



TITLE:

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Title page

Assessment of Edematous Changes using 3D Body-scanning and Segmental–Bioelectrical Impedance

Spectroscopy

Running title: Assessment of Leg Edema using 3D-scanning and BIS

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Abstract

Purpose The primary purpose of this study was to clarify the occurrence of sites of edematous changes using the measured circumferences of the thigh and lower leg via 3D body scanning. The secondary purpose was to determine the relationship between the volume changes using 3D body scanning and the resistance changes as indicator of extracellular water (ECW) via segmental–bioelectrical impedance spectroscopy (S-BIS).

Methods Fifteen healthy women participated. Limb circumferences were measured using 3D body scanning at 10% intervals between 50 and 80% in the thigh circumference and between 0 and 80% in the lower-leg circumference. The resistance of the ECW component (R_{ECW}) and total body water (R_{TBW}) was measured using S-BIS in the thigh and lower-leg segments. These measurements were conducted at baseline and 6-h post-observation. A paired *t*-test was conducted for the differences in these parameters, and the effect sizes were calculated using Cohen's *d*. Correlations between changes in segmental volume and R_{ECW} were analyzed.

Results Measurement-site circumferences and segmental volume significantly increased in the lower leg at post-observation but not in the thigh. The effect size (ES) of circumference changes in the lower leg's central region was larger (ESs were 0.40–0.71 at 30–50%) than in other regions. A significant correlation was observed between changes in segmental volume and R_{ECW} of the lower leg ($\rho = -0.79$, $p < 0.001$).

Conclusions Assessing the circumference using 3D body scanning, we found the edematous changes to be significant in the lower leg's central regions. Moreover, volumetry using 3D body scanning can detect edematous change in the lower leg.

Condensed Abstract

This study clarified the occurrence of sites of edematous changes using the measured circumferences of the thigh and lower leg and determined the relationship between volume changes using 3D body scanning and the resistance of extracellular water (R_{ECW}) changes, measured using segmental–bioelectrical impedance spectroscopy. The effect size of circumference changes in the lower leg's central region was larger than in other regions. A significant correlation was observed between changes in segmental volume and R_{ECW} of the lower leg. Moreover, volumetry using 3D body scanning was found to detect edematous changes in the lower leg.

Keywords: 3D body scanning; bioelectrical impedance spectroscopy; edematous change; lower leg; thigh.

1 Introduction

2 In previous studies, leg edema, heaviness, and pain were shown to be caused by prolonged sitting and
3 standing, even in healthy participants.^{1, 2} The leg edema was observed to increase over time with larger
4 changes occurring in the lower leg than in the thigh, owing to gravity.³ Accurate assessment concerning
5 where and to what degree leg edema occurs may help in the development of optimal countermeasures for
6 preventing edematous changes.

7 The most common method for measuring leg edema has been via circumference measurements using a
8 tape measure. However, in cases such as pooling of fluid, due to gravity or cardiac insufficiency and
9 occurring at the distal part of the lower leg, circumference measurements at the middle part of the lower
10 leg may underestimate the actual extent of the edema, and measurement at the thigh may not be reliable for
11 edema detection. Therefore, circumference measurements throughout the whole leg would be needed to
12 detect leg edema. On the other hand, water plethysmography is the gold-standard methodology, affording
13 highly reliable leg volumetric assessments.⁴ Over the past decade, many studies have used multi-frequency
14 segmental–bioelectrical impedance spectroscopy (S-BIS) to assess edema in healthy participants and
15 patients having various diseases.⁵⁻⁹ S-BIS estimates the body water content and/or the changes in water
16 distribution using impedance measurements comprised of two components (i.e., resistance and reactance)
17 at multi-frequency currents. In particular, the impedance at low-frequency currents mainly reflect the
18 extracellular water (ECW) of plasma or interstitial fluid in extracellular space,^{10, 11} therefore the resistance

