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Ultrasound based navigation of robotic drilling at the lateral skull base

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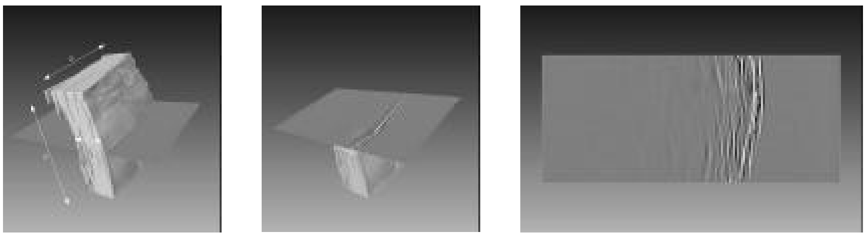
Introduction*:* Robotic surgery at the lateral skull base must be navigated due to the noble adjacent structures. The accuracy of CT based intraoperative navigation is limited by the resolution of the CT scan itself, but could be substantially improved by using ultrasound scanning.
Material and Methods: 24 human skull bone specimen fixed in formaldehyde were acoustically characterized by an ultrasound transmission system in water at the frequencies 1, 2.25, 5 and 7.5 MHz.
Results: Sound velocity c in skull bone was 2593 m/s (SD 276). The acoustic dampening coefficient ß was 2.8875 dB/mm*MHz (SD 0.424, ±7%). The best of the tested frequencies proved to be 2.25 MHz, as it allows scanning down to a depth of 8 mm while giving axial resolution of 0.6 mm in standard data processing. Thereby, it was possible to automatically detect the inner bony contour and to create a 3D map of the scanned bone (shown below).



Discussion: As the acoustic dampening was rising substantially with the used frequency, the 7.5-MHz transducer did not prove to be appropriate despite of theoretically highest axial resolution. Detection of the inner bony contour could even be enhanced by using coded excitation. The ultrasound scan is connected to the robot (Stäubli RX 130) to perform the scanning and, thereby, registering itself to the field of surgery. Ultrasound shows to be a promising complementary or even alternative method to CT based navigation by creating a 3D map of bony tissue with the option of intraoperative data acquisition.

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