

Mapping the language landscape: A systematic review of interventions used in awake craniotomy

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Background and Aims:

Awake craniotomy often results in postoperative aphasia. Over the last several decades, neurosurgical technologies have evolved, increasing resection precision for the surgeon (e.g., intraoperative fMRI). However, one ongoing concern reported by surgical teams is delineating the extent of tissue that can be safely resected – remove too little and one may not get the desired result; remove too much and one risks impairing language function. Despite technological advances and considerable progress in the neuroanatomy of language, the Penfield three-task approach (counting, naming, reading; based on the Wernicke-Geschwind model) for intraoperative language mapping remains the standard. Although this can elicit speech-arrest and “aphasic” errors, the basic tasks are not aligned with current language models and fail to probe subtler language functions that are often impaired postoperatively (De Witte & Marien, 2013). For example, stimulation of anterior and posterior cortex could invoke reading problems due to different reasons (e.g., phonology, vision). Preserving language function is therefore reliant on probing a spectrum of multimodal functions during cortical mapping. This requires a test-battery driven by a multifaceted theoretical framework (MRI, experimental neuropsychology etc.). The first step towards developing such a tool is to establish which intraoperative tasks are effective in mapping language function and minimising aphasic symptoms.

Methods:

A systematic review was conducted. Databases were searched for articles using key terms (e.g., “brain tumour” AND “neurosurgery” AND “language” etc.). This returned 7294 articles screened for inclusion by title, abstract and full-text by independent reviewers based on the following criteria: 1) patients aged >18 years; 2) brain tumour excision under awake conditions or general anaesthesia; 3) validated language outcomes for pre-, intra- and post-operative assessment. Data were extracted from eligible papers including intervention (intraoperative tasks) and outcomes (language function pre-, intra- and post-operatively), and are currently being analysed.

Results:

It is expected that adopting a multimodal approach will provide better outcomes than the traditional Penfield approach. For example, employing tasks engaging different input modalities (e.g., phonology, vision) and measuring a range of processes (e.g., rhyme judgement, pattern recognition) will provide a better profile of language functioning for the surgeon. Not all modalities and processes will be affected by the tumour and resection location so task delivery should be optimised as a function of patient group (e.g., semantic tasks are more beneficial for anterior temporal resection).

Conclusions:

For the first time the results from this review will allow predictions to be made regarding the best combination of tasks for mapping and preserving language function in and out of theatre. It will consider important factors such as tumour location, from which more valid conclusions may be reached on how to tailor interventions. Data from cortical mapping may also provide insights into the neuroanatomy of language. The findings will provide a basis for the development of specific tasks that comprehensively and concisely assess the functions associated with a particular region pre-, intra-, and post-operatively. Such a tool is not only relevant for craniotomy but for diagnosis of different language impairments in non-tumour patients.

References

De Witte, E., & Marien, P. (2013). The neurolinguistic approach to awake surgery reviewed. *Clinical Neurology and Neurosurgery*, 115(2), 127-145. doi:<http://dx.doi.org/10.1016/j.clineuro.2012.09.015>

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