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Intraoperative Visualization

Purpose:
Increasingly, surgeons have access during surgery to (predominantly visually encoded) additional information for the monitoring of nerve function, tissue differentiation and anatomical orientation. We are following up on investigations by our work group carried out last year aimed at assessing the benefits of using microdisplays, which may give the surgeon an alternative source of information to that provided by conventional external monitors.

Methods:
The most recent generation of displays, including representative models certified for intraoperative use (monochrome or colour, monocular or binocular, view-through and non-view-through) was tested during procedures at the anterior skull base. Wearing comfort, the recognisability of minute structures, technical data, freedom of movement and ease of handling were evaluated. An artificial head was used to determine the centre of gravity. The quality of the image (resolution, distortion, trueness of colour) was evaluated with test images provided by the Society of Motion Picture and Television Engineers (SMPTE) used as a benchmark. Furthermore the surgeons were questioned postoperatively concerning handling and comfort of use.

Results:
All displays provided acceptable image quality, although larger displays did not always yield more information. The key factors influencing the wearing comfort of the displays are weight distribution and the installation of micromonitors. Reduction of the source signal (1280 x 1024 pixels) invariably entailed an unacceptable loss of detail. View-through displays make image assessment more difficult owing to superimposition with the real image.

Conclusion:
The technical advances made in recent years have provided surgeons with additional multimodal data, which are often used to complement the visual information generated provided by simple inspection of the surgical site. These assistance devices comprise neuromonitoring, intraoperative imaging such as sonography, optical coherence tomography or contact endoscopy or the use of navigation systems. The additional information should ideally be assessed by the surgeons themselves. The flood of data can only be managed if the information is simplified (pre-filtering, acoustical encoding). However, visualisation remains the most intuitive form of information transfer. In the past, the surgeon always had to physically turn towards an additional screen, thus prolonging surgery. The advantage of microdisplays is that they present visual information within the periphery of the field of view. Our investigations into the visualisation of navigation data revealed that displays with a resolution of 800 x 600 pixels - given a virtual image area of approx. 15 x 12 mm - permit sufficient evaluation of anatomically critical regions if the portion of the image can be limited to individual CT image projections. It would be desirable to find a simple way of alternating between the sectional planes (e.g. by using voice control). The display quality was acceptable in all tested displays. However, monochrome red displays reduce the recognisability of details. In order to maximise wearing comfort it is essential that the display can be positioned as close as possible to the natural optical axis of the eye. When non-3D data are used binocular displays represent no advantage. The limits of miniaturisation have not yet been reached, so that these highly compact aids will represent an increasingly interesting tool for the surgeon.

Key words:
head mounted displays, intraoperative assistance device, work flow, ergonomy