1 of ECW component (R_{ECW}) has been used as the assessment of edematous changes in patients with
2 lymphedema.^{12, 13} It is well known that body water, mainly plasma volume, is redistributed from upper- to
3 lower-limb segments while standing because of gravity.¹⁴ This causes an increase in intravascular pressure
4 in the lower extremities, changing the pressure gradient for fluid filtration from the intravascular toward
5 the extravascular space. Currently, assessment of edema using S-BIS has confirmed intra- and inter-rater
6 reliability, and it is perceived as a viable alternative method to water plethysmography.⁴ A recent study,³
7 reporting on the edematous changes due to gravity on the whole body including the lower extremities, stated
8 that changes in the whole body were observed after 6 h from the baseline taken at 07.00, but in the lower
9 extremities changes were observed after just 2 h. Therefore, in addition to being simple and convenient to
10 measure, S-BIS is also useful for assessing the degree of edema in a specific region.

11 S-BIS can assess the edematous changes of intra-limb small region.¹⁵ As an alternative to S-BIS, 3D
12 body scanning based on the external human body shape has been applied for morphometry to measure the
13 circumference, cross-sectional area, and volume at specific sites or regions¹⁶. Because the differences in
14 the lower-leg volumes measured using 3D body scanning and water plethysmography methods,
15 respectively, were less than 1%,¹⁷ 3D body scanning has been validated as a quantitative method for
16 assessing edematous changes. Therefore, this method is effective not only for identifying the site where
17 edema occurs but also for measuring the degree of edema. To the best of our knowledge, there is no study
18 that has clarified the sites within the thigh and lower leg in which edema occurs during the daily lives of

1 healthy participants. Additionally, the relationship between the volume changes in the thigh and lower leg
2 using 3D body scanning and R_{ECW} changes using S-BIS remains unclear.

3 The primary purpose of this study was to clarify the occurrence of sites of edematous change in the thigh
4 and lower leg. The secondary purpose was to determine the relationship between the volume and the ECW
5 changes using two volumetry methods. We hypothesized that common sites of edematous change were in
6 the distal lower leg, not the thigh or the proximal lower leg. Furthermore, we hypothesized that the volume
7 changes in the thigh and lower leg using 3D body scanning were associated with the R_{ECW} changes using
8 S-BIS. These results may provide valuable information for the development of optimal countermeasures
9 against leg edema.

10

11

12 **Materials and Methods**

13 **Participants**

14 Fifteen women participated in the study. They were eligible if they were healthy, did not use any medication,
15 were able to refrain from vigorous exercise for 24 h prior to our assessments, and were able to comply with
16 all the study procedures. Participants were excluded if they had a history of surgery in the lower extremities,
17 neuromuscular disorders, cardiovascular or kidney disease. The sample size was calculated based on our
18 preliminary data (n=5), which evaluated the R_{ECW} values in the lower leg at the baseline and after 6 h. Based

1 on an Effect Size (ES) of 0.89 in the R_{ECW} between the baseline and after 6 h with an alpha-level of 0.05
2 and a beta level of 0.20, it was calculated that at least 12 participants were necessary. Considering the
3 possibility of missing data and measurement variations, the study ultimately included 15 participants.

4 All study procedures were approved by the Ethics Committee of the Kyoto University Graduate
5 School of Medicine and were conducted in accordance with the principles of the Declaration of Helsinki.
6 All participants provided written informed consent when enrolling into the study.

7

8 **Experimental protocol**

9 The day before the measurements were taken, participants were prohibited from vigorous exercise,
10 excessive water intake, and any alcoholic drinks. On the day of the measurements, the participants awoke
11 by 07:00 and came to the laboratory after their usual breakfast, the quantity and type of breakfast was
12 uncontrolled. The study defined the time point, after laying down in a supine position more than 20 min, as
13 the pre-observation (Baseline) measurement; this was to minimize the effect of fluid redistribution after
14 awaking. The baseline measurements were started between 9:00 and 10:00, first using BIS and then using
15 3D body scanning. Observation took place during the 6-h period after the baseline measurements, with the
16 post-observation measurements conducted between 15:00 and 16:00. The participants consumed a
17 controlled lunch between 12:00 and 13:00 and were permitted to drink up to 500 ml of fluid (e.g., tea, juice,
18 and coffee) during observation. The measurement and observation rooms were maintained at 23–24 °C,

1 and the participants were asked to continue their normal daily activities, such as primarily desk work and
2 reading. Vigorous exercise was prohibited during the observation period.

