Night compression use in a patient with primary lymphoedema - Milroy's disease: A Case Study.

Short title: Night compression in a patient with Milroy's disease.

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Abstract

Aim: Lymphoedema is associated with dysfunctional lymphatics, tissue fibrosis and inflammatory changes in the skin and local tissue. Ensuring compression supports tissue health is crucial to the management of lymphoedema. Providing patients with safe compression which enhances their tissue health is paramount when supporting their 24-hour self-management regimens. This case-study aims explore the use of a new compression garment in two sitting positions in an adult with primary lymphoedema.

Methods: An eighteen-year-old female (BMI: 25.2kg/m^2) with Milroy's Disease, was recruited. She attended two separate one-hour sessions to evaluate StO_2 in chair-sitting and long-sitting positions. Following removal of her usual Class 2 (20-30mmHg) flat-knit compression hosiery, StO_2 was recorded for 20-minutes: Pre, during and post a 20-minute application of the garment (Lohmann-Rauscher, DE) to the right leg.

Results: In the long-sitting position, StO_2 levels started high at baseline (94.5%) remaining relatively maintained both during and post a short 20-minute intervention (94.1%). In the chair-sitting position, StO_2 levels were significantly lower at baseline (52%), showing a 77% increase during the intervention (92%) followed by a small 9% decrease post-intervention (83.7%).

Conclusion: This compression garment significantly increased StO_2 levels in the chair-sitting position whilst maintaining the effects of the patients' compression stockings, in the long-sitting position. Similar to non-lymphoedematous limbs, the patients' normal prescription hosiery maintains StO_2. Through implementation of short intervention sessions, might compression garments may have the potential to improve tissue health in individuals with primary lymphoedema, encouraging self-management and offering a potential night compression solution where the need arises in a 24-hour management plan.

Key words: Compression garment, tissue oxygenation, self-management, lymphoedema

INTRODUCTION

The lymphatic system has three major roles in human physiology: regulation of homeostasis, removal of fat from the gut to the blood stream and immune trafficking (Jiang et al., 2019). Lymphoedema is associated with dysfunctional lymphatics, tissue fibrosis and inflammatory changes in the skin and local tissue (Nores et al., 2018). Dunnill et al., (2017) attributed poor tissue perfusion and oxygenation to be major factors in the sequence leading to epithelial damage in wound formation. They also acknowledged that oxygen was an essential substrate required to supply the amount of energy required for tissue renewal (Nores et al., 2018). Providing patients with safe equipment such as compression which in-turn also enhances their tissue health, is paramount when supporting their self-management regimens. Ensuring compression supports tissue health is crucial to the management of lymphoedema (Wanchai et al., 2016). In a 24-hour management plan, a range of compression devices should be available to meet individual needs through the day, without compromising their lymphoedema and tissue health during activity change (Bertsch, 2018; Whitaker, 2016).

If left untreated lymphoedema can develop into different stages of disease progression as has been documented by the International Society of Lymphology (ISL) in the summarised stages 0-3 (ISL, 2016). As lymphoedema progresses through these stages, increased changes in tissue fibrosis and adipose tissue can be observed, replacing the once 'pitting oedema' tissue (ISL, 2016). An increase in obesity in western cultures has become a global issue and the WHO recently stated that in 2016, more than 1.9 billion people aged 18 and over were overweight, with more than 650 million considered obese (WHO, 2018). Moreover, these adult obesity rates were highest among the region of the Americas (29%), European (23%) and Eastern Mediterranean (21%) (WHO, 2018). The expansion of adipose tissue in obesity has been linked to an inappropriate supply of oxygen and hypoxia development, which then further initiates adipose tissue fibrosis (Buechler, 2015) and in turn being further aggravated by inflammation. Adipose tissue, fibrosis and inflammation are all common presentations in later stages of lymphoedema (ISL, 2016). Dysfunctional lymphatic systems sensitize individuals to become obese, and obesity can worsen lymphatic function (Jiang et al., 2019).

