Characterization of Laser-Induced Ablation on Polymethyl Methacrylate (PMMA) Model for Precision Ophthalmic Surgeries

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The evolving landscape of femtosecond laser technology presents a diverse array of precise surgical techniques. This study aims to refine these methodologies for heightened safety, precision, and equipment miniaturization. The primary objective is to comprehensively characterize laser-induced ablation parameters, employing Polymethyl methacrylate (PMMA) as a corneal surrogate. The surgical processes utilizing femtosecond lasers were characterized through surface and volume analysis using Scanning Electron Microscopy and Optical Coherence Tomography, elucidating micromachining techniques and precision damage critical for the development of replicable scanning systems. To investigate laser-induced ablation on PMMA, micromachining studies were conducted, exploring damage thresholds and incubation with two different femtosecond lasers (800 nm and 1030 nm) across varying pulse numbers. Results achieved using the PMMA model illustrate comparable precision damage efficacy between high repetition rates with low-energy pulses and the standard low repetition rates with high-energy pulses found in commercial surgical lasers. These findings highlight the potential of employing compact, high repetition rate lasers with low-energy pulses to enhance surgical processes and reduce costs.