3

4 **Assessment of ECW using multi-frequency S-BIS**

5 Multi-frequency S-BIS was applied after the participants had lain in a relaxed supine position for more than
6 10 min to study the immediate shift of body fluids.¹⁸ S-BIS (SFB7; ImpediMed Inc., Australia) with a
7 logarithmic spectrum of 256 frequencies, ranging from 4 to 1,000 kHz, was conducted on the right leg by
8 using disposable clip-type electrodes (Red Dot TM; 3M Inc., Japan). Two injection electrodes were placed
9 on the dorsal surfaces of the right hand and forefoot, and sensing electrodes were placed on the right anterior
10 superior iliac spine, the lateral knee articular condyles, and the midpoint of the ankle joint. To assess the
11 bioelectrical impedance of the thigh and lower leg separately, the measurement sites were defined as
12 follows: thigh—between the anterior superior iliac spine and the lateral knee articular condyles; and lower
13 leg—between the lateral knee articular condyles and the midpoint of the ankle joint.^{19, 20} The bioelectrical
14 impedance measurements were repeated three times consecutively, and the average value used for analysis.
15 The acquisition, storage, and analysis of the data were conducted using the SFB7 Bioimp software
16 application (ImpediMed Inc., Australia). The R_{ECW} at 0 kHz and the resistance of total body water (TBW)
17 at infinity kHz (R_{TBW}) was obtained from the Cole model using analytic software. The rate of R_{ECW} and
18 R_{TBW} change (%) after 6 h from the baseline was calculated, and indicated a reduction of R_{ECW} and R_{TBW}

1 due to edematous changes.³ As the index of the relative change of ECW against TBW, the R_{TBW} / R_{ECW}
2 ratio was also calculated at baseline and after 6 h. The mean values obtained from the three measurements
3 were determined for subsequent analysis. The coefficient of variations (CV) for the thigh and lower leg
4 were 0.12 and 0.08 in R_{ECW} , and 0.16 and 0.15 in R_{TBW} , respectively. When confirming the R_{ECW} and R_{TBW}
5 values at 10 and 15 min after lying in a supine position, the CVs between the replicate measurements for
6 the thigh and lower leg were 0.83 and 0.84 in R_{ECW} , and 0.73 and 0.65 in R_{TBW} , respectively.

7

8 **Assessment of circumference and segment volume using 3D body scanning**

9 Following the S-BIS measurements, 3D body scanning was performed on the participants to assess the
10 circumference and segmental volume in each thigh and lower leg. A 3D body scanner (Body line Scanner
11 C9036; Hamamatsu Photonics K.K., Japan) with optical triangulation was used to obtain the free-form 3D
12 data in the form of a point cloud with 1,204,000 plots by moving the scan heads with near infra-red light
13 vertically.²¹ Whole-body scanning using this equipment requires approximately 6 s with a resolution in the
14 vertical direction of 2.5 mm and in the horizontal direction of 1.0 mm.

15 Participants were marked to distinguish the measurement sites of the circumference and
16 segmental volume in each thigh and lower leg. The 3D body scanning measurements were conducted in a
17 single standing position (e.g., on the right leg with the left leg on a box). Participants were asked to maintain
18 an upright single-leg standing position with their arms on the equipment frame during the scanning process

1 (Fig. 1). After the free-form 3D data were acquired, segmentation and smoothing was done using 3D
2 modelling software (Rhinoceros 5.0; Robert McNeel & Associates, USA). The thigh segment was aligned
3 in the 3D model based on four landmarks and defined as the length between the greater trochanter and the
4 lateral epicondyle of the femur. The lower-leg segment was aligned based on four landmarks and defined
5 as the length between the fibula head and the lateral malleolus of the fibula (Fig. 2). The circumferences
6 around the knee and ankle joint (at 90 and 100% circumferences) were excluded from the analysis in order
7 to study only the changes in the muscles and tendons caused by standing. Consequently, the circumferences
8 (cm) were measured at 10% intervals between 50–80% in the thigh and between 0–80% in the lower leg.
9 Additionally, a cylinder-like body shape in the same region was constructed and its segmental volume (cm³)
10 calculated for the thigh and lower leg, separately. The test-retest CVs for the circumferences and segmental
11 volumes measured at the baseline and after several minutes were 0.10–0.59%.

