Plasma Lipid Analysis of Simultaneous Application of Radiofrequency Synchronized With HIFEM for Fat Reduction in Same-Day Multiple Sessions

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BACKGROUND High-intensity focused electromagnetic field (HIFEM) and synchronized radiofrequency (RF) technologies have been shown to be safe and effective on multiple body parts

OBJECTIVE To determine the plasma lipid levels and liver function tests of consecutive HIFEM + RF procedures delivered on the same day.

METHODS Eight women and 2 men (24–59 years, BMI 22.4–30.6 kg/m^2) underwent 4 30-minute consecutive HIFEM + RF procedures. The treated area differed according to gender (females: abdomen and lateral and inner thighs; males: abdomen and front and back thighs). Liver function (aspartate aminotransferase [AST], alanine aminotransferase [ALT], gamma-glutamyltransferase [GGT], alkaline phosphatase [ALP]) and lipid profile (cholesterol, high-density lipoprotein [HDL], low-density lipoprotein [LDL], triglycerides [TG]) was monitored from blood samples drawn before the treatment, 1 hour, 24 to 48 hours, and 1 month after treatment. The subject's satisfaction, comfort, abdominal circumference, and digital photographs were also monitored.

RESULTS All 10 patients completed planned treatments and follow-up blood draws. No significant fluctuation or notable deviation in the measured blood parameters was observed. The average values during the study were in a range of AST 15.7 to 16.7IU/L, ALT 11.9 to 13.4IU/L, GGT 11.6 to 13.8IU/L, and ALP 71.4 to 77.2IU/L, TG 1.0 mmol/L, HDL 1.7 mmol/L, LDL 3.0 mmol/L, and cholesterol 5.0 to 5.1 mmol/L corresponded to the normal ranges. Subjects reported high comfort during the treatment and satisfaction with their results. No adverse event occurred.

CONCLUSION Plasma levels remained stable and normal or lipids and LFTs for multiple same-day treatments of RF plus HIFEM.

There are 5 FDA-approved technologies for NIV body contouring[1]: cryolipolysis, high-intensity focused ultrasound (HIFU), laser, high-intensity focused electromagnetic field (HIFEM), and radiofrequency (RF). All of the listed technologies have proved their efficacy. However, each modality has its limitations for treatment effect dependent on the targeted tissue and body area. Synchronized RF combined simultaneously with HIFEM can effectively achieve fat reduction and muscle strengthening since both fat and muscle thickness are affected and both substantially contribute to overall body appearance.[2] High-intensity focused electromagnetic field technology is based on electromagnetic stimulation of muscles through motor neurons that are depolarized throughout the treatment. This triggers supramaximal contractions that are unattainable by voluntary exercise.[3] Muscular tissue adapts to the intensive workload by hypertrophy and hyperplasia, and as a result, muscle is strengthened and thickened.[4] High-intensity focused electromagnetic field technology has shown to be safe and effective on the muscles of the abdomen,[5] arms and calves,[6] and buttock.[7]

Radiofrequency technology relies on the penetration of the oscillating electrical current to the treated tissue where it drives collisions between charged molecules and ions, converting this kinetic energy into heat.[8] In adipose tissue, the RF-induced temperature should stay between 42°C and 45°C for most of the treatment time to begin the fat cells' natural death process—apoptosis.[9–11] Furthermore, as RF heating dissipates to the underlying muscle tissue, in synergy with the HIFEM procedure, it activates a significant portion of myosatellite cells, leading to regeneration and further strengthening of the muscles [12].

The RF + HIFEM procedure usually consists of 4 30-minute treatments applied to the treated area, spaced 5 to 10 days apart. HIFEM is always set to the maximum tolerated levels on a 0% to 100% scale, depending on the treated body area and patient's feedback, whereas RF starts at the maximum output level from the beginning of the therapy. This combination of technologies has shown to be efficacious and without any serious adverse events or side effects for the contouring of the abdomen,[13] lateral thighs (saddlebags),[14] upper arms,[15] inner thighs, and buttock.[16]

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Although the liver is a center of glucose, protein, and lipid metabolism, lipid accumulation in the liver promotes hepatic insulin resistance which is associated with obesity or Type II diabetes and elevated levels of cholesterol and low-density lipoprotein lead to an increased chance of developing cardiovascular disease. Since this treatment induces lipolysis,[13] we wanted to document safety of consecutive use of HIFEM + RF technology, especially when used on multiple body parts on the same day. This study was designed to investigate safety of multiple HIFEM + RF treatments performed on various body parts delivered on the same day by monitoring serum liver enzymes and serum lipid concentrations.