Deteriorating lymphoedema as well as other factors, may result in an increase in localised adipose tissue and obesity, thus causing tissue inflammation such as that seen in venous disease. Venous insufficiency may therefore lead to a situation of sustained cellular hypoxia (Ortega et al., 2018). This implies that clinically the condition may continue to deteriorate where the environment is not supported or corrected. Many patients who have chronic oedema have a venous component to their oedema and in western countries, this affects up to 80% of the adult population, therefore suggesting that the presence of venous insufficiency may contribute to further deterioration due to hypoxia (Ortega et al., 2021).

A genetic study looking at the autosomal dominant condition primary congenital lymphoedema Milroy's Disease, reviewed the clinical findings of 71 patients (Brice et al., 2005). Not unexpectedly 90% had presence of oedema, however more surprisingly 23% had large caliber leg veins. Primary lymphoedema is predominantly associated with just failure of the lymphatics, however this study shows that other vascular structures can also be affected leading to the consideration of management strategies. Both lymphatic and venous disorders are managed primarily through conservative approaches using compression, such as bandages, stockings and wrap systems (Cooper, 2015; Green 2018; Kalodiki et al., 2007; Felty & Rooke, 2005; Chiang et al, 2019).

Night-time compression remains an area which is gaining momentum in the literature. A study across five countries showed that up to 89% of individual with chronic swelling see an increase over night if no compression is used (Whitaker, 2016). This is contrary to the belief that limb swelling will reduce overnight or stay the same due to elevation (Bertsch, 2018). A new night-time compression device has recently been shown to improve tissue oxygenation levels in healthy legs and has been suggested to likely contribute to the option of a tolerable night-time compression garment (Chohan et al., 2019). As no oedema was present in the study, due to the healthy leg population it was not possible to undertake limb volume measurements. This single case study explores the short-term impact of a night-time compression garment for primary lymphoedema on tissue oxygen and limb volume.

METHODS

Patient history

A single female patient aged 18 with primary lymphoedema (Milroy's Disease), was recruited to this study. The patient was diagnosed at birth and followed up in a Genetics Centre. Family history was mapped back to the great-grandfather from a symptom perspective and to the patient's mother and aunts from a genetic perspective, following testing. The primary lymphoedema was also associated with venous prominence with large veins and was visible bilaterally (Figure 1)

Management since birth was initially skin care and self-massage, and through her adolescence compression garments were introduced. These consisted of toe garments and flat knit made to measure below knee compression stockings, 20-30mmHg. Five weeks prior to the study, she had a short course of Decongestive Lymphoedema Therapy (DLT), consisting of three treatments in one week; Negative Pressure Lymph Drainage (NPLD) using the LymphaTouch® (Lymphatouch, FI) and multi-layer lymphoedema bandaging (MLLB). Post treatment the patient was fitted with new made to measure garments as before. All data collection conformed to the declaration of Helsinki and general data protection principles (GDPR), the patient gave written informed consent prior to participation.

Procedure

The participant visited the testing facility for two, one-hour sessions, 1 week apart. At the first session, baseline anthropometric measures were taken from the right lower leg to enable sizing in line with current manufacturer guidance. As previous research has shown there is no significant difference in tissue oxygenation levels between long-sitting and lying supine in healthy legs, lying supine was omitted from this study (Chohan et al., 2019). The participant was then tested in one of two sitting positions (Chair-sitting and long sitting) in a randomised order (www.randomization.com). Skin temperature was taken from the calf at baseline followed by 20, 40 and 60 minutes. Tissue Oxygenation (StO_2) was measured throughout each session using a Near-Infrared Spectroscopy monitor (MoXY Monitor, MN), averaging tissue oxygenation over each of the three twenty-minute time periods (baseline, during intervention, and post-intervention). The intervention consisted of the application of a compression garment (TributeWrap™, Lohman-Rauscher, DE; Figure 2) to the right leg following the twenty-minute acclimatisation period. The participant completed a series of questions following each session relating to comfort, sensation and potential adherence to the intervention if it was to be prescribed by a clinician.

Limb volumes using the 4cm pre-tension tape measure method (Williams and Whitaker, 2015), were recorded on both the right and left leg to knee level, pre and post long-sitting intervention.

