Mechanical properties of human brain and tumor tissues

Debergue, Patricia; Pazos, Valérie; DiRaddo, Robert; Del Maestro, Rolando; Guiot, Marie-Christine; Gélinas-Phaneuf, Nicholas; Ajlan, Abdulrazzag

Publisher's version / Version de l'éditeur:

Division of Neurosurgery: Fellows Day events at the Montreal Neurological Institute, 2010-06-18, Montreal, Québec, Canada [Proceedings], 2010-06-18

Mechanical Properties of Human Brain and Tumour Tissues

Patricia Debergue[1], Valérie Pazos[1], Robert DiRaddo[1], Rolando Del Maestro[2], Marie-Christine Guiot[2], Nicholas Gelinas-Phaneuf[2], Abdulrazzag Ajlan [2]

(1) *National Research Council Canada, Industrial Materials Institute, Boucherville, Quebec*

(2) *Montreal Neurological Institute and Hospital, McGill University, Montreal, Quebec*

BACKGROUND

This study is part of the research program entitled "Patient-Specific Virtual Reality Systems for Surgical Oncology", funded by phase four of NRC's Genomics and Health Initiative (GHI). The main objective of this program is to develop a simulator for training neurosurgeons to perform brain tumour resections. In order to improve safety in the training of neurosurgeons and reduce intraoperative errors in neurosurgery, a virtual reality system is being developed. It incorporates imaging data (e.g. magnetic resonance imaging), computer simulation, and haptic feedback, which mimics the "touch and feel" aspect of surgery.

OBJECTIVES

To maximize the reality of the simulation, mechanical properties of tissue must be known. The most common way for doing this is through the indentation method, which simultaneously records the force and position of a probe as it pushes on the tissue. This essentially mimics the surgeon's palpation of tissue. We designed a portable prototype indentor capable of these measurements. It is one of our goals in this study to better characterize the mechanical properties of human brain and tumour tissues as these may be quite inhomogeneous and different with the patient, type and grade.

METHODOLOGY

To our knowledge, *ex vivo* testing of freshly resected human brain and tumour tissue using indentation has not been done before. Due to the limited information available in the literature, a study is presently carried out to quantify mechanical properties of freshly excised brain and tumour tissue and to fine-tune both the device and protocol. Tissue samples are obtained from resection on a patient. Typically these must be large specimens of brain and/or tumour. Collected tissue is tested within an hour after resection and then identified by type. A more precise identification is afterwards conducted by the neuropathologist and a correlation between the measured properties and the tissue type can then be performed. The data that are obtained from this study are used in the surgical simulator as a model for how different types of brain tissue respond to manipulations by the simulated surgical instruments. The surgical simulator will have a haptic response; the tools the surgeons-in-training are using will provide appropriate force feedback, providing the surgeons with the feeling of probing the brain during surgery.

RESULTS

To date, a total of six samples have been tested that were all gliomas of different grades. Mechanical properties of the tissues are mapped across the sample for each case. Although it is still premature at this stage of the study to correlate tumour type and grade with tumour rigidity, results are however very promising.

CONCLUSION

This study represents the first *ex vivo* indentation measurements of freshly resected human brain and tumour tissues. The measurements taken from the human brain samples ensure that the simulated tissue deformation under virtual surgical manipulations is physically correct. This will allow a high degree of realism during surgical training and rehearsal on the virtual reality simulator.