Methods

In this prospective, single-center, open-label, one-arm clinical trial, 10 patients were enrolled (8 women and 2 men, 24–59 year old, BMI 22.4–30.6 kg/m^2). The study included 6 young adults (up to 35 years), 2 middle-aged adults (36–55 years), and 2 older adults (older than 55 years).[22] The medical records of the eligible participants (≥21 years, BMI <35 kg/m^2) were screened at the recruitment phase to ensure that subjects did not meet any of the excursion criteria, such as electronic or metal implants, metal IUD, drug pumps, malignant tumor, injured muscles, pulmonary insufficiency, acute inflammation, infection (local or systematic), coagulation disorder, cardiovascular disease, serious skin inflammation or metabolic disorders, disturbance in pain, or temperature perception. In addition, the history of poor healing or unhealed wounds in the treated areas or any condition causing involuntary weight fluctuation or pregnancy. All study participants reviewed and signed a written informed consent form, and the study protocol adhered to ethical requirements of ISO-14155 and the 1975 Declaration of Helsinki. Patients were instructed not to change their lifestyle for diet and physical activity, and this was verified verbally at all treatment visits and 1-month follow-up visit.

The device that uses simultaneous emission of HIFEM + RF energies (Emsculpt Neo, BTL Industries, Boston, MA) was used in this study. The treatment schedule included 4 30-minute sessions spaced 1 week apart, administered over 3 different body parts treated consecutively at each session. The treated body parts differed based on the gender of the subjects. For example, female subjects were treated over the abdomen, saddlebags, and inner thighs, whereas male subjects were treated over the abdomen, front thighs, and back thighs. At each treatment, the HIFEM intensity was set to maximum tolerated levels. Most of the subjects initially reached an intensity of 60% while tolerating the maximum HIFEM intensity (100%) over the course of treatments. The RF intensity was set to 100% at all therapy sessions. All areas were treated with the advanced protocol, which maintains apoptotic temperatures (42–45°C) in adipocyte tissue, reducing the numbers and size of fat cells.[10]

The investigated device had 2 applicators (large and small curved) for treating differently sized and shaped body parts. The applicators were placed bilaterally over the treated areas, respecting the anatomy of underlying muscle tissue to achieve intense, homogeneous, and comfortable contractions without overlying bony prominences. The subjects were treated in either supine (abdomen and inner and front thighs) or prone position (saddlebags and back thighs). The female patients were asked to move into a half-sitting position to treat the inner thighs, with pillows underneath the knees to place the applicators comfortably.

Subjects' blood was drawn fasting at baseline, 1 hour after the last treatment, 24 to 48 h follow-up visit, and 1-month follow-up visit. The analysis focused on liver function tests and lipid profile.

Laboratory measurements included alanine aminotransferase (ALT), aspartate aminotransferase, alkaline phosphatase, and gamma-glutamyltransferase.[23] The lipid profile included total cholesterol, low-density lipoprotein, high-density lipoprotein, and triglycerides. The normal ranges are listed in Table 1.

The evaluation of secondary outcomes included abdominal circumference measurements (since all subjects underwent abdominal treatments), the subject's satisfaction, and comfort questionnaire. Digital photographs were also taken to document individual subjects' results. The abdominal circumference measurements and digital photographs were taken at baseline, after the fourth treatment, and at a 1-month follow-up. The circumference was taken at the umbilical level using a stretch-resistant tape.

TABLE 1. Normal Ranges of Measured Analytes

	ALT	AST	ALP	GGT	Cholesterol	LDL	HDL	TG
Range	7–56 U/L[24]	0–35 U/L[24]	20–140 U/L[25]	9–85 U/L[26]	Below 5.2 mmol/L[27]	Below 3.4 mmol/L[27]	Above 1.0 mmol/L[27]	Below 1.8 mmol/L[28]

