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EFFECTS OF PULSED RADIO FREQUENCY DIATHERMY ON POSTMASTECTOMY ARM LYMPHEDEMA AND SKIN BLOOD FLOW: A PILOT INVESTIGATION

H. N. Mayrovitz, N. Sims, and J. Macdonald

Department of Physiology, College of Medical Sciences, Nova Southeastern University, and Wound Healing Lymphedema Center, North Broward Hospital District, Ft Lauderdale Florida

INTRODUCTION

Arm lymphedema that occurs following mastectomy and related cancer treatment often develops gradually, and if untreated tends to worsen[1]. Compelling evidence suggests that complete decongestive therapy or alternatively, complex physical therapy (CPT), is highly effective in reducing lymphedema and reversing its potentially progressive course in many patients[2-4]. One physiological aspect of properly applied massage is its promotion of lymphatic drainage by expanding collateral lymphatic channels that connect to normally functioning lymphatic collectors. This provides useful alternative lymphatic pathways to accommodate drainage of excess lymph that is blocked from its normal routes. It was reasoned that if a simple method were available to facilitate collateral lymphatic enlargement, then it might initially augment CPT outcomes and possibly provide patients with a longer-term continuous therapy option. Since a few reports[5-7] have described good adjunctive results using microwave treatments, it was reasoned that an alternate form of electromagnetic therapy, might also be effective. Because previous work[8-9] showed that low-energy pulsed radio-frequency therapy at 27.12 MHz increased skin blood flow, likely via enlargement of vascular channels, it was hypothesized that this approach might also serve to similarly affect lymphatic channels. We therefore sought to determine if such short-wave diathermy might also have a positive impact on lymphedema reduction. Because this form of therapy has not been previously reported for lymphedema, the present research was exploratory, with its main goal to determine if such treatments alone would provide evidence of potential efficacy.

METHODS

Subjects and Treatment: Seven post-mastectomy patients were included in this pilot study and were treated between 4-6 times over a 2-week interval. During this interval, no other treatment was provided. Each treatment was 60 minutes with the patient supine and lightly covered. dual heads of the device (Magnatherm, International Medical Electronics) were placed so as to encompass all, or nearly all of the affected arm (Figure 1). Treatment power levels were standardized to the device maximum peak power and minimum repetition rate. At these settings the average power was estimated to be about 12% of maximum. The excitation pattern at these settings is radio frequency energy (27.120 MHz) pulsed on for 95 msec at a rate of 700 pulses per second. This modality is also called short-wave diathermy

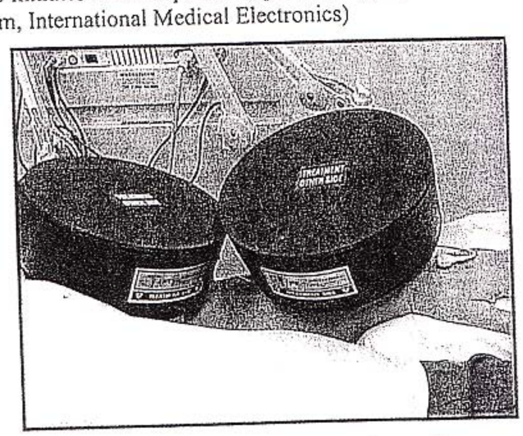

Figure 1. Dual treatment heads in position.

Limb Volume: Arms volumes were measured before starting treatment and prior to the start of each follow-up treatment Circumferences (C) were measured at separations of L = 4 cm starting from the wrist. Segmental volumes, Vseg within adjacent measurement sites (C_1 and C_2) were calculated using a truncated cone model $Vseg = (L/12\pi)(C_1^2+C_2^2+C_1C_2)$. The total arm volume was determined by summing all segmental volumes. Edema volume was calculated as the difference between the affected arm volume and the contralateral control arm. Percent Edema was calculated as the edema volume divided by the control arm volume.