12

13 **Statistical analysis**

14 All values are expressed as mean \pm standard deviation. All variables were confirmed to be distributed
15 normally using the Kolmogorov–Smirnov test. A paired *t*-test was conducted for differences in the R_{ECW} ,
16 R_{TBW} , R_{TBW} / R_{ECW} ratio, segmental volume, and circumferences of the thigh and lower leg between the
17 baseline and the post-observation. The ES of these parameters was calculated using Cohen's *d*. Correlations
18 between the changes in the R_{ECW} , R_{TBW} , and segmental volume in the thigh and lower leg were analyzed

1 using the Spearman rank correlation coefficient. All statistical analyses were performed using SPSS
2 software (version 25.0; SPSS Japan Inc., Japan). The level of significance was set at $p < 0.05$.

3

4

5 **Results**

6 Participants in this study were of mean age, 48.1 ± 7.1 years; height, 156.6 ± 3.7 cm; body weight, $51.3 \pm$
7 4.9 kg, and body mass index, 20.9 ± 1.8 kg/m². The changes in the R_{ECW} , R_{TBW} , R_{TBW} / R_{ECW} ratio and
8 segmental volume in the thigh and lower leg, from the baseline to post-observation, are shown in Table 1.

9 The R_{ECW} and R_{TBW} values for both the thigh and lower leg significantly decreased at post-observation
10 compared with the baseline values, especially the % change and ES of R_{ECW} in the lower leg that were
11 larger than that in the thigh. The R_{TBW} / R_{ECW} ratio in both the thigh and lower leg also significantly
12 decreased at post-observation compared with the baseline values. On the other hand, a significant increase
13 in the segmental volume in the lower leg at post-observation was observed compared with the baseline
14 values, but no significant difference in the thigh was observed (Table 1). The changes for all measurement
15 sites on the thigh segment, in terms of the results of changes in circumference, between the baseline and
16 post-observation were of no statistical significance (Table 2). By contrast, the circumferences for all
17 measurement sites on the lower-leg segment significantly increased at post-observation compared with the
18 baseline values. The ES of the circumference changes in the central region of the lower leg was larger (ESs

1 were 0.40–0.71 at 30–50%) than in the proximal and distal regions (Table 3). Moreover, the result of the
2 correlation between the segmental volume and the R_{ECW} showed that the change in segmental volume
3 correlated well with the change in the R_{ECW} in the lower leg ($\rho = -0.79$, $p < 0.001$). By contrast, there was
4 no significant correlation between the segmental volume and the R_{ECW} in the thigh ($\rho = 0.16$, $p = 0.564$).

5

6

7 **Discussion**

8 To the best of our knowledge, this is the first study to verify the occurrence sites of edematous change in
9 the lower leg and the relationship between segmental volume changes, measured using 3D body scanning,
10 and the R_{ECW} and R_{TBW} changes measured using S-BIS. In agreement with a previous report ³, this study
11 also observed decreases in the R_{ECW} and R_{TBW} in the thigh and lower leg. Additionally, this study showed
12 that the R_{TBW} / R_{ECW} ratios in both the thigh and lower leg at post-observation significantly decreased
13 compared to those at the baseline values, that is, the relative increase of ECW against TBW was confirmed.
14 By contrast, an increase in the segmental volume was only confirmed in the lower leg. Similarly, the
15 circumferences significantly increased at all the measurement sites on the lower leg segment, but not on the
16 thigh. Of the measurement sites whose circumferences increased, the changes were larger in the central
17 region than in the proximal and distal regions of the lower leg, contradicting our hypothesis. Furthermore,
18 changes in the segmental volume in the lower leg, that were observed using 3D body scanning, were

1 associated with the R_{ECW} and R_{TBW} changes that were observed using S-BIS. These findings suggest that
2 the circumference assessment in the central region on the lower leg is reflected more accurately for
3 edematous changes, and change in the segmental volume on the lower leg using 3D body scanning can also
4 detect water retention due to gravity.

