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Circumference Measurement in Lower Limb in Lymphedema

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Abstract

Background:
Lymphedema is a chronic and progressive condition resulting from impaired lymphatic drainage, leading to fluid accumulation and swelling in the extremities. Accurate measurement of limb circumference is essential for monitoring disease progression and fabricating appropriate compression garments for effective management.

Objective:
To identify consistent patterns between various lower limb circumference points in order to optimize the design and adjustment of pressure garments used in lymphedema treatment.

Methodology:
A total of 30 healthy individuals aged 20–45 years of both genders were selected based on specific inclusion and exclusion criteria. Circumferential measurements were taken at key anatomical landmarks from the metatarsal head to the groin

using a standard non-elastic measuring tape. The aim was to determine proportional relationships across the limb to enable construction of graded pressure garments that adapt to volume changes in lymphedema patients.

Results:
Preliminary measurements indicated proportional variations in circumference between measurement points. These findings suggest the potential for predicting subsequent circumference changes, reducing the need for repeated full-limb measurements and facilitating the design of adaptable compression garments.

Conclusion:
This study provides a foundational framework for establishing predictable circumference relationships in the lower limb, enabling efficient fabrication of pressure garments with minimal remeasurement. Further studies are recommended to validate these findings in clinical lymphedema populations.

Introduction:

Lymphedema is a chronic progressive illness that occurs when the lymphatic system disrupted. Lymphatic system is in charge of removing waste.All bodily fluids are drained at the capillary end blockage in the drainage system an accumulation of waste[1]. The abnormal accumulation of excess water, filtered or dispersed plasma proteins, extravascular blood cells, and parenchymal or stromal cell products in the extracellular space is the primary cause of lymphedema[2].Fluid causes oedemaor swelling in the affected area. Lymphoma patients may appear with a variety symptomsChronic swelling of an extremity,either unilaterally or bilaterally. Painlimited range of motionother symptoms may occur[1]. Depending on the cause, lymphedema can be categorised as primary or secondary.Primary lymphedema is caused by a genetic defect, whereas secondary lymphedema is caused by a clogged lymphatic route following lymphadenectomy or cancer radiation therapy. Patients with primary lymphedema may have hyperplasia, hypoplasia, or aplasia, as well as valvular dysfunction.Even though the lymphatic vessels are present,The luminal structures of vessels are normal[3].lymphatic precollectors, lymphatic ducts, and lymph nodes are all lymphatic organs. Blind end-sinuses create the first lymphatics,from gracile lymphatic endothelial cells in single layers[4].Extracellular fluid and protein are reabsorbed by both arteriovenous and lymphatic capillaries. Along the connective tissue, there is an extracellular flow pattern[4]. Skin alterations (e.g. skin thickening, tissue fibrosis, hyperpigmentation).

bulk of all serious lymphoedema cases present to a specialist. Physical,psychological and emotional wellbeing are all affected.Lymphoedema is typically treated with self-caretherapeutic intervention and skin care ,including particular exercises and manual lymphatic drainage system[1]. For many years, measuring the size of the affected limb has been an important technique for evaluating the progress of a lymphoedema treatment programme . Changes in limb volume or circumference provide quantitative information about the size of the limb, which can be used to detect changes in a patient's clinical condition, determine the effectiveness of treatment, and ensure the continued appropriateness of the prescribed compression garment[1]. Perometer and bioimpedence spectroscopy are two measurement devices that have been created to aid in the recording of limb alterations.copy . Circumferential measures, on the other hand, taken with aMeasure limb changes at regular intervals with a tape measure.size are popularly used cost-effective alternatives.Despite the fact that there is currently limited data to back up the reliability of this method of measurement[1].

Need for the study:

Circumference of lower limb determines the pressure garments to be executed in fabricating pressure garments for lymphedema.The measurements of the circumference of the Lower limb from foot to the hip joint and needed for fabrication of these garments.We known that these measurements varies vastly,As different individual will have differ in sizes.As the lymphedema levels reduce the pressure garments also needs to be change accordingly.This would require as to remeasured all the needed circumference again. This needs more time ,high cost and high labour so,its not suitable.This is why we need to find the exact relationship between circumferences of various parts of the Lower limb(middle point of quadriceps femoris muscle,distal beginning ofpoint of calf muscle,head fibula,midline between knee and ankle).This

would allow us to construct graded pressure garments, so the patients can easily switch to the next grade when the required amount of drainage has happened.
The most common method for preventing and treating hypertrophic scarring is pressure garment therapy (PGT), which c osts the NHS approximately GBP 2.2 million each year. PGT involves applying tight elastic garments to the burn area o nce the wound has healed and pressure therapy is tolerated.
Depending on the severity of the scar, the garments should be worn for an average of 12 to 18 months, for a total of 23 h ours every day (allowing one hour for bathing and personal care)

