Quality and Quantity of Memories in Patients Who Undergo Awake Brain Tumor Resection

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■ BACKGROUND: **Awake craniotomy is performed with increasing frequency for brain tumor surgery in eloquent areas; however, little is known about patients' memories of this procedure. Here we retrospectively analyzed the quality and quantity of memories in a series of patients treated following a standardized protocol.**

■ METHODS: **We treated 61 consecutive patients within 3 years, 48 of whom were alive when the study was performed. Each of these patients received a questionnaire eliciting information about their perioperative memories and perceptions. The perioperative process was broken down into steps, and for each step the patient was to judge the quantity (nothing—everything) and quality (very negative—very positive) of his or her memories.**

■ RESULTS: **Thirty-six of the 48 patients completed the questionnaire (75%). The quantity of memories was quite incomplete, even for intraoperative moments when patients were awake and cooperative. On average, the quality of memories was neutral or positive. A higher quantity of memories was associated with a higher quality of memories. The most commonly reported sources of discomfort were placement of the Mayfield clamp, followed by laying on the operating room table with movement restriction, and irritation by the urinary catheter in situ.**

■ CONCLUSIONS: **Awake craniotomy can be performed following our protocol in such a way that it is experienced as (very) comfortable. However, there are moments of discomfort, which can be managed by the team. Extensive preoperative preparation may be considered a crucial part of the procedure. Less amnesia seems to improve patient satisfaction. The results of this study can help guide protocol optimization, expectation management, and information for future patients.**

INTRODUCTION

Evidence that extensive resection of brain tumors can improve the duration of survival has contributed to a renaissance of awake brain surgery for tumors in eloquent areas.[1-3] This technique allows instantaneous control of higher brain functions and enables the neurosurgeon to perform maximum brain tumor resection with a minimal risk of functional damage for the patient. Despite multiple positive studies showing high acceptance by patients, being awake during brain tumor removal is still considered difficult to tolerate by some anesthesiologists and neurosurgeons.[4] However, we have demonstrated that even a 9-year-old child can tolerate this procedure with good psychological preparation and support.[5] After years of studies only addressing the safety and feasibility of awake craniotomies, just recently an increasing number of studies are addressing the perspective of patients undergoing awake brain tumor resection. These studies have been performed mostly in small groups (<30 patients) and have focused mainly on "satisfaction" in a general way.[4,6-10]

We are not aware of any previous study that has attempted to quantify the amount and quality of memories of the perioperative period in patients undergoing awake brain tumor resection. Preoperative preparation plays a key role in alleviating the understandable anxiety of patients undergoing awake craniotomy. Therefore, we conducted the present retrospective observational study to provide data about the quantity and

Key words
- (Awake) craniotomy
- Memories
- Patient experience
- Perioperative

Abbreviations and Acronyms
IQR: Interquartile range
OR: Operating room

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quality of memories associated with this procedure. This information should be considered useful for preoperative patient counseling to decrease anxiety and improve appropriate expectation management.

METHODS

This voluntary, retrospective short questionnaire study was performed in accordance with the guidelines of our local Ethical Committee. Sixty-one consecutive patients underwent surgery over a 3-year period for various types of malignant brain tumors (including grade IV glioblastoma multiforme) following a standard protocol for preoperative preparation, intraoperative sedation, and postoperative care as described previously.[5,11]

The cornerstone of our protocol is intensive preoperative patient preparation with a digital presentation (slides and short movies) of the entire procedure by the scheduled anesthesiologist. Intraoperatively, we use a light propofol sedation with spontaneous respiration in combination with local infiltration of the surgical field and the insertion points of the Mayfield clamp during the craniotomy period and for wound closure. We do not use any invasive airway management or continuous remifentanil infusion; however, we do give a bolus (50–75 μg) of remifentanil just before infiltration of local anesthesia. After opening of the dura, the patient is completely unsedated until the completion of tumor resection, allowing for both cortical mapping and intraoperative deeper stimulation and mapping of the resection field. A neuropsychologist/linguist is available for neuropsychological testing and distracting chat during this period.

At the start of this study, 13 of the 61 applicable patients in our hospital's database were documented as deceased. The remaining 48 patients were mailed a paper questionnaire (Appendix 1) eliciting responses about the quality and quantity of their memories of the perioperative period and the sources of possible discomfort experienced throughout the procedure. We mailed the questionnaire once, and sent no reminder; the patients received a preaddressed postage paid envelope to return the questionnaire. An accompanying letter explained the goal of the study and provided a contact address for any questions or distress caused by the questionnaire.

The perioperative process was broken down into 11 consecutive steps according to our local protocol. Table 1 lists these steps and the sedative drugs given at each respective step.

Table 1. Steps and Use of Sedative Drugs According to Our Awake Craniotomy Protocol

Step	Sedative Drugs Used
1. Preparation on the ward	No
2. Arrival in the operating room	Promethazine 25 mg i.m., piritramid 7.5 mg i.m.
3. Placement of the lines/catheters	Propofol (1–2 mg/kg bolus, 4–6 mg/kg/hour continuing)
4. Placement of the Mayfield clamp	Remifentanil 50–75 μg i.v.
5. Local anesthesia of the surgical field	Remifentanil 50–75 μg i.v.
6. Craniotomy	Propofol (1–2 mg/kg bolus, 4–6 mg/kg/hour continuing)
7. Neuropsychological monitoring	No
8. Resection of the tumor	No
9. Closure of the craniotomy	Propofol (1 mg/kg bolus, 3–4 mg/kg/hour continuing)
10. Transport to the PACU	No
11. First night on the PACU	No

PACU, postanesthesia care unit.

The patients were asked to rate the quantity of memories on a scale of 0–4: 0 = remember nothing, 1 = remember a little, 2 = remember partially, 3 = remember quite a lot, 4 = remember (almost) everything. They were also asked to rate the quality of memories on a scale of 0–4: 0 = absolutely negative, 1 = more negative than positive, 2 = neutral, 3 = more positive than negative, 4 = absolutely positive. Patients reporting no memories for a certain step of the procedure (quantity = 0) were excluded from analysis of the quality of the memories for the respective step.

Furthermore, patients were asked about specific possible causes of discomfort (Mayfield clamp, position on the operating room (OR) table, restricted movement, shaving, laying under drapes, intravenous/arterial catheter, urinary catheter, dry mouth, local anesthesia of the surgical field, body temperature). Multiple answers were possible for that question.

The interval between the surgical procedure and questionnaire completion ranged from 0 to 37 months. Because this variation might have an effect on the quantity of memories, we analyzed for a correlation between the average quantity of memories for each of the 11 steps and the interval between the procedure and questionnaire completion.

Statistical analyses were performed using SPSS version 22.0.0 (IBM, Armonk, New York, USA), and figures were plotted using R version 3.1.3 (R Institute for Statistical Computing, Vienna, Austria). Categorical variables are presented as numbers and percentages. Continuous data are presented as mean ± standard deviation when normally distributed or as median values and corresponding 25th and 75th percentiles when skewed. The quantity and quality of memories of each of the 11 steps were summed to quantity and quality sum-scores, respectively (possible range, 0–44 for both scores). Differences in sum-scores between subgroups of patients were analyzed using the nonparametric Mann–Whitney test or Kruskal–Wallis test, as appropriate. Correlations were assessed using Spearman's correlation coefficient. Significance was set at a 2-sided P value <0.05.

RESULTS

The procedure could be performed in all patients as planned. No patient required an invasive airway procedure (e.g., intubation, laryngeal mask airway, mechanical ventilation), and no patient was converted to general anesthesia.