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The effect of pulse shape and duration in ablative fractional CO2 laser treatment studied with high-speed thermal imaging: implications for clinical use

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CO2 lasers have been a successfully used in the ablative fractional treatment of skin for wrinkles, dyschromias, and scars. Several CO2 lasers systems have shown a varying range of performance which is attributed to differences in the pulse shape, pulse duration, and spot size while the wavelength is 10.6 um. In this study the laser-tissue interaction mechanisms for varying the pulse shape and duration at a constant fluence was examined.

Special laser control technologies allowed the variation of the pulse shape and duration for fixed energy settings commonly used in CO2 ablative fractional applications. High speed and thermal Schlieren imaging techniques were applied during ablation of phantom tissue consisting of a polyacrylamide gel (90% water content similar to the dermis) at a fixed spot size and energy.

Significant differences in ablation depth as well as residual thermal damage zones were observed which will have an impact on the clinical performance of the various CO2 ablative fractional systems. Ultrashort high power pulsed CO2 lasers leave the least margin of thermal damage and provide the most efficient ablation of the varying pulsed modalities which is attributed to a hot vapour plume that is expelled quicker than the lower power modalities. Longer pulsed CO2 lasers modalities have less efficient ablation and a residual superheated plume that contributes to the larger thermal damage zones.