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**SUB-ZERO AND RESIDENCE TIMES OF
MULTIPLE CRYOGEN SPURTS**

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Background and Objectives: Cryogen spray cooling (CSC) is used to minimize epidermal damage during various laser dermatologic surgeries. The objective of this study was to measure the time the surface of a human skin model remains below 0°C (sub-zero time, t_s) and -26°C (residence time, t_r) as well as the minimum surface temperature (T_{min}) and the time at which T_{min} occurs (t_{Tmin}) during the application of a continuous and multiple cryogen spurts (MCS).

Study Design/Materials and Methods: An epoxy human skin model was used to measure t_s , t_r , T_{min} , and t_{Tmin} for four sequences: one continuous spurt and three MCS sequences, all adding to a total cryogen-delivery time (Δt_T) of 40 milliseconds. The MCS sequences consisted of two-20, four-10, and eight-5 milliseconds spurts, respectively, with a constant delay (d) of 10 milliseconds in between spurts and a constant nozzle-to-sprayed surface distance of 31 mm.

Results: For the MCS sequences, t_s increases up to 100% with respect to that of a continuous 40 milliseconds spurt. In all experiments, however, t_r was zero, since the surface temperature was never below -26°C.

Conclusions: In MCS sequences, t_s increases consistently with respect to that of a continuous spurt of the same duration (40 milliseconds). If not properly controlled, this situation could increase the risk of epidermal freezing damage.