SPIRAL ORTHOSIS FOR THE LOWER EXTREMITY

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ABSTRACT
An orthosis device for the lower extremity having a footplate and a horizontal calf-encircling band interconnected by a spiral portion extending from the medial side of the plate, posteriorly around the leg to terminate at the level of the medial tibial condyle.

10 Claims, 2 Drawing Figures
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SPIRAL ORTHOSIS FOR THE LOWER EXTREMITY

BACKGROUND OF THE INVENTION

This invention relates generally to orthotic management of lower extremity disabilities and more particularly to orthosis devices adapted for use with disabilities involving lack of motor power in the ankle-foot complex.

Orthotics involving braces for the lower extremity have been known in the art for some time. The design of conventional braces has not undergone any basic change in more than a century other than changes adapted to make use of modern materials such as aluminum or stainless steel. One of the major disadvantages of the present art in orthotic is that it has been empirically derived rather than being based on an analysis and the requirements of human locomotion. Prior art orthotics has furthermore been over designed to prevent breakage which, in most cases, has been found to be a result of poor fitting and/or poor alignment. Prior art braces have poor cosmetic appearance and are therefore considerably heavier than need be, as their function and alignment are far from being analogous to those of a normally functioning extremity.

Although some attempts have been made in recent years to overcome the disadvantages of the prior art braces, none of the suggested designs provides an orthosis which is aligned and functions analogous to the normally functioning extremity. Although a dual axis brace has been developed at the Biomechanics Laboratory of the University of California at San Francisco to add another degree of freedom to conventional braces by permitting subtal motion in addition to ankle motion, the device involves greater mechanical complexity and additional bulk. Furthermore, the cosmetic appeal of such braces is not thereby improved.

SUMMARY OF THE INVENTION

This invention provides an orthosis for lower extremities which avoids the disadvantages of the prior art by furnishing a multi-axis brace which functions in a manner nearly analogous to that of a normally functioning extremity.

The invention also furnishes a multi-axis brace which is simple, lightweight and has greater cosmetic appeal than those of the prior art by providing an orthosis which utilizes the engineering principles of the spiral helix to achieve multi-axis motion similar to the motion of a normally functioning extremity.

In a preferred embodiment the invention provides an orthosis including a footplate fitting the sole of the foot; a resilient spiral portion extending upwardly from the medial side of the footplate, posteriorly around the leg and terminating at the level of the medial tibial condyle; and a band encircling the leg for fixing the upper terminus of the spiral portion to the leg.

These and other objects and many of the attendant advantages of this invention will become better understood to those skilled in the art by reference to the following detailed description when viewed in light of the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front elevational view of an orthosis in accordance with the invention; and

FIG. 2 is a side elevational view of the orthosis of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the figures, the device, indicated generally at 10, is shown installed on the lower extremity of a leg, shown in phantom at 12.

The device comprises a footplate 14, an upwardly extending spiral portion 16 with a horizontal band or cuff 18 at the upper end thereof. The footplate 14 is preferably formed as an integral part of the spiral portion 16 with the band 18 connected by means of fasteners such as rivets 20. The band is openable on one side thereof and may be provided with an openable fastener such as a snap fastener 22 to provide means to close the band 18 and encircle the leg 12 for fixing the upper part of the device. Obviously other means, such for example, as a horizontal continuation of the spiral portion with a lateral opening for donning and removing the device, may be provided to fix the upper portion of the device if so desired.

The footplate 14 and spiral portion 16 are preferably constructed of a heat formable plastic material which has strength and resiliency properties suitable for the purpose as will be described below. As an example, a thermoplastic material such as an acrylonitrile marketed under the trademark FLEXIDUR by the Rhom and Haas Company of Darmstadt, Germany, has been found to be suitable for the purpose of this invention. Where the device is to be fabricated with the band 18, a material 2 to 2.5 mm in thickness is sufficient for the purposes of the invention. If the device is fabricated with a continuation of the spiral portion 16 constituting means to fix the upper portion of the device, material 4 mm in thickness may be required. The device is preferably fabricated and provided to the orthotist in two components, e.g., the footplate 14 — spiral portion 16, with the spiral portion 16 preferably in a straight, unspiraled configuration, and the band 18. The orthotist then fits the components to the individual wearer preferably by leg cast, heating and forming the spiral portion on the cast, cutting the components to the proper lengths and connecting the components with the rivets 20. With the device 10 properly formed to fit the leg 12, the footplate is placed under the foot 24 with the portion 16 extending up the medial side thereof, passing around the leg 10 posteriorly and terminating approximately at the level of the medial tibial condyle. The band 18, preferably formed of a flexible plastic or fabric material compatible with the use, then encircles the calf portion of the leg.