Physiological Measurements: Skin blood perfusion (SBF) was measured by a laser-Doppler method[10-11] using a thin non-metallic laser-Doppler probe placed on the affected arm at a standardized site midway between the wrist and elbow (Figure 2). Transcutaneous oxygen tension ($TcPO_2$) was monitored with $TcPO_2$ probes placed on the affected and control limbs. Individual treatments were typically associated with an increase in SBF (Figure 3). Laser-Doppler data is displayed in arbitrary perfusion units (a.u.)

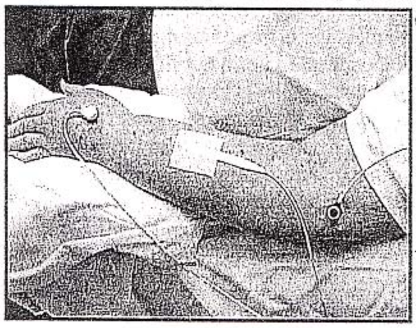

Figure 2. Laser-Doppler and $TcPO_2$ placement at standardized arm sites.

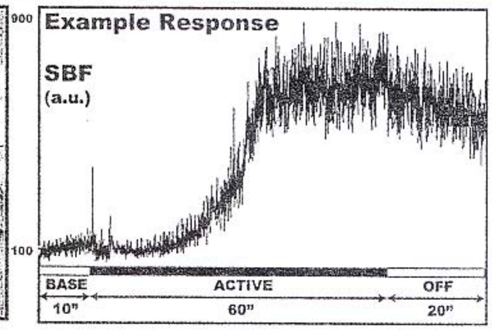

Figure 3. Example SBF response to 60 minutes of active treatment

RESULTS

Edema: The initial edema volume was decreased after one treatment with subsequent decreases through the 4th treatment (Figure 4). Similar patterns of change occurred for percentage edema, which by the 4th treatment was about half that present prior to treatment start (Figure 5). However, the main effect appeared to occur early in the treatment sequence.

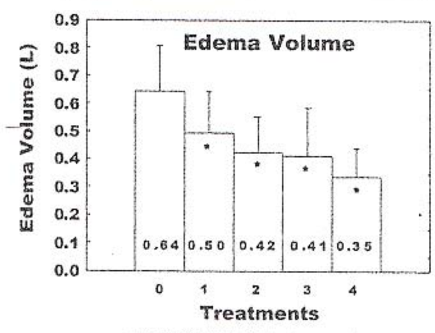

Figure 4. Edema volume changes.
* indicates p<0.01 vs. initial edema volume.

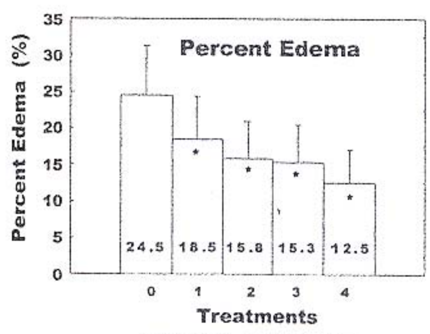

Figure 5. Change in percent of edema.
* indicates p<0.01 vs. initial percent edema

Arm volume data (mean ± sem) showed that the initial percent edema of 24.5 ± 7.3% of this patient group, was significantly reduced to 18.5 ± 6.3% ($p<0.01$) after one treatment, with further reductions occurring through the fourth treatment (n=7). Four treatments were associated with a reduction in percent edema to 56.2 ± 8.4% of its initial

Skin blood perfusion and TcPO2 SBF significantly increased after about 30 minutes of treatment, continued to rise and was maintained for at least 20 minutes after treatment was terminated (Figure 6). Thus, SBF showed a progressive increase from its baseline value of 266 ± 10 a.u. (Friedman test, $p<0.001$) and was significantly greater than baseline after 30 minutes of treatment (371 ± 38 a.u., p=0.018 Wilcoxon test). By 60 minutes, SBF reached 705 ± 122 a.u., which was on average 4.10 ± 0.87 times greater than baseline. Contrastingly, $TcPO_2$ did not significantly change in either the treated or control arm (Figure 7). Prior to initiation of treatment, $TcPO_2$ values were not significantly different between affected and treated arms (72.7 ±6.9 vs. 64.1 ± 6.4 mmHg).

