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Preliminary Demonstration Using Localized Skin Temperature Elevation as Observed With Thermal Imaging as an Indicator of Fat-Specific Absorption During Focused-Field Radiofrequency Therapy

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ABSTRACT

Background: This study incorporates concurrent thermal camera imaging as a means of both safely extending the length of each treatment session within skin surface temperature tolerances and to demonstrate not only the homogeneous nature of skin surface temperature heating but the distribution of that heating pattern as a reflection of localization of subcutaneous fat distribution.

Methods: Five subjects were selected because of a desire to reduce abdomen and flank fullness. Full treatment field thermal camera imaging was captured at 15 minute intervals, specifically at 15, 30, and 45 minutes into active treatment with the purpose of monitoring skin temperature and avoiding any patterns of skin temperature excess.

Results: Peak areas of heating corresponded anatomically to the patients' areas of greatest fat excess ie, visible "pinchable" fat.

Conclusion: Preliminary observation of high-resolution thermal camera imaging used concurrently with focused field RF therapy show peak skin heating patterns overlying the areas of greatest fat excess.

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INTRODUCTION

Recent demonstrations of effective fat reduction with the use of a focused field radiofrequency system designed for contactless deep tissue thermal energy application were based on a protocol of 4 treatments of 30 minutes each.^{1,2} Results of efficacy in these studies were based on duplex ultrasound reduction in the subcutaneous fat layer and circumferential tape measure reduction. This study incorporates concurrent thermal camera imaging as a means of both safely extending the length of each treatment session within skin surface temperature tolerances and to demonstrate not only the homogeneous nature of skin surface temperature heating but the distribution of that heating pattern as a reflection of localization of subcutaneous fat distribution.

The use of thermal imaging to reflect the pattern of subcutaneous heat energy capture was recently demonstrated by this author in a different model, one of creating structural tightening of the skin with subsurface radiofrequency heating.^{3,4} In this author's study, a direct linear relationship was established between skin surface temperature, as measured by thermal camera imaging, and subcutaneously measured temperature

elevations, as determined by the placement of a radiofrequency thermistor probe. In this prior published study, subsurface thermistor probe placement allowed both subsurface heating and subcutaneous temperature monitoring, with observed mean and median subcutaneous temperature of 54.4°C and 55.0°C, respectively, as measured by thermal camera imaging and skin surface temperature peaks of 43.6°C and 43.8°C, respectively.

In other words, skin surface temperature monitoring can be used as an index of subcutaneous heat capture, whether by direct subsurface thermistor probe as in this author's prior publication, or by transcutaneous delivery of energy as in this current study using contactless focused-field RF energy as an energy source.³

METHODS

The five subjects for this study were selected because of a desire to reduce both abdomen and flank fullness. The prior published protocol treatment sessions of 30 minutes duration were extended using thermal camera imaging. Taking into ac-

FIGURE 1. Patient 1 photos taken at baseline, 15 minutes, 30 minutes, and 45 minutes into treatment. Note the color differentiation in the circled areas. The highest subcutaneous fat densities register the greatest skin temperature elevation as shown with thermal imaging.



