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Optical Feedback Mechanism for Minimally Invasive Laserosteotome

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Abstract: Laserosteotomy has become a generally accepted method in surgical applications. However, the method still suffers from a lack of information about the type of tissue currently being ablated. Therefore, critical structures of the body near the focal spot of the laser beam are prone to inadvertent ablation. This issue can be solved by connecting the laserosteotome to an optical detection setup, which can differentiate various types of tissues, especially bone from soft connective tissues. This study examines the applicability of laser-induced breakdown spectroscopy (LIBS) as a potential technique to differentiate bone from surrounding soft tissue (fat and muscle). Additionally, the efficiency of the developed system to detect laser-induced thermal effects on the bone (dehydration and carbonization) has been investigated. In this experiment, fresh porcine femur bone, muscle, and fat were used. The beam of frequency-doubled Nd:YAG laser with nanoseconds pulse duration was used to ablate the tissue samples and generate the plasma. The plasma light emitted from the ablated spot, which is associated with the recombination spectra of ionized atoms and molecules, was collected with an optical fiber and sent to an Echelle spectrometer for resolving the atomic composition of the ablated sample. The results showed that LIBS is capable to differentiate between tissues and also detect laser-induced thermal damages with high accuracy.