	AST (UI/L)	ALT (IU/L)	GGT (IU/L)	ALP (U/L)	Total Cholesterol (mmol/L)	HDL (mmol/L)	LDL (mmol/L)	TG (mmol/L)
Baseline	16.7 ± 3.1	13.4 ± 6.8	12.7 ± 6.5	74.3 ± 19.2	5.1 ± 1.1	1.7 ± 0.4	3.0 ± 1.2	1.0 ± 0.4
1 h after last Tx	16.3 ± 2.6	12.3 ± 4.9	12.0 ± 5.2	72.2 ± 20.4	5.1 ± 1.0	1.7 ± 0.5	3.0 ± 1.1	1.0 ± 0.4
24/48 h FU	16.1 ± 2.6	11.9 ± 4.6	11.6 ± 5.3	71.4 ± 22.0	5.0 ± 1.0	1.7 ± 0.5	3.0 ± 1.0	1.0 ± 0.6
1M FU	15.7 ± 3.2	12.5 ± 6.9	13.8 ± 6.6	77.2 ± 26.3	5.1 ± 1.1	1.7 ± 0.5	3.0 ± 1.1	1.1 ± 0.9

The average levels of measured analytes, mean ± SD.
ALT, alanine aminotransferase; AST, aspartate aminotransferase; ALP, alkaline phosphatase; FU, follow-up; GGT, gamma-glutamyltransferase; HDL, high-density lipoprotein; LDL, low-density lipoprotein; M, month; TG, triglycerides; Tx, treatment.

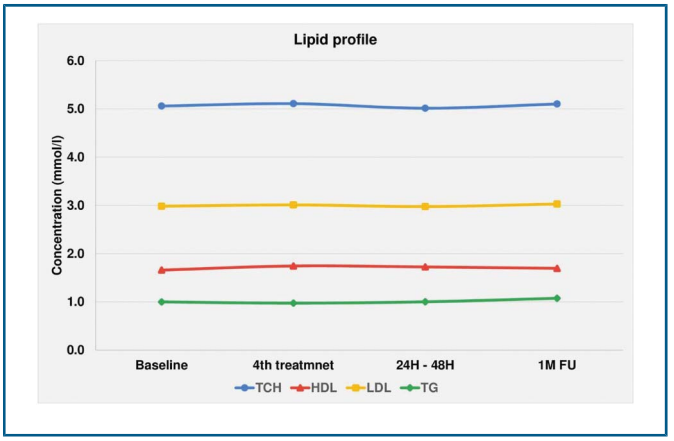

Figure 1. A chart visualizing no fluctuation in the analytes of the lipid profile. TCH, total cholesterol; HDL, high-density lipoprotein; LDL, low-density lipoprotein; TG, triglycerides.

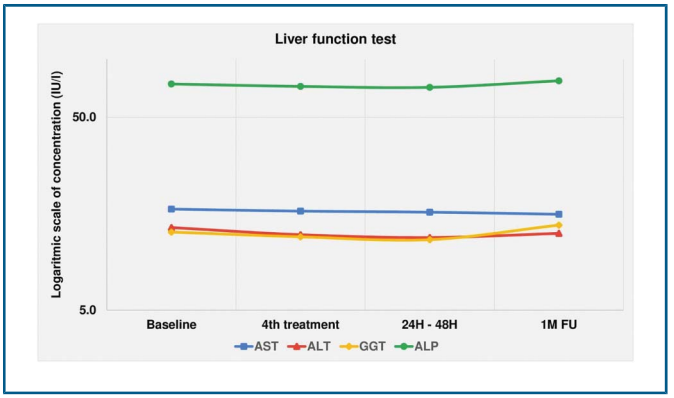

Figure 2. Chart showing no fluctuation in analytes of liver function test. ALT, alanine aminotransferase; AST, aspartate aminotransferase; ALP, alkaline phosphatase; GGT, gamma-glutamyltransferase.

The questionnaires were based on a 5-point Likert scale (1–strongly disagree and 5–strongly agree) and a 10-point Visual Analog Scale (VAS, 0—no pain and 10—implacable pain). The satisfaction questionnaire contained 4 statements regarding improvement in the appearance of the treated area, improvement in treated tissues (muscle tone and fat thickness), satisfaction with the treatment results, and pain levels during the treatment. In addition, a comfort questionnaire was collected after the last treatment, whereas a satisfaction questionnaire was filled out after the last treatment and at a 1-month follow-up. Finally, adverse events and side effects were monitored throughout the study.

The changes in the measured values were tested for statistical significance by the Friedman test. The significance level for statistical analyses was set to $\alpha = 0.05$.

