ADEQUACY OF USING LEG SEGMENTS GREATER THAN FOUR CENTIMETERS TO ASSESS LEG VOLUME CHANGES IN PATIENTS WITH BILATERAL LYMPHEDEMA

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BACKGROUND/GOALS

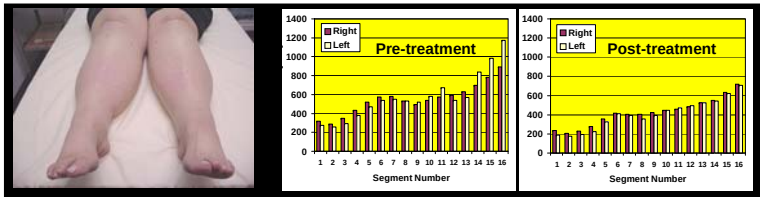
Treatment outcomes of therapy for limb edema and lymphedema are often assessed in the clinic based on limb circumferences that are used to estimate limb volume changes from suitable geometric models and mathematical formula or algorithms[1-4]. Previous work has established the validity of such circumference-based measurements as good estimators of arm and leg volume[5-9] although different algorithms may be needed for volume determinations of hand[10] and foot[11]. Application of circumference-based methods to determine limb volume requires a decision as to the number of limb circumference measurements to be made. Segment lengths (distance between consecutive circumference measurements) used to track limb volume changes[12-14] include 4 , 5 and 10 cm. Using larger segmental lengths mean less required circumference measurements and less segmental volumes that need to be determined, which in a busy clinic, may mean a considerable saving of time. However, with one possible exception[15], there has been little systematic study of the impact of chosen segment lengths on estimated changes in limb volume. Thus, one of our goals was to investigate the extent to which estimated outcomes of lymphedema therapy are affected by choice of segment length. This analysis was done based on data from 70 patients that had bilateral lower extremity lymphedema.

METHODS

In 70 patients with bilateral leg lymphedema (74.5±12.5 years, 24 male), leg volume (140 legs) and its change with therapy were determined using circumference separations of 4, 8 and 12 cm. Circumferences were determined by tape-measure, starting at the ankle and at 4 cm intervals up the leg toward the groin. Leg volumes, based on the 4 cm measured separations and on 8 and 12 cm separations were determined before treatment and after at least 10 complete decongestive physiotherapy CDP) treatments using a frustum model and validated automated software*. For this algorithm, segmental volume V_S is determined as: $V_S = (L/12\pi)(C_1^2+C_1C_2+C_2^2)$ in which C_1 and C_2 are the circumferences at either end of a segment of length L. Limb volume is determined by the sum of segment volumes. Pre and post treatment leg volumes, determined on the basis of 4, 8 and 12 cm length segments, were compared using a general linear model for repeated measures with *post hoc* Bonferonni tests for within-subject differences. Outcome efficacy of the therapy, which is the primary clinical parameter of interest to patient and therapist, was assessed by comparing calculated leg volume reductions for each of the three circumference separations

* Limb Volumes Professional, www.limbvolumes.org

Example of Leg Volume Procedures*



Pre- and post-treatment volumes are compared on the basis of the length of the segmental volume used to calculate the leg volume of interest. The segment lengths were 4, 8 and 12 cm. Changes in edema volume for each method was compared.

Segmental volumes for both legs are measured at 4 cm separations starting at the ankle. In this example a total of 16 segments were included. Segment volumes are summed to yield overall leg volume measures.

