

SLOVENIA PRESENTATION (1 March 2009)

Introduction

The present study was carried out to examine and compare the reaction of subcutaneous fat tissue to cavitation treatment. Cavitation effect in fat tissues produces fat fragmentation and the subsequent diffusion of adipocytes' lipid matrix which join to tissue fluids. In the cavitations performed in these studies, treatments extended to the depth of 2-4 cm, lasting 40-45 minutes per patient per visit. In the present study the patients were handled according to the Finnish law and in keeping with the guidelines of patient consent. Emulsificated fat is carried to the liver through normal metabolic tracks. Action caused by the equipment on the person's organism could be defined as lipolysis through local ultrasonic cavitation.

Cavitation is defined as the phenomenon of formation of vapour bubbles of a flowing liquid in a region where the pressure of the liquid falls below its vapour pressure. Cavitation is usually divided into two classes of behavior: inertial (or transient) cavitation, and noninertial cavitation. Inertial cavitation is the process where a void or bubble in a liquid rapidly collapses, producing a shock wave. Such cavitation often occurs in pumps, propellers, impellers, and in the vascular tissues of plants. Noninertial cavitation is the process in which a bubble in a fluid is forced to oscillate in size or shape due to some form of energy input, such as an acoustic field. Such cavitation is often employed in ultrasonic cleaning baths and can also be observed in pumps, propellers, etc. Since the shock waves formed by cavitation are strong enough to significantly damage moving parts, cavitation is usually an undesirable phenomenon.

It is specifically avoided in the design of machines such as turbines or propellers, and eliminating cavitation is a major field in the study of fluid dynamics.

Results and methods

We first conducted the preliminary research, the promising results of which encouraged us to proceed to the actual clinical study phase. All the equipment and software used were customary, commercially available applications, including a 9 MHz linear probe.

The measurements were taken with a linear ultrasound probe using the middle part of the ultrasonic beam, leaving the lateral parts in the shadow, so that no compression occurred and precise measurement became feasible.

In the first experiment, subcutaneous fat tissue's width was evaluated prior to the first cavitation treatment. Three treatments were then administered at two weeks' intervals. In each treatment, the subcutaneous fat tissue's depth and width, as well as its visibility and harmony was evaluated in two weeks' intervals and conducted three times. This was followed by a two-week recuperation period, after which the final ultrasound scan was performed.

In the region of the abdomen, six specific regions of interest (ROI) were analysed for

each patient. These regions were located 4 cm above umbilicus and 4 cm inferior to craniocaudal direction in the region of linea alba. Subcutaneous fat tissue's width was also examined in the ROI of the short head of the biceps brachii muscle caudal of the axillary lymph nodes. The skin was excluded from the measurement of the total width.

The other two ROIs in the abdomen region were located where the thickest and widest fat tissue was found, just above the region of the lateral superior iliac spine above the external abdominal oblique muscle.

In the region of hip and thigh, the measurements were taken in the widest part of subcutaneous fat tissue above the gracilis muscle fasciae and tensor fasciae latae muscle, excluding the skin.

In the preliminary study, the number of patients was 31, which was found to be insufficient for completely reliable results, even though these results encouraged us to proceed in the direction of clinical treatments.

A total of 101 patients were admitted to receive clinical treatment in the second phase of the study.

In the region of the linea alba in the abdomen, the reduction of the fat tissue after three treatments was as follows: 4 cm above umbilicus $46 \% \pm 21-27 \% \text{ SD}$; 4 cm inferior to umbilicus $55 \% \pm 15-20 \% \text{ SD}$; and 10 cm inferior to umbilicus $34 \% \pm 17-25 \% \text{ SD}$.

In the region of the lateral iliac spine, the results were even better, $60 \% \pm 13-18 \% \text{ SD}$.

In the ROI of thigh and hip, the values of the lateral part were $19 \% \pm 7-12 \% \text{ SD}$. In the ROI of the tensor fasciae latae muscle, the values were $16 \% \pm 4-8 \% \text{ SD}$.

In the ROI of the short head of the biceps brachii muscle, the thickness of the subcutaneous fat tissue was reduced by $21 \% \pm 7-9 \% \text{ SD}$ (Table 1).

Table 1

Prior to the treatment, cm (mean value)	Region of interest (ROI)	Two weeks after the treatment, % decrease
1.9 - 2.1	4 cm above umbilicus	$46 \% \pm 21-27 \% \text{ SD}$
1.8 - 3.3	4 cm inferior to umbilicus	$55 \% \pm 15-20 \%$
1.7 - 3.1	10 cm inferior umbilicus	$34 \% \pm 17-25 \%$
1.5 - 2.2	Lateral iliac spine	$60 \% \pm 13-18 \%$
1.8 - 2.7	Thigh and hip	$19 \% \pm 7-12 \%$
1.5 - 2.1	Tensor fasciae latae muscle	$16 \% \pm 4-8 \%$
1.6 - 2.2	Short head of the biceps brachii muscle	$21 \% \pm 7-9 \%$

Statistics

All the values were reported as pooled means and standard deviations with paired comparisons, which were performed using a Wilcoxon test. All differences were considered significant at the probability level of 95 % ($P < 0,05$)(Table 1). All the statistical analyses were performed with a commercially available software program.

The nature of the fat tissue which was evaluated in the ultrasound was analysed by using the linear analogous scale (0-100). Special attention was paid to the harmony of the ultrasound and the septal structure and harmony of the fat cells.

Conclusions

The new cavitation technology offers solutions to several problems related to conventional surgical procedures. This prospect could be even more important in the future, as cavitation and ultrasound technologies develop and non-invasive methods open new alternatives for fat tissue treatment and monitoring techniques. These non-invasive methods can provide the information necessary to determine possible augmentation of treatment, and to guide surgical intervention in the clinical situation. The great potential benefit of ultrasound, such as ultrasound coupled with cavitation without any observed medical complications, have not been fully appreciated and applied, and therefore further investigations are still needed.

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