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Clinical Orthopedic Device Innovation: The Anchored Ankle Brace™ & Full Leg Support System™

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Abstract- An ankle brace design innovation including a circumferential proximal calf anchor member that is connected by a lateral anchor strap to an ankle support member is described that facilitates increased resistance to lateral roll at the ankle. The ankle support member includes an ankle surround that encloses a portion of the foot and an anchor member for positioning about the circumference above a midpoint of the lower leg characterized by a girth that is increasing as a distance from the ankle joint decreases. The anchored ankle brace also includes a lateral anchor strap attached at a first end to the ankle support member and at a second end to the anchor member. The anchored ankle brace stabilizes the ankle joint increasing resistance to ankle sprain characterized by excessive inversion with planter flexion also known as "rolling the ankle". Additionally, the ankle brace can be fitted to a valgus-varus knee brace in order to provide for a full leg support system.

Keywords- *ankle support, prophylactic ankle brace, calf anchor, lateral collateral ligament (LCL).*

I. INTRODUCTION

Traditionally, prophylactic ankle braces have utilized linear and diagonal strapping as well as various fastening systems, for instance laces or hook and loop closures, to provide static resistance to excessive sub-talar, ankle mortise, and mid-foot inversion and eversion. The most common athletic injury is the ankle sprain. Moreover, the most common mechanism injury (MOI) of ankle sprain is that of excessive inversion with planter flexion, also known as "rolling the ankle" [1]. Excessive inversion may damage the lateral collateral ligaments (LCL). Specifically, the LCL is comprised of the anterior talo-fibular, calcano-fibular and posterior talo-fibular ligaments of the ankle.

In attempt to protect this ligament complex, athletes, coaches, and medical professionals apply external, static structural support to the ankle by applying athletic adhesive tape or a brace [2]. The purpose of this external support is to physically restrict ankle inversion. The previously mentioned linear and diagonal strapping found in the state of the art ankle braces affix or anchor these straps to the stocking-like body of the brace to establish support and resistance to excessive motion. Of these straps, the lateral strap plays the primary role in resisting inversion.

The typical lateral strap originates from the medial side of the hind or mid-foot and runs laterally under the foot and then up the lateral side of the lower leg, parallel to the distal one-third of the fibula. State of the art lateral straps terminate at the top of the brace. For that matter, straps in all state of the art ankle braces terminate at the top of their respective braces. This is a point approximately two-thirds of the way down the shaft of the tibia, just below the muscle-tendon junction of the gastrocnemius [3].

Stability, characterized by resistance to inversion, arises from both the position of this lateral strap as well as from the fibers of the body of the brace that encompass the girth of the lower leg. The problem with deriving stability from these circumferential fibers at the top of the brace is that forces pulling distal ward, for instance those forces observed during inversion, can cause downward slippage of the most proximal faces of the brace due to the decreasing girth of the lower leg at this point.

Accordingly, there is a need for an improved device and method for stabilizing the ankle joint and surrounding ligament complex. Therefore, one objective of the brace presented here is to provide the aforementioned methods for stabilizing the ankle joint and surrounding ligament complex.

II. METHODS AND MATERIALS

The ankle joint stabilizing system described here consists of an ankle support that is anchored by attachment around the proximal end of the lower leg [4]. This novel design is based on the concept of stabilizing the ankle joint and surrounding ligament complex via a check reign (anchor) attachment to a location below the knee joint line and above a midpoint or belly of the calf musculature.

This anchored brace includes an ankle support member and ankle-surround element that encloses at least a portion of the foot and a proximal calf member adapted for positioning and attachment about a circumference of the proximal end of the lower leg, above a midpoint or belly of the calf musculature (Fig. 1). This portion of the lower leg is characterized by a girth that is increasing as a distance from the ankle decreases. The anchored ankle brace system also includes a lateral anchor strap distally attached to the ankle support member and proximally attached to the calf anchor member.

The calf anchor member takes advantage of the enlarging girth of the calf to resist downward pulling force on the anchor member and the lateral anchor strap, thereby improving performance of the anchored ankle brace, particularly over a period of time and as a result of strenuous activity typically encountered in physical activities. The net result is an observed improvement to resistance to excessive ankle inversion with plantar flexion and the associated damage to the lateral collateral ligaments (ankle sprain). This novel design and device may now be used to minimize the high frequency of the most common athletic related joint injury, the inversion ankle sprain [1].

