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Development of A Miniaturized Robotic Platform for Stereotactic Neurosurgery: Experience with Stealth AutoGuide from the First Series of 133 Patients

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Introduction

Stereotactic interventions are among the most frequent procedures in cranial neurosurgery. To overcome the limitations of frame-based, frame-less, or free-hand techniques, robotic arms have been introduced. Limited by their commonly large form-factor, AutoGuide has been designed as a miniature robotic guidance system dedicated to cranial neurosurgery.

The aim of this study is to present the feasibility and accuracy of the AutoGuide robotic guidance device in stereotactic neurosurgical procedures in the routine clinical setting as well as future development and applications.

Methods

During the last 4 years we conducted an approved clinical trial to assess and optimize the feasibility, OR setup and accuracy of the robotic guidance platform. Altogether, 133 cases were performed with AutoGuide including tumor biopsies (n=100), intracranial catheter (n=10) and depth electrode placements (n=23 patients, n=138 electrodes).

Results

Application of AutoGuide was feasible in all cases. During the course of this trial, AutoGuide device was optimized to a state that allows operation by a single surgeon in the sterile field.

Trajectory alignment error was =0.1mm in all cases. For stereotactic biopsies, the median real target error was 1.5mm (range 0.2 - 5.1mm) at entry points and 1.6mm (range 0.0 - 3.9mm) at target points. In SEEG procedures, median real target error was 1.1mm (range 0.0 - 3.4mm) at entry points and 1.5mm (range 0.2 - 5.6mm) at target points. In all cases of catheter placement, a satisfactory functional catheter position was achieved. No adverse effects related to the application of the robotic device were encountered.

Conclusions

Our single center results indicate that application of AutoGuide in stereotactic neurosurgical procedures is feasible and provides high procedural accuracy without adding operating time. Due to its small form-factor, the robotic device was found to seamlessly integrate into the routine operating workflow. Future developments are focused on endoscope, brain trocar, and DBS electrode positioning.

Learning Objectives

By the conclusion of this session, participants should be able to: 1) Describe the importance of robotic guidance for stereotactic procedures, 2) Discuss the pros and cons of different types of available robots, 3) Identify patient cases that will benefit from robot guided surgery.

References

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