Anesthesia for Awake Craniotomy

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Regional Anesthesia for Craniotomy with Awake Intraoperative Brain Mapping

Supratrochlear
Supraorbital
Zygomaticotemporal
Auriculotemporal
Greater occipital
Lesser occipital
<table>
<thead>
<tr>
<th>Craniotomy</th>
<th>Mapping</th>
<th>Resection</th>
<th>Closure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Awake</td>
<td>Awake</td>
<td>Awake</td>
<td>Awake</td>
</tr>
<tr>
<td>Sedated</td>
<td>Awake</td>
<td>Sedated</td>
<td>Sedated</td>
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<tr>
<td>Sedated</td>
<td>Awake</td>
<td>Awake</td>
<td>Sedated</td>
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<tr>
<td>Deep sedation GA</td>
<td>Awake</td>
<td>Deep sedation GA</td>
<td>Deep sedation GA</td>
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<tr>
<td>Deep sedation GA</td>
<td>Awake</td>
<td>Awake</td>
<td>Deep sedation GA</td>
</tr>
</tbody>
</table>
Goals for anesthesia for craniotomy with awake intraoperative brain mapping

- Comfortable
- Cooperative
- Calm
- Minimal movement
- Stable Vital Signs
- Adequate ventilation
- Optimal brain conditions
- Optimal mapping and monitoring
Ideal anesthetic agents for craniotomy with awake intraoperative brain mapping

- Analgesic
- Anxiolytic
- Amnestic
- Minimally respiratory depressant
- Easy to titrate
- Rapidly reversible
- Compatible with neurophysiologic monitoring

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Maximum Propofol</strong></td>
<td>115 (100-150) mcg/kg/min</td>
</tr>
<tr>
<td><strong>Maximum Remifentanil</strong></td>
<td>.05 (.05-.09) mcg/kg/min</td>
</tr>
<tr>
<td><strong>Incision to request for</strong></td>
<td>48 (28-51) min</td>
</tr>
<tr>
<td><strong>Start drug to request</strong></td>
<td>78 (58-98 min)</td>
</tr>
<tr>
<td><strong>Infusion off to eyes</strong></td>
<td><strong>9 (6-13) min</strong></td>
</tr>
<tr>
<td>Technique</td>
<td>Asleep Awake Asleep</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td><strong>Agents</strong></td>
<td>Remifentanil and Propofol</td>
</tr>
<tr>
<td><strong>Estimation of Effect Site Concentration</strong></td>
<td>Pharmacokinetic Simulation BIS</td>
</tr>
</tbody>
</table>

- Time for intraoperative awakening: 218 ± 91 seconds
- From time neurosurgeon asked for patient to be awake until patient opened eyes and followed orders

Propofol & Remifentanil anesthesia for craniotomy with awake intraoperative brain mapping

- ✔ easily titratable
- ✔ readily reversible
<table>
<thead>
<tr>
<th>Study</th>
<th>Technique</th>
<th>Events</th>
<th>%</th>
<th>Clinical significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kiefer 2005 N=98</td>
<td>Propofol + Remifentanil AAA</td>
<td>30 seconds of apnea</td>
<td>69%</td>
<td>Minor; no patient required ET intubation; no pt with “tight brain”</td>
</tr>
<tr>
<td>Maninnen 2006 N=50</td>
<td>Propofol + Remifentanil or + Fentanyl Conscious sedation analgesia</td>
<td>Transient O2 desat, mild obstruction, nasal airway req, RR req mask ventilation</td>
<td>18%</td>
<td>Minor; all events brief and easily treated</td>
</tr>
<tr>
<td>Skucas 2006 N=332</td>
<td>Propofol AAA</td>
<td>Respiratory event requiring any manuever beyond placing a nasal airway Sat 91-95%</td>
<td>3/332</td>
<td>LMA (2) ETT (1) Risk factor BMI ≥ 30</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>16%</td>
<td></td>
</tr>
</tbody>
</table>
The incidence of respiratory complications in consecutive groups of 5 patients each. N=25

Dexmedetomidine

- **Advantages**
  - Sedation & analgesia
  - No respiratory depression
  - No disinhibition

- **Use**
  - Alone
  - As adjunct
  - As rescue drug

- **Neurocognitive Testing**
  - Adequate in most reports
  - Excessive sedation has been reported

- **Recommendation:**
  - DEX infusion at lower range for intraoperative functional testing e.g. 0.1-0.3 mcg/kg/hr

Arguments for an LMA during AAA and AA

• Maximum patient comfort with less concern for potential respiratory depression
• Controlled ventilation possible
• Decreased incidence of hypercarbia
• Smooth emergence
• Multiple reports document safety & efficacy
<table>
<thead>
<tr>
<th></th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anaesthetic Agent</td>
<td>Propofol, Droperidol, Fentanyl</td>
<td>Propofol infusion Fentanyl</td>
<td>Propofol infusion remifentanil</td>
</tr>
<tr>
<td>Airway Device</td>
<td>Nasal airway</td>
<td>LMA</td>
<td>LMA</td>
</tr>
<tr>
<td>Ventilation Mode</td>
<td>Spontaneous ventilation</td>
<td>Spontaneous ventilation</td>
<td>Controlled ventilation</td>
</tr>
<tr>
<td>Airway Obstruction</td>
<td>7%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hypercarbia</td>
<td>N/A</td>
<td>100%</td>
<td>0</td>
</tr>
</tbody>
</table>

• Induction: Propofol
• ETT: Nasotracheal (DL or FO assist) LITA
• Maintenance: Propofol + Remifentanil
• Monitoring: Standard+ Aline+Bis
• Prior to emergence: 4% lido via LITA; Zofran
• Extubate over tube changer
• After testing: Re-induce GA; Re-intubate over tube changer
Reversible Extubation for Awake Craniotomy: A 10 Year Experience

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Department of Anesthesiology, David Geffen School of Medicine at UCLA, Los Angeles, CA, USA

INTRODUCTION
In 1998 we reported preliminary experience with an anesthesia technique for awake craniotomy that incorporates reversible extubation over a tube changer. The present report describes our ten year experience with this anesthesia technique.