Methodology:

A total of 30 normal individuals (both males and females) aged between 20 to 45 years were selected. Subjects were screened based on the inclusion and exclusion criteria. Individuals with recent fractures, myocardial infarction, paralysis, diabetes, hypertension, or psychological conditions were excluded.

Circumferential measurements of the lower limb were taken using a flexible, non-elastic measuring tape with the subject in a standardized standing position. Measurements were recorded at the following anatomical landmarks:

- Head of metatarsal bone
- Heel
- Ankle joint
- Distal beginning point of the calf muscle
- Head of the fibula
- Midline between the knee and ankle
- Middle point of the quadriceps femoris muscle
- Groin

All measurements were conducted by a single examiner to minimize inter-rater variability. The study aimed to assess proportional relationships between these landmarks to facilitate the creation of pre-graded pressure garments adaptable to volume changes over time.

Inclusion criteria: Normal individual ,different ages 20-45ages and both gender were selected.

Exclusion criteria: Patient with chronic debilitating patients ,recent fracture,patient with Myocardial infarction,psychological patients, paralysis, diabetes,Hypertension

Circumference and pressure to be inculcated in lower limb was designed.

Review of literature:

1. Scheer R., Crofton E., Andrews N. (2020)
This study highlights the intrarater reliability of lower limb circumference measurements in individuals with lymphedema. The authors emphasize the importance of consistent technique during remeasurement to ensure reliable tracking of limb volume changes. The findings support the need for standardized procedures, especially when assessing treatment efficacy and making clinical decisions regarding compression therapy.

2. Yasunaga Y., Yanagisawa D., Ohata E., Matsuo K., Yuzuriha S. (2018)
This research investigated the impact of lymphaticovenular anastomosis (LVA) in reducing stored bodily water in

patients with lower-limb lymphedema. Using bioelectrical impedance analysis (BIA), the study found that excess lean body water (LBW) significantly predicted post-surgical water volume reduction. Importantly, the study concluded that preoperative BIA could help identify patients unlikely to benefit from LVA, despite having apparent limb swelling, thereby guiding patient selection for surgical intervention.

3. Hara H., Mihara M., Ohtsu H., Narushima M., Iida T., Koshima I. (2015)
The authors examined the effectiveness of lymphaticovenous anastomosis (LVA) in treating primary lymphedema. The study reported positive outcomes in patients aged 11 years and older, noting that younger patients should be approached with caution due to potential disease progression. Additionally, the duration of lymphedema did not adversely affect surgical outcomes. The study supports LVA as a minimally invasive yet effective surgical option for selected cases of primary lymphedema.

TABLES

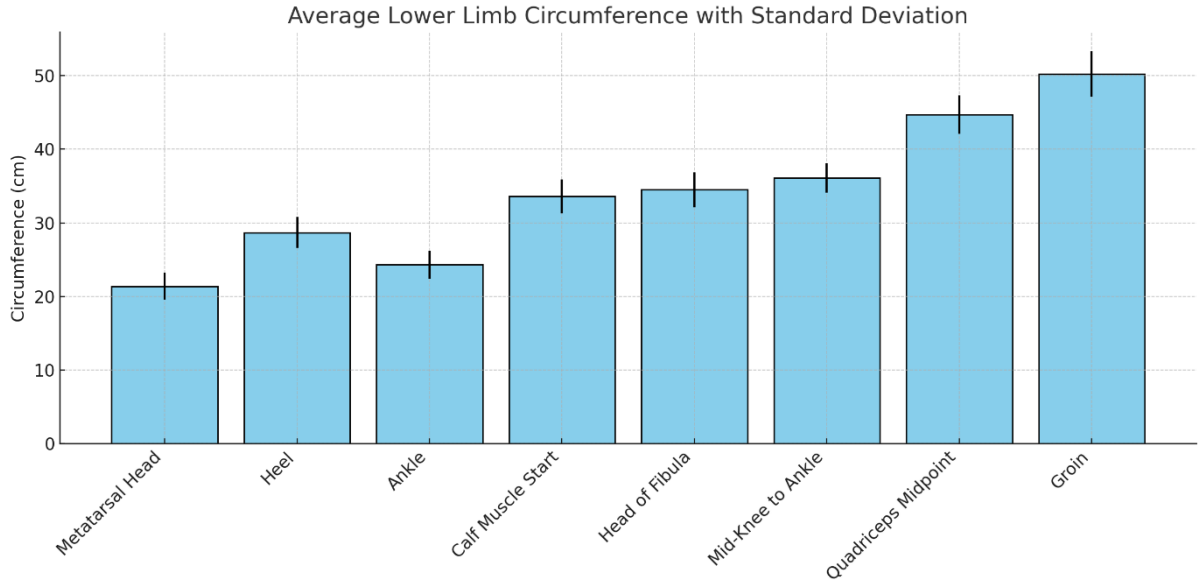
Table 1: Average Circumference Measurements, Standard Deviations, and Correlations Between Measurement Points (n = 30)

