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A robotic system for extended transsphenoidal endoscopic skull base surgery

Objective

To adapt a robotic system for its use in extended transsphenoidal endoscopic skull base surgery and to evaluate its feasibility.

Methods

The Evolution 1 (URS, Schwerin) is based on an instrument interface (z-axis), which is mounted on a hexapod platform, allowing repeated movements with a submillimeter precision. Movements along the z-axis and pivoting in relation to an entry point can be operated using a joystick. The tip of the rigid endoscope (Hopkins straight forward & forward oblique 4mm diameter, Storz, Tuttlingen, Germany), which is attached to the instrument interface, can be localized by a neuronavigation system (Stealth, Medtronic, Broomfield, USA).

Results

Phantom studies showed that pivoting and z-axis movements were not sufficient to allow the system to be used for endoscope-assisted extended transsphenoidal skull base surgery. For positioning of the endoscope in the narrow space of the speculum additional features had to be implemented. After redesigning of the instrument interface, additional instruments besides the endoscope can be placed in the speculum for surgery. Furthermore, translational movements were implemented, which now allow a free positioning of the endoscope. Additionally, a rotational movement of the supporting system of the hexapod is integrated, facilitating the quick change between endoscope-assisted mode of surgery and the use of a microscope, without the need of recalibrating the robot system at the entry point.

This modified robotic system was applied in five patients suffering from large intra- and suprasellar pituitary adenomas, which were operated on a transsphenoidal approach. In all cases the robotic assistance allowed a precise positioning of the endoscope. The positioning could be easily controlled by the joystick. The implementation of robotic assistance enabled surgery under endoscope view while two further instruments, such as drills or curettes, could be used simultaneously. So structures beyond the view of the microscope could be accessed.

Discussion

Modifications, including a redesigned instrument interface, the capability for translational movements, and the quick alteration between endoscope- and microscope-mode, are the prerequisites to enable the application of the hexapod-based robotic system for extended endoscopic skull base surgery. This modified robotic system is the first step in implementation of extended skull base surgery. The simultaneous use of different instruments under endoscope view, allows to expand the skull base area which is accessible via the transsphenoidal approach. Further steps will be the integration of the passive neuronavigation tracking into the robotic system, the development of an active robotic mode, where the positioning of the instrument is controlled via the navigation system, as well as the development of different instrument interfaces, which will also allow robotic-driven drilling at the skull base.