5 Assessment of the ECW using S-BIS can estimate water distribution between intracellular and
6 extracellular from the bioelectrical impedance. Although the R_{TBW} in both the thigh and the lower leg also
7 decreased as well as the R_{ECW} after the 6 h observation in this study, interestingly, the R_{TBW}/R_{ECW} ratios at
8 post-observation were lower compared with the baseline. Thus, these results suggested that the relative
9 increases of ECW against TBW were due to gravity. These edematous changes were confirmed in both the
10 thigh and the lower leg, whereas the circumferences obtained using 3D body scanning only increased in the
11 lower leg. This means that volumetry, using 3D body scanning, cannot capture edematous changes unless
12 morphological increases occur. Therefore, these findings suggest that S-BIS was accurate for edema
13 evaluation without changes in circumference. We know that the distribution of body water is affected by
14 posture. Hence, prolonged standing induces water variation from the trunk to the lower limbs. In fact, a
15 previous report that investigated the changes in extracellular resistance of the trunk and lower extremities
16 using S-BIS³ showed that the ECW in the trunk exhibited no change or decreased slightly, whereas in the
17 lower limbs, the ECW continued to increase. Edematous change occurs because of the high venous pressure
18 in the peripheral vessel, owing to the gravity-induced water distribution. Although increases in the ECW in

1 the thigh and lower leg were confirmed in our study, the degree of increase was larger in the lower leg than
2 in the thigh.

3 Interestingly, edematous changes due to gravity were significant in the central regions of the
4 lower leg, indicating that the ES of the circumference changes at 30–50% was moderate-to-large. As a
5 previous study has reported that S-BIS can be used locally in the arm of patients with lymphedema,¹⁵ it
6 may be better to conduct S-BIS in the middle of the lower leg when measuring leg edema in healthy
7 individuals. Muscle pump action should function easily, because the central regions of the lower leg have
8 a large cross-sectional area of the triceps surae muscle.²² As such, we assumed that edematous changes
9 were larger in the distal of the lower leg owing to gravity. However, because the blood circulation in skeletal
10 muscle depends on muscle activity,²³ inactive and low physical activity results in poor muscle pump action
11 and increasing capillary pressure. Because skeletal muscle has a large quantity of water (including blood),
12 edema may be likely to occur in regions having more muscle mass as the result of the accumulation of
13 intracellular water (i.e., muscle cell mass) and/or interstitial fluid extravasated from the veins. However,
14 participants in the current study were limited to healthy women, and cases of excessive increases in ECW,
15 such as lymphedema and patients with heart failure,^{5,6} could have had more edematous changes at the distal
16 lower leg, thereby suggesting that our findings need cautious generalization.

17 Moreover, the change in the segmental volume in the lower leg using 3D body scanning
18 correlated strongly with the R_{ECW} change using S-BIS. To the best of our knowledge, there has been no

1 study that has determined an association between the changes measured using 3D body scanning and S-
2 BIS. A previous study reported that measurement error between 3D body scanning and water
3 plethysmography was less than 1%, exhibiting high validity.¹⁷ When we assumed that the volume change
4 using 3D scanning in this study showed the same degree of change using water plethysmography, the
5 significant correlation between 3D body scanning and S-BIS was a natural consequence. However, because
6 this association was not confirmed in the thigh segment, it was limited to the case when a significant volume
7 change occurred that could be measured using 3D body scanning. This discussion was supported by a
8 previous study examining the relationship between BIS and perometry measurements in the arm in patients
9 with lymphedema,²⁴ and BIS was more sensitive to the localized edema than perometry.

