the plantar fascia absorbs shock and provides a stable yet flexible cushion that allows for efficient foot movement and weight distribution.

The plantar fascia also separates the muscles of the foot into fascial compartments, optimizing both static and dynamic foot function. The fascial compartments also shape the muscles, facilitate movement, and influence blood flow and nerve function.

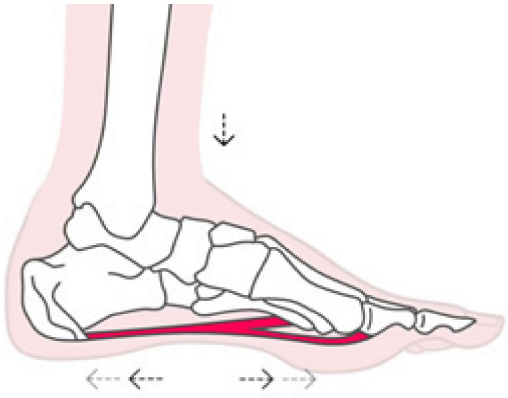
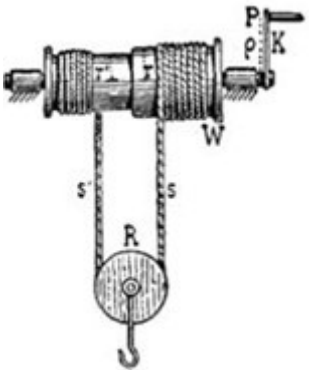


Figure 1: The plantar fascia is designed to support vertical and horizontal forces.

What is a "windlass" and what does it have to do with the plantar fascia?



The term "windlass" originated from Middle English (1350-1400) and is a combination of the Old Norse word 'vinda' meaning 'to wind' [i.e. turn] and 'áss' meaning 'pole'. This name reflects the device's primary function, which involves winding a rope or chain around a rotating spindle to lift or lower heavy weights, such as an anchor.

The word "windlass" can either be a noun describing a type of winch used especially on ships, or a verb meaning to haul or lift something with a windlass.

The term "windlass mechanism" of the foot was first used by John H. Hicks, an orthopedic surgeon, in 1954 when he described how the plantar fascia acts like a "windlass" when the big toe is flexed, causing increased tension on the plantar fascia to support the arch of the foot. Since his introduction of this term in the 1950s, tightening of the fascia has been called the "windlass mechanism."

The Windlass Mechanism

Originally described by Hicks in the 1950s, the windlass mechanism of the plantar fascia illustrates how it functions as a truss or tie rod to support the foot.

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This biomechanical model explains two critical ways the foot maintains structural integrity: 1) by preventing the separation or splaying of the metatarsal heads and 2) by resisting arch collapse.

The term "windlass" refers to a tightening effect like winding a rope or cable. The arch structures, composed of the calcaneus, the midtarsal joint, and the metatarsals, relies on the plantar fascia to maintain the bony arrangement under body weight. During the "toe-off" phase of the gait cycle, ankle dorsiflexion extends the toes, "winding" the fascia around the metatarsal heads. This action tightens the plantar fascia, reinforcing the arch and limiting excessive widening of the metatarsals, thereby conserving energy and optimizing propulsion.

Impact of Taping on the Plantar Fascia

Taping the foot is an effective strategy for optimizing the plantar fascia function by redistributing mechanical loads and providing targeted structural reinforcement. It also plays a crucial role in reducing strain, enhancing foot stability, and preventing excessive movement that can lead to discomfort or injury. Specifically, taping supports the two primary functions described by the windlass mechanism:

1. ***Preventing Excessive Splaying of the Metatarsal Heads***

   The metatarsals form the forefoot's bony framework, and their proper alignment is essential for maintaining foot stability and efficient force distribution. Excessive splaying of the metatarsal heads weakens the foot's structural integrity, leading to increased stress on the plantar fascia which creates foot pain or dysfunction.

   Applying a circumferential tape around the metatarsals heads limits their excessive widening which stabilizes the transverse arch, reducing unnecessary strain on the plantar fascia and thus improving foot mechanics. Taping is particularly beneficial for individuals with conditions such as flat feet, overpronation, or metatarsalgia, where excessive forefoot spreading can exacerbate discomfort.

2. ***Maintaining Arch Integrity and Reducing Plantar Fascia Strain***

   The plantar fascia plays a crucial role in supporting the medial longitudinal arch, particularly during weight-bearing. Excessive arch collapse increases the tensile load on the plantar fascia, contributing to conditions like plantar fasciitis, heel pain, or arch fatigue.

   Taping that is applied from the forefoot around the calcaneus, reinforcing the arch and reducing excessive elongation of the plantar fascia. This taping technique helps maintain the natural height and function of the arch, reducing stress during walking, running, or prolonged standing. Supporting the plantar fascia in this way can reduce pain and enhance overall foot biomechanics, especially for individuals recovering from foot injuries or dealing with chronic foot instability conditions.



Figure 2: Taping provides external support of the horizontal and vertical force.

Conclusion

The plantar fascia is a key structural component of the foot, providing both mechanical and functional benefits. Through the windlass mechanism, the plantar fascia plays a critical role in arch stabilization and energy efficient gait. Taping can be a valuable intervention to support the fascia, reduce pain, and enhance functional movement. Understanding these concepts is essential for maintaining optimal foot health and performance.

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