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Anwendungsgenauigkeit des BrainLAB VectorVision Neuronavigationssystemes mit „TREGS"-einem neuen Hilfsmittel zur automatischen Registrierung

Application accuracy of the BrainLAB VectorVision used with „TREGS"-a new tool for automated registration

Jens Rachinger[1], A. Dombay[2], U. Mezger[2], B. v. Keller[3], O. Ganslandt[3], R. Fahlbusch[3],. C. Nimsky[3]

[1]Department of Neurosurgery, University of Erlangen
[2]BrainLAB AG, Heimstetten, Germany
[3]Department of Neurosurgery, University of Erlangen, Germany

Objective

Clinical usefulness of frameless stereotaxy now has been widely accepted. Over the years several different methods for referencing physical space to image space emerged, for example registration based on external fiducial markers or anatomical landmarks as well as surface-fit registration techniques. In most systems active participation of the surgeon in the registration process is necessary. To make this process easier and faster, especially when an intraoperative MRI system is used, and to simplify intraoperative updating of navigation data, "TREGS" was developed – a system that provides an automated registration process. Aim of this study was to compare the application accuracy of the Brainlab VectorVision® Neuronavigation system when it is used with the automatic "TREGS"-registration with the application accuracy when standard fiducial-based registration is performed.

Material/Methods

The automatic referencing tool is based on five markers that are integrated in the MRI-compatible head rest holder we routinely use in our intraoperative MRI setting. The navigation software automatically detects the markers. A phantom was fixed in the head holder, thus forming a rigid system.

Then we acquired multiple optimized gradient echo slices, axial (thickness: 220 mm, FoV: 300mm, scan time 27s), sagittal (25 mm, 300 mm, 33 s) and coronar (18 mm, 300 mm, 27s), containing the clamp-integrated markers. After that we measured a T1 MPRAGE sequence with a slice thickness of 1.0 mm for navigation. For navigation targeting we used a Plexiglas phantom with 32 notched rods of different heights. The deepest points of the funnel-shaped surface of the rods were defined as target points in image space, 7 standard skin fiducials were attached to the surface of the phantom. In three measurement cycles we referenced the phantom once with 4, once with 7 fiducials and twice automated with "TREGS".
In one cycle we performed only one automatic registration. The localization error for each rod was documented and was measured three times per rod and registration. Thus a total number of 1440 error values was obtained.

Results

The average localization error for the standard registration with 7 fiducials was 1.48 mm in the first cycle, 3.01 mm in the second, 1.15 mm in the third and 2.55 mm in the fourth. For the standard registration with four fiducials it was 2.19, 2.24, 1.88 and 2.14 mm. For the automatic registration ("TREGS") we measured average localization errors of 1.00, 1.06, 1.52 and 1.93 mm. Different statistical tests were performed and the spatial distribution of the error values over the phantom has been evaluated.

Discussion

The application accuracy found for "TREGS"-referencing was in no case worse than that for standard registration no matter whether 4 or 7 fiducial markers were used. In some series even lower error values were measured than with standard registration. "TREGS" has proved to be reliable and fast as well as easy to handle. In combination with iop MRI it is a favourable alternative to standard fiducial based registration especially when an intraoperative update of the navigation data is necessary.