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Experimentelle und klinische Erfahrungen mit dem Robotersystem „Evolution1“

Experimental and clinical experience with the Evolution 1 robotic system

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Objective

The Evolution 1 robotic system (form. URS Inc., Schwerin, Germany) is a hexapod-based robotic system with 6 degrees-of-freedom, the maximum working space of the tip of the instrument which is attached to the interface is 160x60x100 mm. The system is operated by a joystick allowing translational and rotational movements. The hexapod has an absolute mechanical positioning accuracy of 20 µm with a maximum technical motion resolution of 1 µm. The system can be used in combination with a fameless stereotactic system, thus tracking the tip of the attached instrument. At the Department of Neurosurgery of the University of Erlangen, Germany, we experimentally and clinically evaluated a set-up consisting of the Evolution 1 and the Stealth Neuronavigation system (Medtronic).

Material and Methods

In an experimental approach we tested the application accuracy and handling in the insertion of pedicle screws. We utilized two human specimens, under navigational guidance we drilled the pedicles from T2 to S1 using a guide tube positioned with the robot and inserted metal rods. After performing a CT-scan we measured the distances from each rod to the anterior and lateral vertebral body as well as the ones to the medial and lateral pedicle wall. Furthermore the sagittal and axial rod angles were documented. In a clinical approach we adapted the system for extended endoscope-assisted transsphenoidal skull base surgery. In this set-up the endoscope was held by the robot, whilst the tip of the endoscope was tracked by the navigation system.

Results

The experimental approach showed that with careful use a positional error of below 2 mm and an orientation error of below 4o can be achieved.

In the clinical evaluation two patients suffering from large hormonally inactive pituitary adenomas with parasellar extension were operated successfully. We did not encounter any adverse effects related to the application of the robotic system. Robotic assistance allowed the simultaneous use of two additional instruments under endoscopic view, so drilling, suctioning and microscopic tumor removal were feasible. In both evaluations the application of the robot turned out to be cumbersome and time consuming.

Discussion

Despite the high mechanical accuracy and our promising results concerning application accuracy and the potential new possibilities in accessing lesions beyond the standard transsphenoidal approach this robotic system seems not suitable for a routine clinical use. The device is too cumbersome, its application and transport too time consuming. Another serious drawback is the lack of an integrated neuronavigation system allowing direct data flow between the navigational system and the robot`s control software. In 2003 the robotic system "A73" was introduced by the ENT Department of the University of Erlangen, Germany, as a system for endoscopic paranasal sinus surgery. In cooperation with the Department of Neurosurgery, University of Erlangen, Medical Intelligence Inc., Schwabmuenchen, Germany, and CAS-Innovations, Erlangen, Germany, an advanced set-up was created. This system is comparatively easy to use, frameless stereotaxy is integrated and it is potentially open to several different types of neurosurgical procedures. Further research will show if it can become a real help in daily clinical work.