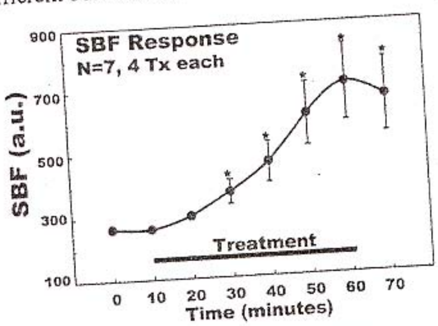

Figure 6. Skin blood perfusion (SBF).

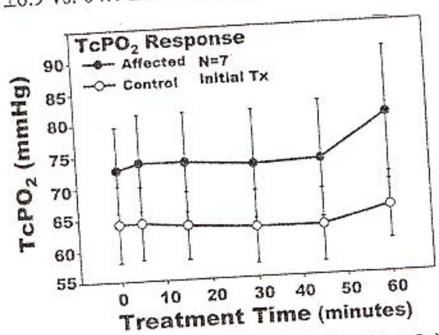

Figure 7. Transuctaneous O_2 tension ($TcPO_2$)

CONCLUSIONS

The main findings indicate a potentially beneficial effect of pulsed radio frequency energy with respect to reduction in arm lymphedema. These initial findings are encouraging in light of the fact that the women included in this pilot study had already received CDT therapy and had long standing residual grade two lymphedema. The treatment related reduction in the percentage of lymphedema was rapid and significant. It was associated with a single treatment power level, which was deliberately maintained low at about 12% of the total device power. It is unknown whether different power levels would improve the observed short-term outcome. The physiological measurements obtained coincident with treatment indicate a significant increase in SBF associated with the application of pulsed radio frequency energy. The increase in SBF occurs after about 30 minutes of treatment and remains elevated as compared with pre-treatment baseline SBF for at least 20 minutes after treatment is stopped. The role of the observed SBF increase during treatment, in mediating the treatment related reduction in arm lymphedema, is as yet unknown. However, an intriguing possibility is that mechanisms similar to those that caused SBF to increase, also act to increase lymphatic flow by expanding collateral channels or by enhancing functional activity of lymph vessels. Although these initial findings are encouraging and the method tested may prove to be a useful compliment to current therapeutic practice, final conclusions must await further and expanded placebo controlled tests that are currently underway.

REFERENCES

1.Casley-Smith, JR. Alterations of untreated lymphoedma and its grades over time. Lymphology 28 (1995),174.
2.Foldi, M. Treatment of lymphedema. Lymphology 27 (1994),1.
3.Ko, DSC, R Lerner, G Klose et al: Effective treatment of lymphedema of the extremities. Arch Surg 133 (1998), 452.
4.Casley-Smith, JR, M Boris M, S Weindorf, B Lasinski: Treatment for lymphedema of the arm -The Casley-Smith method. Cancer (suppl) 83 (1998), 2843.
5.Chang, TS, LY Han: Microwave: an alternative to electric heating in the treatment of peripheral lymphedema. Lymphology 22 (1989), 20
6.Gan, JL, SL Li: Microwave heating in the management of postmastectomy upper limb lymphedema. Ann Plast Surg 36 (1996), 576.
7.Chang, TS, JL Gan: The use of 5,6 benzo-[alpha]-pyrone (coumarin) and heating by microwaves in the treatment of chronic lymphedema of the legs. Lymphology. 29 (1996), 106
8.Mayrovitz, HN, PB Larsen PB: Effects of pulsed electromagnetic fields on skin microvascular blood perfusion. Wounds 4 (1992), 197
9. Mayrovitz, HN, PB Larsen: A preliminary study to evaluate the effect of pulsed radio frequency field treatment on lower extremity periulcer skin microcirculation of diabetic patients. Wounds 7 (1995), 90
10. Mayrovitz, HN: Assessment of the microcirculation: Laser Doppler and transcutaneous oxygen. J. Vasc. Tech. 18 (1994), 269
11. Mayrovitz, HN: Assessment of Human Microvascular Function. In: Analysis of Cardiovascular Function. Drzewiecki ,G, J Li: (Ed.) New York, Springer, 1998 Chapter 16 248-273