Evaluation of Calcified Mitral Valves After Er,Cr:YSGG Irradiation Using Optical Coherence Tomography

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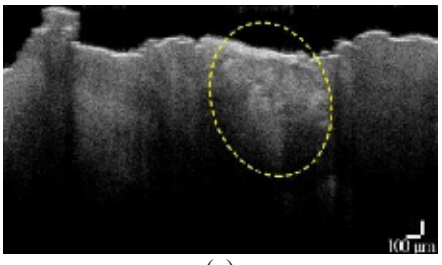
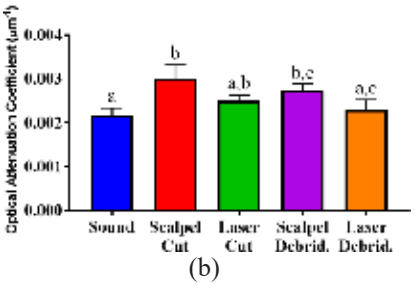
ABSTRACT

Mitral valve is responsible to control the left atrium-ventricle blood flux. Mitral stenosis is a disease that occurs in consequence of calcification and fibrosis on the cuspids of the valve. Diagnosis can be performed using echocardiography. Many treatments are possible, and one of them is commissurotomy (surgical approach). High intensity laser irradiation may be a new strategy for this surgical technique [1], and the optical coherence tomography (OCT) may contribute to the valve evaluation [2], as it provides higher spatial resolution in exchange of lower penetration than ultrasonography. In this way, the aim of this study is to evaluate laser irradiation effects in calcified mitral valves using OCT and digital processing. To that, it was conducted an *ex-vivo* study with four human mitral valves samples, obtained from valve replacement surgeries in the Heart Institute. The samples were split in four groups: scalpel cut, laser cut, scalpel debridement and laser debridement. Cutting and debridement procedures were performed in calcified regions of the valves, using a disposable scalpel blade and an Er,Cr:YSGG laser (Waterlase; Biolase Inc., CA, USA), emitting at 2780 nm. The laser parameters were set at power = 1.6 W, frequency = 20 Hz, energy density = 28.3 J/cm^2, pulse duration = 700 µs, 15% of water and 15% of air. The imaging was performed using a spectral domain OCT system (Callisto110C1; ThorLabs Inc., NJ, USA). It was acquired 10 B-scans per sample, 5 in procedures regions and 5 in sound regions. The Optical Attenuation Coefficient (OAC) was calculated by comparing a beer-lambert like equation to exponential fittings of the A-scans [3]. The distribution and normality of variances were tested using Shapiro-Wilk test, and statistical comparison was performed using one-way ANOVA and Tukey's *post hoc*. All tests considered a level of significance of 5%. The Figure A shows a representative B-scan of a visibly calcified region, where a pattern of higher intensities can be observed. This pattern is related to morphological and optical changes, mainly a refractive index change, due to calcium presence in the valve tissue. This B-scan was acquired only to understand the calcified tissue aspect, as the procedures regions does not present visibly large calcium stones. The Figure B shows the statistical analysis, where the sound OAC values, as a mean of all sound regions, presented a significant statistical difference in comparison to scalpel groups, while no difference was presented in relation to laser groups. Higher OAC values are related to an augmentation of the light backscattering due to calcium refractive index, leading to a change of light propagation in tissue-calcium interfaces. This finding indicates that the laser procedures promoted a better removal of calcified tissue than the scalpel methods, which can be related to tissue-ablation interaction. Furthermore, the statistical difference between scalpel cut group and both laser groups suggests that the scalpel needs more wear interaction with the tissue, such as in the debridement procedure, being unable to significatively remove the calcification in a single cut. This study points the Er,Cr:YSGG and the OCT as potential techniques for the calcified tissue removal and evaluation, respectively, during mitral valves surgeries, although further studies with higher sample number must be performed.



(a)



(b)

Figures: *(a) Representative OCT B-scan of a mitral valve. Dashed circle evidences a calcified region. (b) Statistical analysis (ANOVA-Tukey) of each group. Different letters indicate significant statistical difference.*

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