CLINICAL OUTCOMES OF THE NEW ROBOT-BASED NAVIGATION SYSTEM ROSATM USING AN AUTOMATIC REGISTRATION TECHNIQUE

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Introduction

We describe the use of the new robot-based navigation system ROSA (Robotized Stereotactic Assistant - MedTech, France), a multi-application platform, and its clinical applications on patients for stereotactic brain surgery. Registration between preoperative images and patient was performed using an innovative contactless and non-invasive automatic method. The aim of this study is to assess this new registration technique.

Methods

The system includes a pre-operative planning software, navigation capabilities and robotics technology with haptic features based on force sensing and feedback. It can position and manipulate various neurosurgical instruments and probes, such as a biopsy needle. It features both conventional skin markers based registration, and a new innovative automatic technique based on surface matching.
This new contactless automatic registration method was used and clinically evaluated on patients who underwent brain surgery.
Preoperative 3D MR imaging was performed on each patient. No fiducial markers are required with this technique.
The patient head is immobilized in a Mayfield support device firmly attached to the ROSA trolley. Then the automatic registration can be performed.

Relevant areas of the patient face are scanned by a contactless distance sensor held by the robot arm. This sensor is automatically displaced on a pre-defined, patient specific, trajectory.
Registration error is computed by matching the intraoperative scanned 3D volume with the preoperative 3D MRI data.
The applicative accuracy was estimated by measuring landmarks during navigation.

Results

A preliminary assessment of this markerless registration was carried out in a first in vitro study. A total of 20 measurements were carried out on various targets distributed on a phantom simulating a human skull. The matching RMS error was 0.4 mm with a standard deviation (SD) less than 0.1 mm. The mean target localization accuracy was 1.2mm (SD 0.4mm).
The robustness of registration was further evaluated during a cadaver experimentation session. 9 registration procedures were performed with head positions distributed throughout the robot workspace. The matching RMS error was always lower than 0.6mm (SD 0.01mm).
Finally, the registration error was evaluated on 25 cases involving 5 volunteers, using the same protocol as described before. The mean matching RMS error was 0.6 mm (SD 0.1mm). The mean applicative error during navigation was 1.3mm (SD 0.3mm) with only 2 cases above 1.7 mm (max 2.7 mm).
The first clinical evaluation on 8 patients was consistent with the previous in vitro results. The mean matching RMS error was 0.7 mm (SD 0.1mm). The mean applicative error during navigation was 1.2mm (SD 0.4mm).

Conclusions

The innovative automatic registration implemented in ROSA can be successfully used for stereotactic brain surgery . The result of this study assesses the steady performance of the matching algorithm and the accuracy of the targeting. In this way, ROSA offers a simple and accurate manner to target intracranial lesions with a quick and reliable frameless technique.
It is expected the incorporation of this innovative registration technique into ROSA will contribute to spread the use of computer assisted surgery, including but not limited to stereotactic brain surgery.