10 This study has several limitations. First, the segmental volumes calculated from the 3D
11 measurements did not correspond to those defined for BIS measurements. Although this study defined and
12 used the segment volume measured by 3D body scanning in the largest interval that was not easily affected
13 by skin exposure and muscle contraction, the assessment of segment volume in the thigh was limited to a
14 small area. Hence, care needs to be taken on generalizing the results of correlations between the changes in
15 the R and the segmental volume. Second, the participants in the present study were limited to healthy
16 women. Gender differences of edema occurrence may exist, because the lower leg muscle mass in men is
17 relatively larger than that of women. Also, in patients with marked tissue swelling such as lymphedema,
18 the relationship between volume changes from 3D body scanning and BIS is unclear. Finally, although diet

1 intake and physical activity were controlled between all participants, the observation was conducted only
2 once per participant. The inter-day variability in lower-leg volume measured by water plethysmography,
3 even when not controlling the total diet intake and physical activity, was small ²⁵. Thus, the results in the
4 present study could reflect a typical day in an individual's edematous change. Therefore, future studies are
5 needed to clarify the inter-days, gender differences and disease specific changes for edema.

6

7

8 **Conclusion**

9 In summary, the present study showed that edematous changes measured using S-BIS were
10 confirmed in both the thigh and the lower leg, whereas the circumferences obtained using 3D body scanning
11 only increased in the lower leg. Assessing the circumferences, we found the edematous changes to be
12 significant in the lower leg's central regions. Moreover, the volume change in the lower leg using 3D body
13 scanning correlated with the R_{ECW} change using S-BIS, but not in the thigh. Therefore, the utilization of 3D
14 body scanning may be useful as the alternative method of S-BIS to assess edematous changes of the lower
15 leg in healthy individuals.

16

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1 **Conflict of interest**

2 The present study is funded by endowments from WACOAL CORP to Kyoto University. The authors have
3 no conflicts of interest to disclose.

4

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1 **Fig. 1.** Measurement posture during 3D body scanning

2 Figure legend: Participant kept an upright single-leg posture, standing on the right leg while gripping the
3 frame during scanning.

4

5 **Fig. 2.** 3D segmentation and measurement intervals of the lower leg

6 Figure legend: After the segmentation and smoothing process using 3D modelling software, the lower-leg
7 segment was set as the length between the fibula head (at 0%) and the lateral malleolus of the fibula (at
8 100%). Circumferences (cm) of the lower leg were measured at 10% intervals between 0–80%, and the
9 segmental volume (cm³) in same region was calculated.

10

1 **Table 1.** Changes in the R_{ECW} , R_{TBW} , R_{TBW} / R_{ECW} ratio and segmental volume between baseline and after 6h.

2

	Baseline	Post	p-value	95% CI	%change	ES
R_{ECW} (Ω)						
Thigh	105.9 (7.0)	102.7 (7.6)	0.003	[-5.07, -1.27]	-3.0 (3.3)	0.44
Lower leg	294.0 (25.7)	270.7 (24.1)	0.000	[-30.5, -16.1]	-7.8 (4.2)	0.94
R_{TBW} (Ω)						
Thigh	71.9 (6.3)	67.9 (6.4)	0.000	[-5.02, -2.87]	-5.5 (2.7)	0.63
Lower leg	208.4 (21.5)	194.4 (21.0)	0.000	[-18.79, -9.26]	-6.7 (4.1)	0.66
R_{TBW} / R_{ECW} ratio						
Thigh	0.68 (0.03)	0.66 (0.03)	0.002	[-0.03, -0.00]	-	-
Lower leg	0.72 (0.03)	0.71 (0.03)	0.013	[-0.02, -0.00]	-	-
Volume (cm^3)						
Thigh	1486.6 (169.5)	1488.2 (173.0)	0.602	[-10.66, 17.72]	0.2 (1.7)	0.01
Lower leg	1822.0 (140.9)	1872.7 (139.1)	0.000	[34.77, 66.63]	2.8 (1.6)	0.36

3 CI: confidence interval; ES: effect size.

4

1 **Table 2.** Circumference changes in the thigh between the baseline and post-observation

2

	Baseline	Post-observation	p-value	95% CI	% change	ES
Circumference at 50%	48.2 (1.8)	48.2 (1.8)	0.978	[-0.24, 0.25]	0.0 (0.9)	0.01
at 60%	45.2 (1.7)	45.2 (1.7)	0.915	[-0.18, 0.16]	0.0 (0.7)	0.01
at 70%	42.2 (1.8)	42.3 (1.8)	0.606	[-0.14, 0.23]	0.1 (0.8)	0.03
at 80%	39.6 (1.5)	39.7 (1.5)	0.072	[-0.02, 0.37]	0.5 (0.9)	0.12

