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Abstract-Title:
RAPID PROTOTYPING FOR MANUFACTURING OF INDIVIDUAL STEREOTAXIC DEVICE IN DIAGNOSTIC AND FUNCTIONAL NEUROSURGERY

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Abstract-Text:
Introduction
Frame based stereotaxy using a stereotaxic frame represents one kind of surgical procedures allowing a histological diagnosis by biopsy and an excellent therapeutic effect in patients with movement disorders. Preoperative acquired image data, image postprocessing and standardised stereotaxic algorithm guarantee a high level of accuracy, reliability and safety as well. Nevertheless, before image acquisition and planning stereotaxic coordinates a stereotaxic frame (weight: 2 – 2.5 kg) is fixed on the patients head and stay in this position during the whole procedure of one (biopsy) to six hours (functional surgery). In the next step of surgery all defined coordinates of the space are to be adjusted using a special configurated target arch, which represents additional time consuming maneuvre.

Method and patients
In this study we introduce a newly designed “microTargetingSystem” (mT®System, FHC Company, Chemnitz, Germany), which represents the first example of automation in the stereotaxic neurosurgery. Using this automation technique five patients were operated for diagnostic biopsy (two patients) and deep brain stimulation (DBS, three patients).

For planning procedure and just before image acquisition three (biopsy) and three per side (DBS) WayPoint™ anchors were implanted, basing on the intended entry area location. Anchors were arranged with one in a generally anterior position and two others spaced about 120 degrees in a 50 to 80mm radius from the anticipated entry. After anchor implantation and after installation of additional locator pins in the head of each anchor CT scanning was performed. 1.5 Tesla T1w and T2w (DBS) image series were obtained and sent to the mT® Platform Planning and Design workstation for following image fusion of both, CT and MRI data, using a special image fusion software as the base for definition of target coordinates and electrode trajectories. Contrast media (0.1 mmol/kg bodyweight Gd-DTPA, Magnevist, Schering, Germany), which was given just before MRI acquisition should improve detail informations. The final stage in the surgical planning process involved reviewing the proposed trajectory interactively in the sagittal, axial and coronal plane. Multiplanare planning involved the avoidance of blood vessels; sulci and ventricles; checking the coordinates verified that the cannula passes exactly to the defined target

point. In the next step the export of the mT® Platform planning files took place and were transmitted to FHC\'s fabrication facility by direct internet connection. Validated mT® Platforms (weight: 300 mg), which were manufactured individually were sent 5 day later back to the hospital to realize the planned stereotaxy. Patients were readmitted and prepared for surgery and an indexing ring was installed in the platform, providing a hard metallic surface for accurate and secure attachment of system components. Anchors were exposed, anchor plugs removed and the platform was attached temporarily to define the burr hole site. The platform was removed and a burr hole craniotomy was done under local anaesthesia. After re-attachment of the platform on the patients head and installation of the assembled target drive system a routinely used side cut biopsy needle (biopsy) or five guide tubes (DBS) were placed for further histological diagnosis respectively microrecording and macrostimulation for deep brain stimulation.

Results

In the case of diagnostic biopsies the histological result could be confirmed as low grade gliomas. In the consequence of DBS-surgery of Parkinsonian patients excellent clinical effect of permanent brain stimulation was associated by a mean reduction of daily dopamine dosage of 74% (63-81%).
Used individually manufactured stereotaxic platform fulfilled the surgeons expectations and contributed to a safe diagnostic and functional surgery with excellent results, which made the handling of single stereotaxic components much easier and comfortable.

Discussion and conclusion

The described operative procedure is a further step of automation in stereotaxic neurosurgery as a novum in human-machine-interaction in this field. The advantage of this newly designed device is the fact, that corresponding to the defined stereotaxic coordinates a stereotaxic platform is made individually, which allows the use of only one trajectory, which was calculated preoperatively. In comparison to conventional stereotaxic neurosurgery no stereotaxic frame is necessary during image acquisition, planning procedure and surgery as well. The only, we need, is the implantation of anchors and locator pins instead of stereotaxic frame. Anchors and locator pins were required to eliminate the need for a cumbersome, uncomfortable stereotaxic frame applied before the scan and attached during surgery and were used for co-registration of the system and the patient’s anatomy. This reduces the need for clamping systems that are required to hold the patient in a fixed position relative to a table for surgery and allows mobility. Scan artefacts normally resulting from conventional stereotaxic frames are minimized or eliminated.

With the fixation of the stereotaxic trajectory using the individually manufactured platform all manual steps of adjustment stereotaxic frame and target arch in the three dimensions of the space disappear. This implicates also a significant reduction of possible risks of “mis-adjustments” using a manual system by humans. With the introduction of automation technique in the functional neurosurgery some of surgeons acts are transferred to the manufactured platform, which save additional time and cost consuming resources before and during surgery and allows a maximum of comfort for the patient.

Picture 1

Comparison of conventional and newly designed stereotaxic device

Bild 1/JPG