Data Analysis

Percentage change in tissue oxygenation was calculated in each position. Change in millilitres was noted in limb volumes of both legs, using the formulary 4cm circumferential truncated cone (Sitzia, 1995). Analysis of the limb volume method was done using the percentage change in excess and absolute limb volume, over time (Williams and Whitaker, 2019).

RESULTS

Position, Temperature and tissue oxygenation.

Change in tissue oxygenation was monitored pre, during and post the 20-minute intervention (Figure 3, Table 1). In the long-sitting position, StO_2 levels started high at baseline (94.5%) remaining relatively maintained both during and post a short 20-minute intervention (94.1%). In the chair sitting position, StO_2 levels were significantly lower at baseline (52%), showing a 77% increase during the intervention (92%) followed by a small 9% decrease post-intervention (83.7%).

It is known that at least a 0.5° change is needed in temperature to be clinically important. Whilst in the chair sitting position there was no clinically important change in temperature, it is important to note that in the long sitting position there was a 1°C change in skin temperature at the calf.

Limb Volume

Throughout the treatment protocol, the patient removed the regular compression following several hours of wear and proceeded to the long-sitting position, so was without compression for only 20 minutes prior to the sleeve being applied to the right leg for 20 mins.

Limb volume of the right leg pre-intervention was 2509mls and left leg 2529ml. Post intervention the right leg measured 2444mls and left leg 2530mls, with a total reduction of 65mls in the right leg and an increase of 1ml in the left.

Patient feedback

The patient described comfort levels highly positively in both positions, with further comparisons made to reduction in swelling seen after bandaging also comparing the effects to hosiery, with more movement possible post-intervention. Compliance was described as extremely likely due to the comfort and ease of application.

DISCUSSION

All interventions occurred upon removal of the patients' standard compression garments (20-30mmHg). As this is the patients' normal daily routine it was agreed to use this as the starting point. In a previous study measuring tissue oxygenation on healthy legs with this compression (Chohan et al., 2019) the average of 28 participants oxygen level base line for healthy legs without any compression in the chair sitting position was 56%. The patients' tissue oxygenation levels in this case study upon immediate removal of compression was 52%. Although the patient was lower than the average of 28 healthy participants, it was only by 4%, indicating that the flat knit 20-30mmHg compression garments maintain tissue oxygen levels similar to those in healthy individuals with no compression. When considering the StO_2 in the long-sitting intervention this started and maintained at a higher oxygenation level (94%), supporting the clinical advice to elevate the limbs when at rest. Compared to the control limb (left leg) that remained unchanged, the limb volumes decreased in the intervention limb (right leg). This small decrease of 65mls in only one hour of positioning and 20 minutes of intervention of the compression garment indicated that the products' use of foam chips and sewn chevron design mimicking lymph pathways may have contributed to the maintenance to the StO_2 and decrease in limb volume. It also supports the maintenance of limb volume on the left leg with no intervention upon leg elevation. At the end of a long day when a patient removes their standard compression for the night, a limb can swell upon removal, however this is minimal or static when the limb is elevated, as shown on the left leg. Therefore, rather than just remaining static with no compression, this intervention may be a suitable option for night-time management normal regimen for both limbs. Albeit by a small amount with a short intervention, he patients limb volume reduced whilst wearing the compression sleeve.

The chair-sitting position gave a good insight into the benefits of wearing compression using different materials whilst remaining static in position and posture for one hour with a 20-minute intervention of compression sleeve. A 77% increase in StO_2 levels to 92% showed significant improvement. This gave key insight into understanding that different options in products can produce results akin to positioning of limbs e.g. leg elevation. It gives choice to patients and professionals when considering patients individual lifestyle, activities and needs, with the understanding that good tissue health can be maintained in a non-dynamic intervention is paramount to concordance. The participant recorded comfort levels and ease of application to be attributes which will enhance her self-management regimen. Having a choice of different compression appliances throughout a 24-hour period which have been proven to be of benefit to tissue health should be available for all patients.

