Preoperative Mapping of Calculation Function by rTMS in Patients with Parietal Brain Tumors and Correlation with Postoperative Outcome

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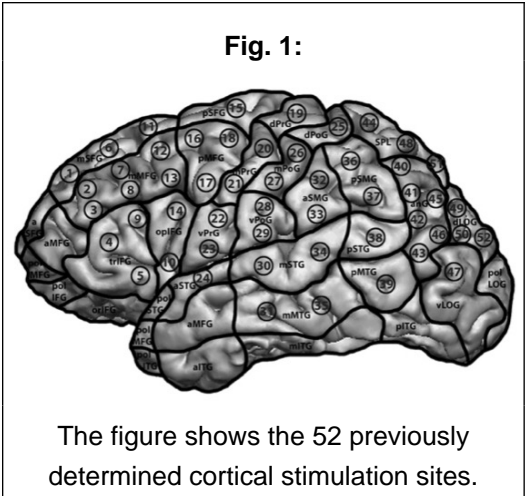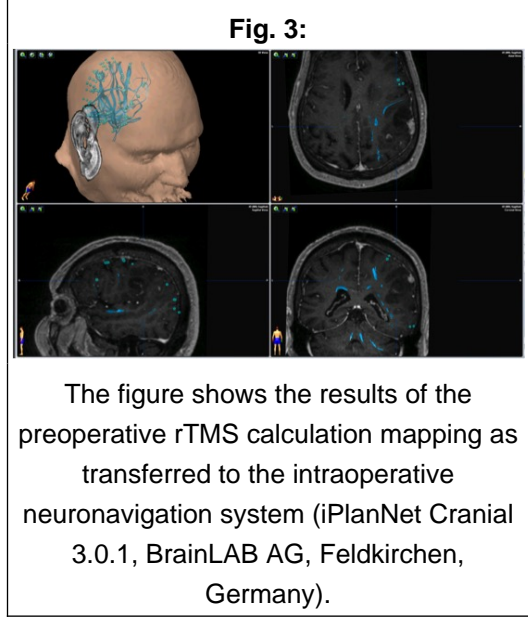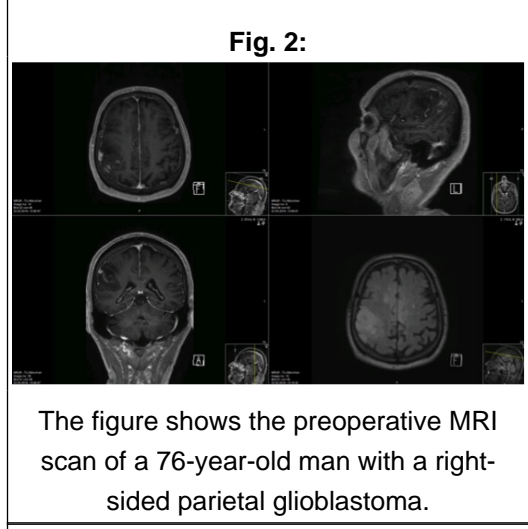
Introduction

In order to resect brain tumors while preserving the patient's brain functions, neurosurgeons apply intraoperative direct cortical stimulation (DCS) during awake surgery. Apart from language mapping, some highly specialized centers also map further higher cortical functions such as calculation function. Recently, the feasibility of mapping calculation function by repetitive navigated transcranial magnetic stimulation (rTMS) in healthy volunteers has been shown. With this in mind the present study aims to correlate the resection of calculation-positive sites in terms of rTMS with functional patient outcome of calculation performance.

Methods

Nine patients with right- or left-sided (7 right-, 2 left-sided) parietal brain tumors (7 gliomas, 2 metastases) underwent preoperative rTMS calculation mapping. We stimulated 52 previously determined cortical sites over the whole tumor hemisphere while patients performed a calculation task with 80 simple arithmetic operations. Pre- and postoperatively, patients performed a standardized number processing and calculation test (NPCT).
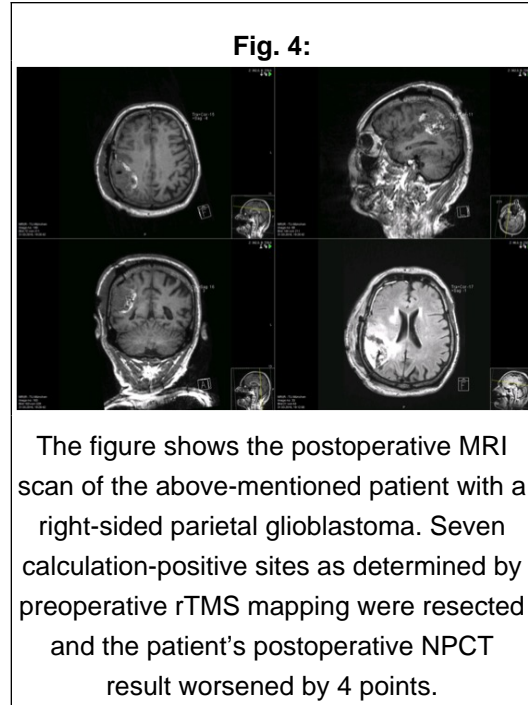
Fig. 1:

The figure shows the 52 previously determined cortical stimulation sites.

Results

Fig. 2:

The figure shows the preoperative MRI scan of a 76-year-old man with a right-sided parietal glioblastoma.

Fig. 3:

The figure shows the results of the preoperative rTMS calculation mapping as transferred to the intraoperative neuronavigation system (iPlanNet Cranial 3.0.1, BrainLAB AG, Feldkirchen, Germany).

The overall error rate (ER = calculation errors per stimulations) for tumor hemispheres was 7.3%. The resection of calculation-positive sites in terms of rTMS worsened the postoperative NPCT result in 6 cases. In 2 cases no calculation-positive sites were resected and the postoperative NPCT result was similar or better than preoperatively. In one case the postoperative NPCT result was better than preoperatively although calculation-positive sites were resected. Overall, sensitivity and negative predictive value are 100%, specificity is 66.7%, and positive predictive value 85.7%.

Fig. 4:

The figure shows the postoperative MRI scan of the above-mentioned patient with a right-sided parietal glioblastoma. Seven calculation-positive sites as determined by preoperative rTMS mapping were resected and the patient's postoperative NPCT result worsened by 4 points.

Table 1

Resection	Postoperative NPCT	n=
yes	worse	6
no	similar / better	2
yes	better	1
no	worse	0
Receiver operating characteristics		
Sensitivity		100%
Specificity		66.7%
Positive predictive value		85.7%
Negative predictive value		100%

The table shows the postoperative calculation performance in dependency of the resection of calculation-positive sites in terms of preoperative rTMS mapping.

Conclusions

The resection of calculation-positive sites in terms of rTMS correlated with postoperative NPCT results in 8 of 9 cases. Despite only presenting a low number of cases, rTMS might be a useful tool for preoperative mapping of calculation function. However, the reliability of the present results has to be evaluated in a larger series.