3 CI: confidence interval; ES: effect size.

4

5

1 **Table 3.** Circumference changes in the lower leg between the baseline and post-observation

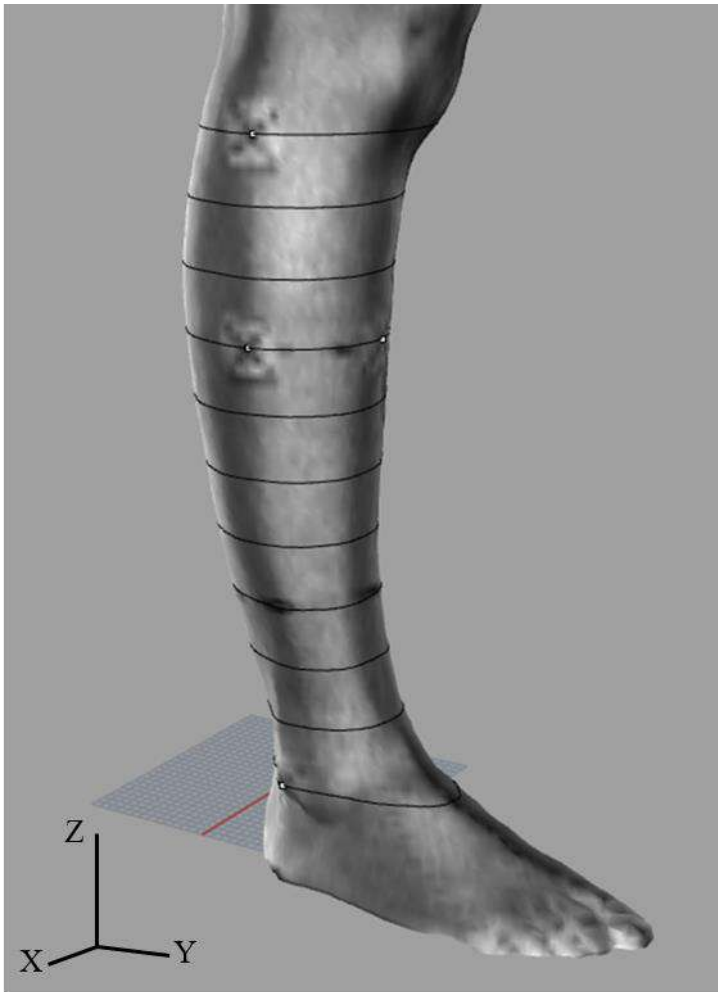
	Baseline	Post-observation	p-value	95% CI	%change	ES
Circumference at 0%	32.2 (0.8)	32.5 (0.7)	0.000	[0.19, 0.47]	1.1 (0.7)	0.40
at 10%	32.6 (1.2)	33.0 (1.4)	0.000	[0.27, 0.54]	1.3 (0.8)	0.31
at 20%	33.9 (1.4)	34.4 (1.5)	0.000	[0.34, 0.62]	1.5 (0.8)	0.35
at 30%	34.2 (1.2)	34.7 (1.3)	0.000	[0.36, 0.65]	1.5 (0.8)	0.40
at 40%	32.8 (1.0)	33.3 (1.0)	0.000	[0.32, 0.71]	1.5 (1.1)	0.50
at 50%	30.0 (0.9)	30.6 (0.8)	0.000	[0.31, 0.72]	1.6 (1.3)	0.71
at 60%	27.0 (0.9)	27.3 (0.8)	0.001	[0.19, 0.56]	1.3 (1.3)	0.35
at 70%	24.2 (1.1)	24.5 (1.0)	0.002	[0.13, 0.47]	1.2 (1.3)	0.29
at 80%	22.0 (1.1)	22.3 (1.1)	0.001	[0.13, 0.38]	1.2 (1.1)	0.27

2 CI: confidence interval; ES: effect size.



1

2 **Fig. 1**



1

2 **Fig. 2**