Plasma plume expansion dynamics in nanosecond Nd:YAG laserosteotome

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In minimal invasive laser osteotomy precise information about the ablation process can be obtained with LIBS in order to avoid carbonization, or cutting of wrong types of tissue. Therefore, the collecting fiber for LIBS needs to be optimally placed in narrow cavities in the endoscope. To determine this optimal placement, the plasma plume expansion dynamics in ablation of bone tissue by the second harmonic of a nanosecond Nd:YAG laser at 532 nm has been studied. The laserinduced plasma plume was monitored in different time delays, from one nanosecond up to one hundred microseconds. Measurements were performed using high-speed gated illumination imaging. The expansion features were studied using illumination of the overall visible emission by using a gated intensified charged coupled device (ICCD). The camera was capable of having a minimum gate width (Optical FWHM) of 3 ns and the timing resolution (minimum temporal shift of the gate) of 10 ps. The imaging data were used to generate position-time data of the luminous plasma-front. Moreover, the velocity of the plasma plume expansion was studied based on the time-resolved intensity data. By knowing the plasma plume profile over time, the optimum position (axial distance from the laser spot) of the collecting fiber and optimal time delay (to have the best signal to noise ratio) in spatial-resolved and time-resolved laser-induced breakdown spectroscopy (LIBS) can be determined. Additionally, the function of plasma plume expansion could be used to study the shock wave of the plasma plume.
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