CONCLUSION

Individuals cannot be mobile for a whole 24-hour period. To ensure better self-management, appliances which not only improve tissue health in a chronic disease setting, but then maintain upon removal, should be priority when considering a care regimen for people with lymphoedema. Knowing the disease progression pathway of Lymphoedema (ISL, 2016), maintaining a healthy tissue environment can ensue deterioration and further progression of the disease is kept to a minimum. The complexities of tissue hypoxia may lead to deterioration of the superficial tissues, delay in wound healing when present, encourage inflammation and then conversely the laying down of localised adipose tissue. Encouraging patients to self-manage their condition with a selection of appliances in their 'product-choice kit', knowing they increase tissue oxygen levels can only enhance control of their disorder and self-care.

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FIGURES:

Figure 1: **(A)** Pre-DLT, 5 weeks before intervention. **(B)** Post-DLT – 3rd session **(C)** Venous component to the leg.

Figure 2: The compression device (TributeWrap™; Lohmann & Rauscher, DE

Figure 3: Tissue oxygenation in the two sitting positions.

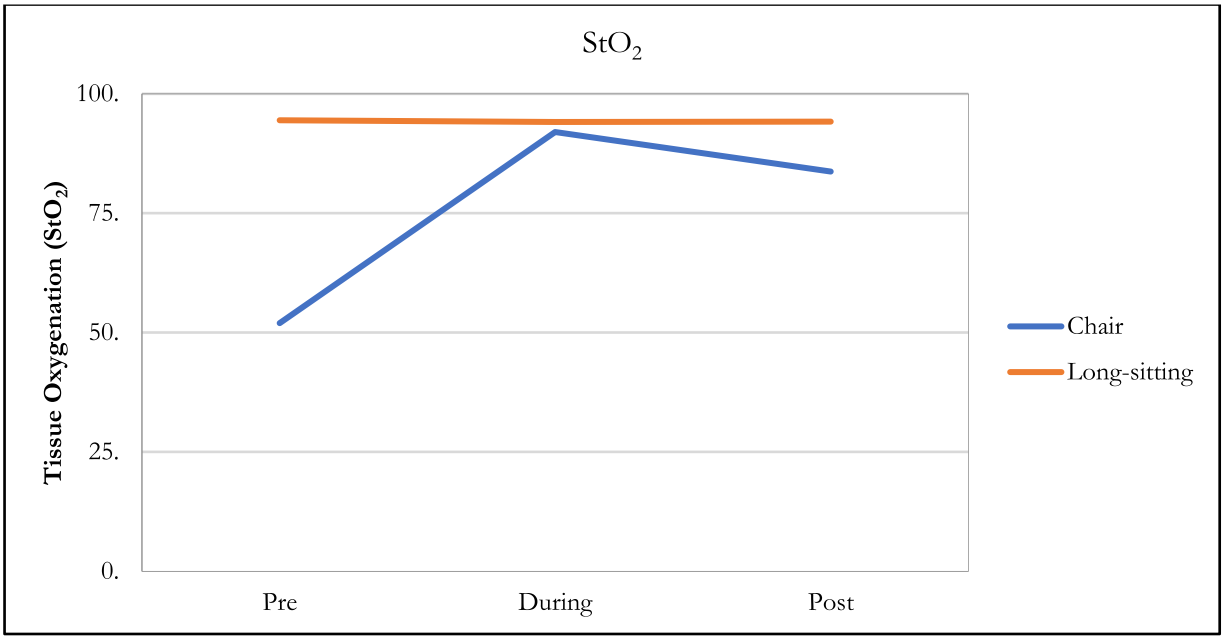
StO2
100.
75.
50.
25.
0.
Tissue Oxygenation (StO2)
Pre
During
Post
Chair
Long-sitting

Table 1: Tissue oxygenation (StO_2) and temperature data:

	Chair	Long-Sitting
RAW DATA (StO_2)		
Baseline (20 minutes)	51.98	94.47
During Intervention (20 Minutes)	92	94.11
Post-intervention (20 minutes)	83.73	94.18
PERCENTAGE CHANGE IN StO_2		
Baseline - during	77.00	-0.38
During – Post	-8.99	0.07
Overall (Baseline-Post)	61.09	-0.31
RAW DATA (TEMPERATURE °C)		
Baseline (20 minutes)	36.3	36.6
During intervention (20 minutes)	36.5	37
Post-Intervention (20 minutes)	36.3	37.6