Results

All 10 enrolled patients completed the scheduled treatment sessions and follow-up visits, including blood sample collection. No adverse events or side effects occurred throughout the study, and no subject requested to discontinue the treatment due to pain or discomfort. After the 4 consecutive treatments, administered the same day, patients could resume their daily routine, including work and/or exercise. The subjects did not report any significant change in their lifestyle when participating in this study. The group's BMI values showed no significant difference at any of the visits ($p = .07$).

Forty blood samples were collected and analyzed for lipid and liver profile changes. None of the values showed any significant changes during the study ($p > .05$) nor did they fluctuate above the normal range, irrespective of age (for detailed results, Table 1, Figures 1 and 2).

The circumference measurements showed an average reduction of -2.20 ± 1.92 cm after the last treatment, peaking at a 1-month follow-up (-2.45 ± 2.34 cm), with a maximum reduction of -6 cm. Furthermore, at the 1-month follow-up visit, all patients agreed or strongly agreed with the statements regarding improved appearance, muscle tone, and fat reduction (average scores of 4.6 ± 0.5 and 4.7 ± 0.5, respectively). Patients were also highly satisfied with the results (4.7 ± 0.5) and found the treatment comfortable and relatively painless based on the VAS (0.4 ± 0.5).

Digital photographs revealed improvement with visible shaping and toning of the abdomen (Figures 3 and 4) and thighs due to changes in fat and muscle.

Discussion

This study indicates the safe use of simultaneous application of HIFEM + RF procedure on multiple body parts on the same day. The repeated procedures did not significantly

Figure 3. A 29-year-old female subject, comparison of digital photographs taken at baseline (left), after the fourth treatment (middle), and 1-month follow-up (right; −3 cm in circumference). The patient's abdomen is noticeably flattened and firmer due to fat reduction and improved muscle tone.

Figure 4. A 59-year-old male subject, comparison of digital photographs taken at baseline (left), after the fourth treatment (middle), and 1-month follow-up (right, −6 cm in circumference). The patient's abdomen is visibly less prominent and round with reduced abdominal fat.

fluctuate assessed blood parameters from the lipid and liver function panel. During the study, no adverse events or side effects were observed. All subjects were satisfied with the noticeable improvement in muscle tone and fat reduction in all treated body parts.

Several past studies have monitored the adverse effects and efficiency of simultaneous use of the HIFEM + RF procedure. The human histology study by Goldberg[11] and the porcine histology study by Weiss and colleagues[10] showed that heating the adipocytes to the apoptotic temperatures leads to natural fat cell elimination with visible fat reduction and no signs of necrosis. The remaining adipocytes were also noticeably smaller, indicating a strong lipolytic effect of HIFEM + RF treatment. Another porcine study by Halaas and colleagues[12] that focused on muscle histology revealed the boosting effect of the synchronized radiofrequency on satellite cells that supports muscle differentiation and growth, with no anticipated muscle damage. In accordance with histological findings, Jacob and colleagues[15] reported a 26.1% muscle mass increase together with a decrease in fat thickness (−30.8%) and separation of abdominal muscles (−18.8%). Although no serious adverse events and side effects were observed in any of the listed studies, there has been no verification of normal liver function and lipid levels after multiple applications of HIFEM + RF on the same day (Table 1).

As a secondary observation, the study also documented that multiple applications of HIFEM + RF resulted in overall muscle toning and fat reduction, as shown in Figures 3 and 4. In addition, the abdominal circumference showed a gradual decrease throughout the study, with an average change of −2.45 ± 2.34 cm at the 1-month follow-up visit. Furthermore, all patients were satisfied with the results (4.7 ± 0.5) and improvement in appearance (4.6 ± 0.5).

The limitation of this study includes a relatively small sample size, stemming from the invasive nature of the blood sampling and demanding treatment schedule. Fortunately, the obtained data were complete due to a zero dropout rate, allowing for statistical analysis. Nonetheless, a larger sample size that should provide a greater variety in subjects and thus measured values would be a favorable addition in the future, along with expanding the number of evaluated blood samples and parameters.

Conclusion

The primary aim of this study was to evaluate the safety of consecutive HIFEM + RF procedures on multiple body parts performed on the same day. The findings documented the safety on the biochemical level, as no out-of-ordinary values in liver and lipid panel were observed immediately or at later follow-up, regardless of age. Furthermore, the simultaneous application of HIFEM + RF resulted in visible aesthetic improvement of multiple treated body parts with high satisfaction.

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