MAIN RESEARCH FINDINGS

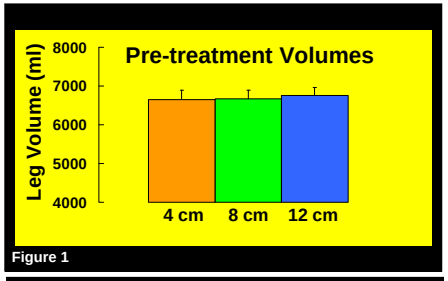


Figure 1

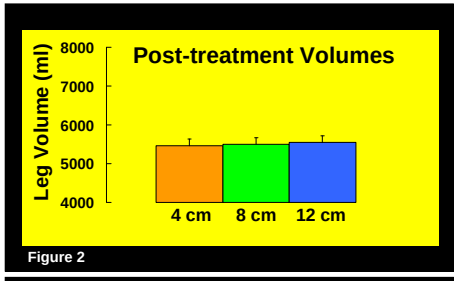


Figure 2

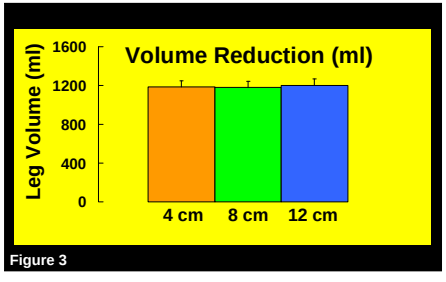


Figure 3

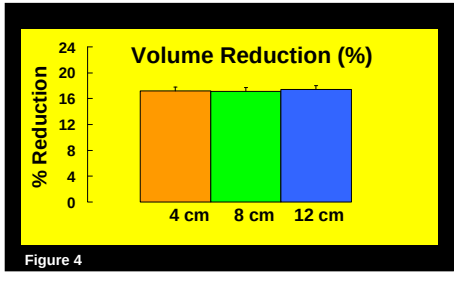


Figure 4

RESULTS

Overall, pre-treatment and post-treatment leg-volumes determined using the three segment lengths differed slightly but significantly ($p<0.001$). Mean values and standard deviations (SD) are summarized in table 1 and shown in figures 1-4. Pre- and post-treatment volumes determined using the 4 cm separation were significantly ($p<01$) less than for volumes determined using 8 and 12 cm separations. Volumes determined using the 8 and 12 cm separations were not significantly different from each other ($p=0.08$ for pre and $p=0.17$ for post). Measures of limb volume reduction, either in ml or as a percentage of the pretreatment value, were not significantly different among the three separations used to calculate volume ($p>0.5$).

CONCLUSIONS

Measurements at 4 cm intervals are generally not necessary to adequately assess clinical outcomes.

REFERENCES

1. Casley-Smith JR. *Lymphology.* Jun 1994;27(2):56-70.
2. Casley-Smith JR, Morgan RG, Piller NB. *N Engl J Med.* 14;993;329(16):1158-1163.
3. Mayrovitz HN, Sims N, Macdonald J. *Adv Skin Wound Care.* 2000;13(6):272-276.
4. Pani SP., Vanamail P, Yuvaraj J. *Lymphology.* 1995;28(2):57-63.
5. Karges JR. et al. *Phys Ther.* 2003;83(2):134-145.
6. Mayrovitz HN. *Lymphology.* 2003;36(3):140-143.
7. Meijer RS. et al. *Lymphology.* 2004;37(3):127-133.
8. Sander AP. et al. *Phys Ther.* 2002;82(12):1201-1212.
9. Taylor R et al. J. *Phys Ther.* 2006;86(2):205-214.
10. Mayrovitz HN et al. *Lymphology.* 2006;39(2):95-103.
11. Mayrovitz HN et al. *Lymphology.* 2005;38(1):20-27.
12. Vignes S et al. *Breast Cancer Res Treat.* 2006;98(1):1-6.
13. Boris M, Weindorf S, Lasinkski S. *Oncology* 1997;11(1):99-109
14. Bunce IH. Et al. *Med J Aust.* 1994;161(2):125-128.
15. Latchford S, Casley-Smith JR. *Lymphology.* 1997;30(4):161-164.
16. Sitzia J. *Eur J Cancer Care (Engl).* 1995;4(1):11-16.

Table 1. Summary of Leg Volumes and Reductions in Bilateral Leg Lymphedema

	Leg Volume Measured (ml)		Volume Reduction	
Segment Length	Pre-Treatment	Post-Treatment	(ml)	(%)
4 cm	6649 ± 2482*	5465 ± 1969*	1183 ± 778	17.2 ± 7.1
8 cm	6676 ± 2497	5496 ± 1990	1180 ± 782	17.1 ± 7.2
12 cm	6756 ± 2510	5554 ± 2001	1202 ± 781	17.4 ± 7.0

Table 1. Data entries are mean ± SD for 140 lymphedematous legs. All post-treatment volumes are significantly less than corresponding pre-treatment volumes ($p<0.001$). Pre- and post treatment volumes based on 4 cm segment lengths were slightly but significantly less than volumes based on 8 cm or 12 cm segment lengths (* $p<0.01$). Volume reductions (ml and %) calculated for 4, 8 and 12 cm segment lengths were not significantly different from each other ($p>0.5$).