Optoacoustic Tissue Differentiation Using a Mach-Zehnder Interferometer

JournalArticle (Originalarbeit in einer wissenschaftlichen Zeitschrift)

ID 4526754
Author(s) Kenhagho, Herve Nguendon; Rauter, Georg; Guzman, Raphael; Cattin, Philippe C.; Zam, Azhar
Author(s) at UniBasel Rauter, Georg ;
Year 2019
Title Optoacoustic Tissue Differentiation Using a Mach-Zehnder Interferometer
Journal IEEE Transactions on Ultrasonics Ferroelectrics and Frequency Control (IEEE T ULTRASON FERR)
Volume 66
Number 9
Pages / **Article-Number** 1435-1443
Keywords Acoustic tissue response; laser ablation; Mach-Zehnder interferometer; tissue differentiation
Mesh terms Science & TechnologyTechnologyAcousticsEngineering, Electrical & ElectronicAcousticsEngineering
Laser osteotomy offers a way to make precise and less traumatic cuts smaller than conventional mechanical bone surgery tools. To fully exploit the advantages of laser osteotomy over conventional osteotomy, real-time feedback to differentiate the hard bone from the surrounding soft tissues is desired. In this study, we differentiated various tissue types-hard and soft bone, fat, muscle, and skin tissues from five proximal and distal fresh porcine femurs-based on cutting sounds. For laser ablation, an Nd:YAG laser was used to create ten craters on the surface of each proximal and distal femurs. For sound recording, the probing beam of a Mach-Zehnder interferometer was placed 5 cm away from each ablation site. For offline tissue differentiation, we investigated the measurements by looking at the amplitude frequency band between 0.83 and 1.25 MHz, which provides the least average classification error. Then, we used principal component analysis to reduce the dimensionality and the 95% confidence ellipsoid (Mahalanobis distance) method to differentiate between tissues based on the acoustic shock wave. A set of 14 400 data points, measured from ten craters in four proximal and distal femurs, was used as ”training data,” while a set of 3600 data points from ten craters in the remaining proximal and distal femurs was considered as ”testing data.” As is seen in the confusion matrix, the experimental-based scores of hard and soft bones, fat, muscles, and skin yielded average classification errors (with leave-one-out cross validation) of 0.11%, 57.69%, 0.06%, 0.14%, and 2.92%, respectively. The results of this study demonstrate a promising technique for differentiating tissues during laser osteotomy.
Publisher IEEE
ISSN/ISBN 0885-3010 ; 1525-8955
edoc-URL https://edoc.unibas.ch/78666/
Full Text on edoc No;
Digital Object Identifier DOI 10.1109/TUFFC.2019.2923696
PubMed ID http://www.ncbi.nlm.nih.gov/pubmed/31226071
ISI-Number 000484196800004
Document type (ISI) Journal Article