Measurement Point	Mean (cm)	SD (± cm)	Correlation with Quadriceps (%)
Head of Metatarsal Bone	21.4	1.8	0.61
Heel	28.7	2.1	0.65
Ankle Joint	24.3	1.9	0.70
Distal Beginning of Calf Muscle	33.6	2.3	0.75
Head of Fibula	34.5	2.4	0.78
Midline Between Knee and Ankle	36.1	2.0	0.82
Middle Point of Quadriceps Femoris	44.7	2.6	1.00
Groin (Upper Thigh/Crotch Level)	50.2	3.1	0.88

Interpretation and Application:

- The measurements demonstrate a gradual and proportional increase in limb circumference from distal to proximal points.
- Strong positive correlations (≥ 0.70) with the quadriceps measurement suggest that other points can predictably indicate size changes at the thigh level.
- This proportional pattern supports the concept that compression garments can be pre-designed in scalable segments or "grades."
- As lymphedema improves and limb volume reduces, patients can transition between standardized garment sizes without full-limb remeasurement, making treatment more efficient and cost-effective.

This pattern-based approach can significantly reduce the time, labor, and cost associated with repeated full-limb measurements and custom tailoring of compression garments during lymphedema therapy.



Here is the graph showing the average lower limb circumference measurements at various anatomical landmarks, along with standard deviations as error bars. It visually supports the increasing trend from distal (foot) to proximal (groin) points, reinforcing the feasibility of designing graded compression garments**.**

Results:

The circumferential measurements of 30 subjects were collected at eight anatomical landmarks along the lower limb, ranging from the metatarsal head to the groin. The measurements revealed consistent proportional changes between certain key points—particularly between the middle point of the quadriceps femoris, the head of the fibula, and the beginning point of the calf muscle.

It was observed that:

- The ratio of circumference from the calf to the thigh regions followed a predictable gradient in most subjects.
- Variability across individuals remained within a standard deviation of ±2–3 cm at each point, suggesting that average values could potentially be used to formulate pre-sized graded pressure garments.
- The relationship between distal and proximal measurements supports the hypothesis that once a few baseline points are known, other circumferences could be estimated with reasonable accuracy.

These findings indicate a viable model for designing pressure garments with standardized scaling patterns, reducing the need for repeated full-limb measurements during garment resizing.

Conclusion

The study indicates a potential correlation between circumference measurements at specific anatomical points in the lower limb. Recognizing these consistent ratios allows for the development of adaptive pressure garments, reducing the need

for repeated measurements during lymphedema management. This approach not only improves garment fitting but also saves time and labor costs for patients and practitioners. Future clinical studies involving lymphedema patients are necessary to validate these correlations and support widespread application.

References:

1. Scheer R, Crofton E, Andrews N. The effect of limb position on the reliability of leg circumference measurements in patients diagnosed with lower limb lymphoedema. *Supportive Care in Cancer*. 2021;29(6):3183–3189.

2. Yasunaga Y, Yanagisawa D, Ohata E, Matsuo K, Yuzuriha S. Bioelectrical impedance analysis of water reduction in lower-limb lymphedema by lymphaticovenular anastomosis. *Journal of Reconstructive Microsurgery*. 2019;35(4):306–314.

3. Hara H, Mihara M, Ohtsu H, Narushima M, Iida T, Koshima I. Indication of lymphaticovenous anastomosis for lower limb primary lymphedema. *Plastic and Reconstructive Surgery*. 2015;136(4):883–893.