The footplate 14 is preferably formed to fit the sole of the foot 24 and is shaped around the periphery thereof, to be accommodated in the shoe of the wearer such that, after donning the device, the wearer may then dress in the usual fashion.

The spiral portion functions both as a support and as a resilient member acting device and, as such, represents a new concept which obviates the need for metallic joints in the brace yet provides controlled motions in all of the natural planes, e.g., adapting to transverse rotation as well as to motions in the frontal and sagittal planes. Studies made of normal human locomotion reveal that, in addition to ankle motion, transverse rotation of the limb and eversion and inversion are im-
important components of the motion in a normally functioning extremity. Normal transverse rotation, for example, may be considerable consisting of about 23° relative rotation between the foot and the pelvis. The spiral portion, when loaded and unloaded, provides motions analogous to each of the above. Specifically, with the brace donned by the wearer, the motions accomplished by the brace during the normal stride are as follows:

a. Upon heel contact, upward force induces unwinding of the spiral portion 16 providing simultaneous plantar flexion and transverse rotation of the limb.

b. In midstance the spiral 14 rewinds returning the foot to a neutral position.

c. In the heel-off-the-ground position, the spiral again unwinds thereby providing for dorsiflexion.

d. In the swing phase of gait, the brace is unloaded, rewinds and the foot is returned again to the neutral position. Eversion-inversion of the ankle is controlled through the three point contact inherent in the spiral portion 16 as it circles the lower leg. As is seen, the total motion imparted to the extremity resembles that of a normally functioning extremity thereby providing an orthosis which can be designed close to the required strength. Both the weight, complexity and bulk of the device may therefore be kept to a minimum providing, not only a better functioning orthosis, but one which is lighter and has greater cosmetic appeal than heretofore possible.

What has been set forth above is intended to be exemplary of a teaching in accordance with the invention to enable those skilled in the art to practice the invention.

What is new and desired to be protected by Letters Patent of the United States is:

1. An orthosis for the lower extremity comprising: a footplate adapted to accommodate the sole of the foot of the wearer; a one-piece elongated resilient spiral portion integrally fixed to and non-articulatively extending from the medial side of said footplate, said elongated portion being configured in a spiral helix to extend around the leg of a wearer posteriorly terminating in an upper end at the level of the medial tibial condyle whereby motion occurs along the entire length of the elongated spiral portion during normal human locomotion; and means to fix the upper end of said resilient portion to the leg of a wearer.

2. An orthosis as described in claim 1 wherein said footplate and resilient portion comprise integrally formed thermoplastic.

3. An orthosis as described in claim 2 wherein said thermoplastic comprises an acrylic-nylon material.

4. An orthosis as described in claim 1 wherein said footplate is molded to generally conform to the sole of the foot of the wearer.

5. An orthosis as described in claim 1 wherein said resilient portion comprises: a flat strip of material molded to conform to the leg of the wearer.

6. An orthosis as described in claim 1 wherein said means to fix the upper end of said resilient portion comprises a flexible band attached to the upper end thereof and positioned to encircle the calf of the leg of the wearer.

7. An orthosis as described in claim 6 wherein said band is split and wherein means are disposed therein to close said band around the leg of the wearer.

8. A component for use in orthosis for the lower extremity comprising: a footplate adapted to fit the sole of the foot of the wearer; and a one-piece elongated resilient spiral portion integrally fixed to and non-articulatively extending from one side of said footplate, at least said elongated portion comprising a formable material configured in a resilient spiral helix adapted to encircle the leg of a wearer and extend at least to the level of the medial tibial condyle whereby motion occurs along the entire length of the elongated spiral portion during normal human locomotion and means to fix the upper end of said resilient portion to the leg of a wearer.

9. A component in accordance with claim 8 wherein said footplate and resilient portion comprise an integrally molded thermoplastic material.

10. A component in accordance with claim 8 wherein said footplate and resilient portion are adapted to be subsequently formed to conform to the configuration of the extremity of the individual wearer.