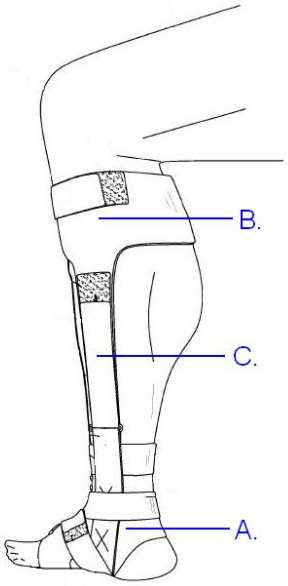

Figure 1. Lateral view of the Anchored Ankle brace system depicting (A) the ankle support member around the foot, (B) the calf anchor member, and (C) the lateral anchor strap connecting the two members.

The lateral anchor strap (C) comprises webbing that extends along a lateral face of the lower leg between the ankle support member and the anchor member. An attachment element, for instance a ring or a buckle that allows selectively tensioning the strap, is incorporated into the construction of the strap and the ankle support member. During application, the wearer (athlete) inserts the end of the anchor strap through a ring fixed near the collar of the ankle support member pulling the strap to a desired tension. The end of the strap is secured by mating surfaces of hook and loop fabric. The wearer may adjust tension as desired or release the strap entirely as need dictates.

In an extension of the design of this anchored ankle brace, the lateral anchor strap extends between the ankle support member and an anchor member configured as a part of a knee brace. The knee brace serves the function of the anchor member inasmuch as at least some portion of every knee brace is positioned and attached about a circumference of the proximal end of the lower leg.

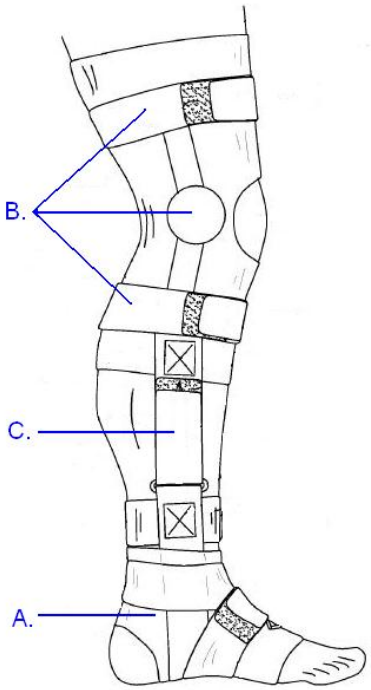

Figure 2. The Full Leg Support System™ as viewed from the lateral aspect depicting (A) the ankle support member around the foot, connected to (B) the distal aspect of a valgus-varus knee brace, via (C) the lateral anchor strap between the two primary members of this system.

III. RESULTS

The Anchored Ankle Brace™ and Full Leg Support System™ provide the following:

- a novel brace design for the prevention of ankle sprains,
- use of the girth of the calf as a restraint against excessive ankle inversion,
- static stabilization of the lateral collateral ligament complex of the ankle, and when incorporated in the Full Leg Support System™, additional stabilization of the medial and lateral collateral ligaments of the knee,

- rapid lateral anchor strap adjustment capabilities to allow wearers to change the inversion resistance tension quickly, without removing the shoe.

IV. IV. Discussion

The foregoing has outlined, rather broadly, the features and technical advantages of the present ankle and leg bracing systems. Additional features and advantages of these bracing systems have been outlined [4].

In much the same way that the peroneal muscle group acts to prevent forced inversion of the ankle [5], so does the strap extending from the proximal calf strap top the lateral aspect of the ankle surround member. Extensibility of lateral restraining tissues does meet limitation in extreme inversion and may be lessened by the static lateral scaffolding provided by this brace system. Additionally, early onset compensatory muscle activity may be facilitated by the presence of the brace and increased cutaneous input [6,7]. The novelty of the aforementioned design is truly unique, and the biomechanical advantage and potential for resistance to inversion realized by its morphology lend this brace and system to be fertile ground for both clinical trial and future investigation.

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