Baseline

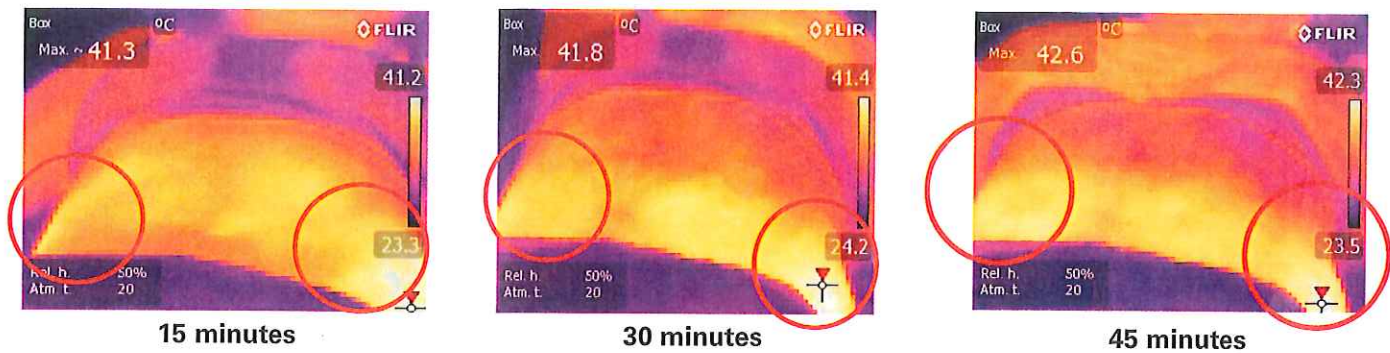


FIGURE 2. Patient 2. Photos taken at 15 minutes, 30 minutes, and 45 minutes into treatment.

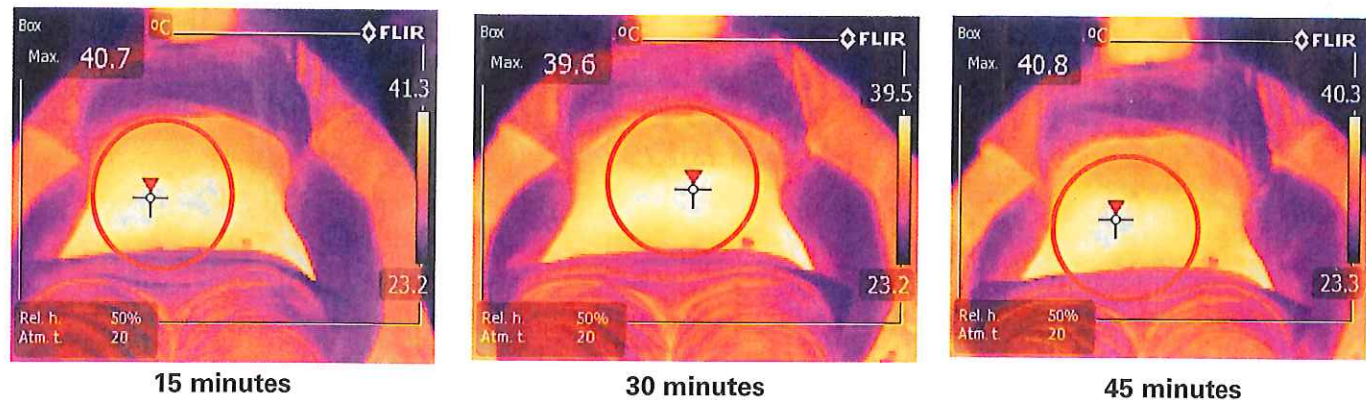


FIGURE 3. Patient 3. Photos taken at 15 minutes, 30 minutes, and 45 minutes into treatment.

