3D ultrasound for intracranial tumor surgery

In glioma surgery, Ravn Munkvold et al. sought to analyze sensitivity, specificity and predictive values of Three-dimensional Intraoperative Ultrasound (US) for detecting residual tumor compared to early postoperative MR imaging. Factors possibly associated with radiological complete resection were also explored.

144 operations for diffuse supratentorial gliomas were included prospectively in an unselected, population-based single institution series. Operating surgeons filled out a questionnaire immediately after surgery, stating if residual tumor was seen with US at the end of resection and rated US image quality (good, medium, poor). Extent of surgical resection was estimated from pre- and postoperative MRI images.

Overall specificity was 85% for “no tumor remnant” seen in US images at the end of resection as compared to postoperative MRI findings. Sensitivity was 46%, but tumor remnants seen on MRI were usually small (median 1.05 ml) in operations with false negative US findings. Specificity was highest in low-grade glioma operations (94%), and lowest in patients who had previously undergone radiotherapy (50%). Smaller tumor volume and superficial location were factors significantly associated with gross total resection in a multivariable logistic regression analysis, while good ultrasound image quality did not reach statistical significance ($p = 0.061$).

The specificity of intraoperative US is rather good, but sensitivity for detecting the last milliliter is low compared to postoperative MRI. Tumor volume and tumor depth are the predictors of achieving gross total resection, while ultrasound image quality was not [1].

An ultrasound device, provided with both a 2D sector probe and a 3D endocavity transducer, was integrated in a surgical navigation system with an optical tracking device. Navigation was performed by fusion of preoperatively acquired MRI data and intraoperatively acquired ultrasound data throughout an open biopsy. Data sets with both probes were acquired transdurally and compared.

The acquisition with the 3D probe, processing and visualization of the volume only took about 2 min in total. The volume data set acquired by the 3D probe appears more homogeneous and offers better image quality in comparison with the image data acquired by the 2D probe.

The integration of a 3D probe into neuronavigation is possible and has certain advantages compared with a 2D probe. The risk of injury can be reduced, and the application can be recommended for certain cases, particularly for small craniotomies [2].

Navigable 3D-US and ALA-induced fluorescence provide information regarding different aspects of tumor extent and combined together enhance the extent of resection. Fluorescence-guided resection may be sufficient for enhancing tumors, but nonenhancing tumors are better resected with navigable 3D-US [3].

1)
Ravn Munkvold BK, Jakola AS, Reinertsen I, Sagberg LM, Unsgård G, Solheim O. The diagnostic properties of intraoperative ultrasound in glioma surgery and factors associated with gross total tumor resection. World Neurosurg. 2018 Apr 6. pii: S1878-8750(18)30700-9. doi: 10.1016/j.wneu.2018.03.208. [Epub ahead of print] PubMed PMID: 29631086.

2)

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3)

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