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BODYWEIGHT APPARATUS USED TO APPLY COMPRESSION GARMENTS FOR LYMPHEDEMA PATIENTS

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INTRODUCTION

Lymphedema is a medical condition caused by an excess of fluid collecting in the interstitial tissue. When the lymphatic system is functioning normally, the interstitial fluid passes into the lymphatic capillaries, thought the lymphatic ducts, and returns to the circulatory system [1]. If this system is disrupted due to congenital reasons, surgery, or radiation therapy associated with cancer treatment, the fluid is unable to properly drain [2]. This collection of fluid leads to swelling of the affected area, usually the legs or arms (Figure 1).

There are two types of lymphedema, primary and secondary. Primary lymphedema is caused by a developmental abnormality of the lymphatic system. Secondary lymphedema occurs when the lymph nodes have been either removed or damaged because of surgery or radiation. It has been estimated that there are over one hundred million cases of lymphedema world-wide, with roughly three million cases in the United States [3].

Lymphedema is an incurable disorder which can be best controlled through compression therapy. The most common means of compression is through the use of specially designed garments and stockings. These garments typically provide approximately 40-50 mmHg (.77-.98 psi) of external pressure. For a leg garment, the compression level is highest at the ankle and decreases towards the heart. This results in a pressure gradient the helps to drive the fluid out of the limb. However, these garments can be quite difficult to put on (don) and take off (doff), especially for elderly and disabled persons.

Currently, there are several donning and doffing aids on the market. These products range from anti-friction aids to rigid metal frames. The effectiveness of these products varies, but they all have one shortcoming; they require the user to pull the garment on using the strength of the upper-body. Many patients, especially the elderly, have limited upper body strength. As a result, they require the help of another person to assist them in the donning process. In the case of an elderly couple, neither person may be able to don the garment, thus the patient may require aid from a nurse.

The goal of this project is to design and develop an assistive device that requires minimal upper body strength to aid in donning a compression garment.

Figure 1: Patient at Siskin Lymphedema Clinic, Chattanooga TN. (picture by John Jordi)

PRODUCT DESCRIPTION

The apparatus is designed to employ the force of gravity and the strength of the lower body to don leg garments. This will be accomplished through using a pulley and cable system that connects a central pedestal to an upper platform (Figure 3).

To use this product, the user must position the garment inside the upper opening of the leaves (Figure 2), with the heel of the garment positioned at the cusp of the opening. The foot of the garment will hang inside the leaves, while the remainder of the garment will be draped around the outside of the leaves. Once the garment has been properly situated on the apparatus, the user slips his/her foot through the opening of the garment and presses down until their foot is properly positioned within the garment. With the foot properly positioned, the user will press down on the central pedestal, which causes the upper platform to travel upwards due to the cable and pulley system (Figure 3). This mechanism provides a 2:1 ratio, meaning the garment will be applied at a rate of two inches for every one inch of leg travel. This action will apply the garment to the leg because the friction between the garment and skin will be greater than the friction between the garment and the leaves.

Figure 2: The collapsed position of the apparatus.

The four cast and polished aluminum leaves form a circle and push up the garment while withstanding the down force of the garment as it slides over the edge of the leaves. The leaves are attached with hinges to the upper platform. These hinges permit the leaves to open and follow the contours of the leg as well as allowing the apparatus to be used with many different leg sizes. In order to accommodate a wide range of user heights, the three legs are telescoping. Three legs were chosen over four to reduce material costs and manufacturing time. The base and central pedestal will be made from Grade-A plywood. The upper platform and legs will be aluminum and all other parts stainless steel.

The apparatus is designed to be circular with an opening on one side to ease the ingress/egress of the leg. The approximate dimensions are as follows; a fully extended height of 99 cm (39 in.), a fully collapsed height of 56 cm (22 in.), a total travel distance of 70 cm (27 in.), and an overall diameter of 50 cm (20 in.).

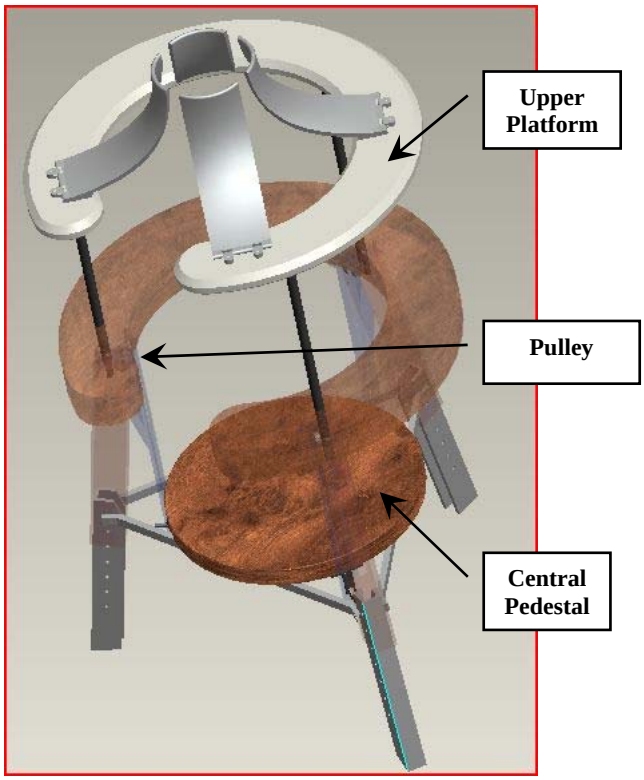

Figure 3: The expanded position of the apparatus.

In addition, this apparatus will be accompanied with an integrated hand rail and elevation aid (not pictured). These features will help the user maintain their balance, as well as requiring less flexibility, and provide safety parameters in order to step into the upper opening.

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