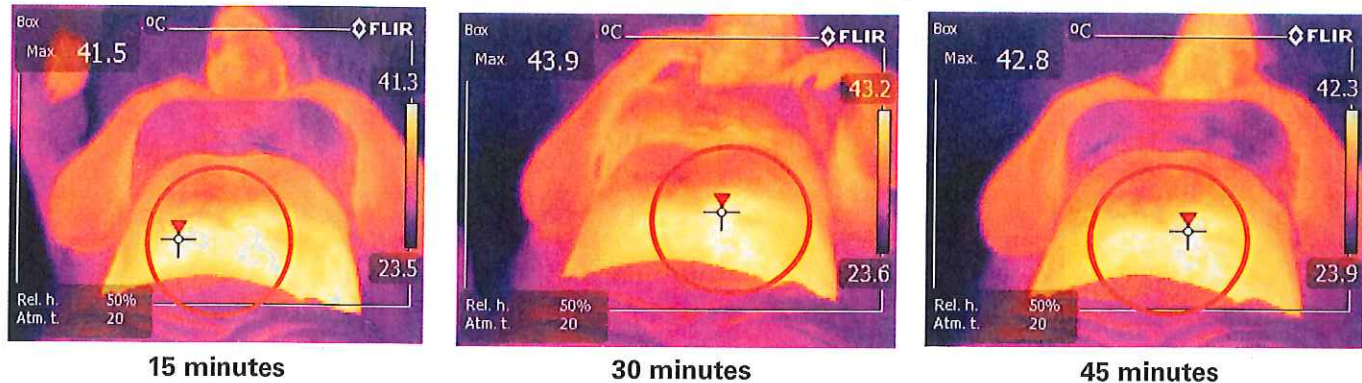
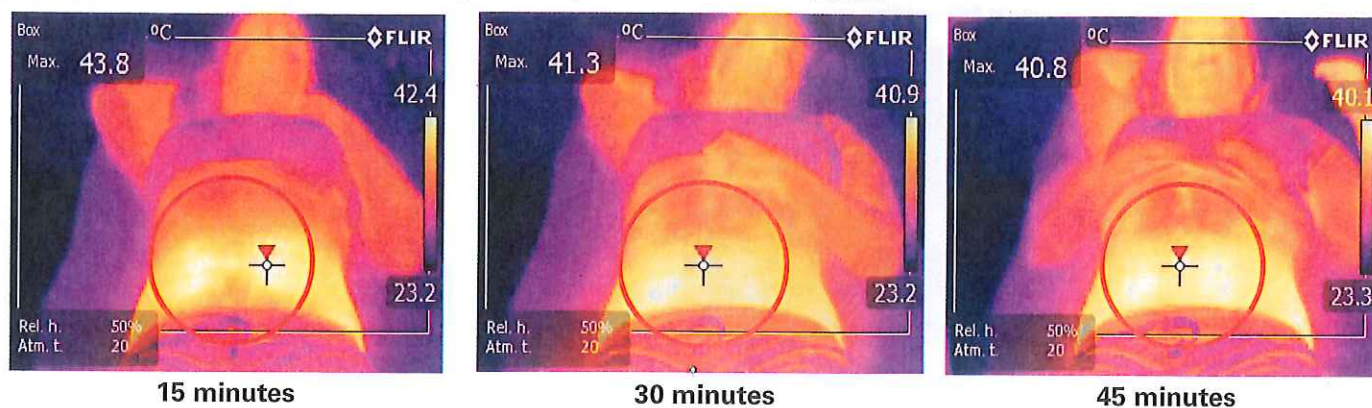


FIGURE 4. Patient 4. Photos taken at 15 minutes, 30 minutes, and 45 minutes into treatment.

count the drawback of the treatment canopy, full treatment field thermal camera imaging was captured at 15 minute intervals, specifically at 15, 30, and 45 minutes into active treatment (Figures 1-4). The purpose of the thermal imaging was to monitor skin temperature and avoid any patterns of skin temperature excess. The dosage levels of heat sensation did not exceed that of pleasant warming, with power settings of 180 to 200 watts. Skin surface temperature monitoring was conducted using a FLIR camera (FLIR E40, FLIR Systems, Inc, Wilsonville, OR), which allowed for thermal monitoring of the entire physical field rather than a single spot as with the more commonly used hand held laser infrared laser thermometer.

RESULTS

Temperature patterns were constant at time intervals of 15, 30, and 45 minutes. Peak areas of heating showed temperature elevations between 41.0° to 43.9°C. Peak areas of heating corresponded anatomically to the patients' areas of greatest fat excess (Figures 1-4). All areas returned to baseline temperatures within two minutes of treatment completion.

DISCUSSION

Thermal camera imaging allows for full treatment field visualization and may be of great advantage when used with the larger treatment areas now possible with focused field RF therapy. Although this treatment sampling is limited in the number of patients, a pattern of peak skin temperatures corresponding to the greatest areas of fat excess was visualized. Importantly as well, treatment field skin surface temperatures were stable, at the extended time intervals, with no significant change in temperature patterns between, 15, 30, and 45, minutes of treatment. Thermal camera imaging may become important not only in the evaluation of safe extension of treatment time, but also may become useful as a predictor as well of fat regression response, and of possible secondary benefits, of nonspecific thermal induced skin tightening.

CONCLUSION

Preliminary observation of high-resolution thermal camera imaging used concurrently with focused field RF therapy show peak skin heating patterns overlying the areas of greatest fat excess. This pattern of heating would confirm fat selective absorption of focused-field RF therapy.

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