

# **An Impact hammer as a decision support system for surgeons during osteotomy**

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Osteotomies are often performed with a surgical mallet and an osteotome in order to cut cartilage and bone tissues in a controlled manner. However, they are delicate interventions that remain mostly based on the surgeon proprioception since it remains difficult to assess the properties of the bone tissue being osteotomized. A mispositioning of the osteotome or too strong impacts may lead to uncontrolled bone fractures, which may have dramatic consequences. The objective of this study is to determine whether a hammer instrumented with a piezoelectric force sensor (referred to as “impact hammer”) can be used to retrieve information on the mechanical properties of the tissue located around the tip of the osteotome. First, the impact hammer was used to impact 100 samples made of different composite materials and of different thickness values. The signal corresponding to the variation of the force as a function of time was recorded and two indicators were derived for each impact. Support Vector Machines (SVM) learning techniques showed that it was possible to predict the material of a sample impacted by the osteotome with an estimated 89% prediction performance, and to estimate its thickness with an error below 10%. Second, an animal model was used to investigate whether it was possible to detect the apparition of fissures as well as changes of bone properties during an in vitro osteotomy. The same hammer was used to perform osteotomies on rabbit nasal bones and the experiments were filmed to track the progression of the osteotome. The results showed that the arrival of the osteotome at the frontal bone was consistently characterized by a significant change in one of the indicators. Moreover, that same indicator appears to be strongly correlated to the displacement of the osteotome, which can itself be used to estimate the apparition of cracks. Based on these results, navigation and decision-support tools could be developed to allow surgeons to adapt their surgical strategy in a patient-specific manner.