The science and methods behind compression to enhance circulation – IPC

There are two main principles of compression therapy. The first one is to create an enclosed system in order to allow an evenly distributed internal pressure in the leg. This principle involves the application of Pascal's Law, which entails muscle movement generating a pressure wave that is distributed evenly in lower limbs during active and passive exercise. The compressive effect can reduce the diameter of veins by positioning valves and forcing the venous blood to return to the heart [1]. The second principle involves the application of Laplace's Law in order to create a varied interface pressure based on limb shape as well as the tension of the stocking or bandage applied [2]. As mentioned above, Lymphedema is a common condition where compression is being used in the management and the principle of action in compression stockings is by improving the calf muscle pumping on the veins as well as to help lymph propulsion by enhancing the extrinsic force such as contractions of the skeletal muscles adjacent to the lymphatic vessels [3] and another possible potential benefit of wearing compression stockings is to decrease the capillary filtration [4] thus, reducing the disease progression.

Intermittent pneumatic compression devices

An IPC device is composed of an inflatable garment consisting of one or more pressure compartments that wraps around the limb or the intended body part, and pneumatic pump that fills the garment with compressed air. The garment is intermittently inflated and deflated with cycle times and pressures that vary between devices. Most of these devices are tethered but there are several non-tethered devices emerging in the market.

1. Single-chambered IPC devices

First generation IPC's consisted of an inflatable single compartment pressure chamber that applied a non-segmented uniform and sustained level of compression to the entire extremity. These non-programmable devices did not provide proper pressure distribution or a pressure gradient. To effectively assist the movement of stagnated lymphoedematous fluid, a pressure gradient between the lower and the upper part of the extremity is crucial; the same principle applied by compression bandages and compression garments. Due to the limited amount of control and lack of appropriate pressure gradient, single-chambered devices are discouraged to be used in the management of medical conditions such as lymphedema, varicose veins, etc.

2. Multi-chambered IPC devices

Multi-chambered, segmented IPC's are the newer generation compression devices which equipped with multiple outflow ports on the pneumatic pump leading to distinct segments of the garment that inflate sequentially from the lower part of the extremity to the upper part of the extremity until all segments are inflated.

Two groups of multi-chambered IPC's can be distinguished – those without or limited manual control and non-calibrated pressure (Healthcare Common Procedure Coding System (HCPCS) Code E0651), and devices equipped with programmable options and calibrated pressure (HCPCS Code E0652) [5] .

The advantage of the latter system is that the level and location of the compression can be adjusted to meet the patients' specific circumstances in regard to comfort (pressure tolerance, pain) and the need to concentrate on specific areas affected by medical conditions such as lymphedema, or on areas with excessive fibrotic tissue formation. The programmability of the pressure profile in segmented devices with calibrated gradient pressure more closely mimics manual lymphatic drainage techniques.

Though the pressure level in IPCs vary according to its intended use, the range of pressures mostly recommended is 35 – 180 mmHg, even though some pumps could provide pressures as high as 300 mmHg [6]. Careful guidance by a practitioner with knowledge in specific medical condition is mandatory to determine optimal treatment frequency and to reduces the danger of potentially damaging effects on the superficial lymphatic and venous structures. As stated in previous sections there are numerous clinical evidence to support the effectiveness of IPCs. However, the sizeable pneumatic cuffs make the IPC bulky and less wearable. Therefore, device manufactures are currently shifting their interest to design portable, smaller size, non-tethered devices which has a pleasant user-friendly appearance.

References

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