METHODS
The study was approved by the Institutional Review Board. Awake craniotomy cases performed between 2000 and 2010 were identified from department records. Information was abstracted from the patient medical records including indication for surgery, co-morbidities, age, weight, height, anesthesia technique, duration of surgery, airway management and conditions for functional mapping.

RESULTS
Records of 138 awake craniotomy procedures in 133 patients were obtained. Indications for surgery included intracerebral tumor (115), intractable epilepsy (16), and arteriovenous malformation (4). All lesions were supratentorial.

Tumor maximum dimension ranged from 0.9 to 12 cm (mean 4.2±1.7). Midline shift was noted in 25 cases.

Surgical venues were MRI (39) and operating rooms (99). Surgical positions were lateral (36) and supine (102). A pin head holder device was used in all cases.

Surgery duration ranged from 3.5 to 15.5 hrs (mean 7.2±1.9).

Comorbidities included obstructive sleep apnea (4), current tobacco use (14), reactive airway disease (9), gastroesophageal reflux symptoms (31), anxiety (3), depression(3), panic attacks(1) and schizoaffective disorder(1) hypertension (12) and obesity [BMI ≥ 30] (15).

All patients received general anesthesia for craniotomy and were awakened for brain mapping. Four patients were unable to tolerate the awake state.

In the majority of cases (115) nasotracheal intubation was performed after induction and the trachea was extubated over a modified tube changer for awake brain mapping.

Re-intubation over the tube changer was without incident in 111 of these cases and unsuccessful in four. No instances of airway trauma, pneumothorax, aspiration, or loss of the airway with hypoxemia associated with this technique were recorded.

Other airway techniques were also used (LMA and fiberoptic intubation).

Clinically significant problems with ventilation occurred in one case not managed with the reversible extubation technique.

CONCLUSIONS
The present review demonstrates a favorable safety profile for reversible extubation for awake intraoperative brain mapping. The technique provides the option of rapidly re-securing the airway with an endotracheal tube in patients who urgently require hyperventilation and those who do not tolerate the awake state. The technique may permit the benefit of awake intraoperative mapping to be extended to subsets of patients who might otherwise be excluded for reasons such as body mass, tumor size, psychological factors, frequent seizures, obstructive sleep apnea, and those undergoing very prolonged surgery.

REFERENCES

- 50 patients
- Assessment of need for sedation
- Therapeutic communication including hypnotic suggestion and dissociation and reframing and avoiding negative suggestion
- No sedation necessary for any pt
- 2/3 requested remifentanil total dose 96mcg before resection (mean)

Preparing the patient for the experience

- Neurosurgeons role
- Anesthesiologists role
- Information resources
- What patient interviews reveal
<table>
<thead>
<tr>
<th>Absolute contraindications</th>
<th>Careful risk benefit analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Altered mental status</td>
<td>• Morbid obesity</td>
</tr>
<tr>
<td>• Receptive aphasia</td>
<td>• Obstructive sleep apnea</td>
</tr>
<tr>
<td>• Severe confusion</td>
<td>• Gastroesophageal reflux</td>
</tr>
<tr>
<td>• Severe mental illness/behavioral disorder</td>
<td>• Difficult airway</td>
</tr>
<tr>
<td>• Profound retardation</td>
<td>• Significant mass effect</td>
</tr>
<tr>
<td>• Patient refusal</td>
<td>• Children and adolescents</td>
</tr>
<tr>
<td>• Prone positioning</td>
<td></td>
</tr>
</tbody>
</table>

Retrospective 10 yr exp; Pts <65 (334) or > 65 (90); Mortality & Cx=; LSS 4.9 vs 6.5d
Awake Intraoperative Brain Mapping

• What functional mapping or monitoring will be used?
  – Motor
  – Sensory
  – Electrocorticography
  – Speech

• What are the implications for my anesthesia plan?
Motor Mapping and Monitoring

- **MEPS**
  - TIVA optimal for muscle MEPs

- **Motor strip mapping by phase reversal**
  - unaffected by anesthetics

- **Cortical stimulation**
  - Awake > TIVA > GA inhalation

- **Motor task monitoring**
  - Patient needs to be awake

Suspend propofol 15 minutes before ECOG


Recommended starting dose 0.3 mcg/kg bolus .2 mcg/kg/hr
Speech and Emergence

- Object naming before semantic proficiency
- Preoperative deficits exaggerated
- Mother tongue before acquired languages
- No anesthetic known to provide for better conditions for speech mapping
OR Ergonomics
Visualization
Communication
Event Management
<table>
<thead>
<tr>
<th>Intraoperative Complications</th>
<th>N=136</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>57</td>
<td>43</td>
</tr>
<tr>
<td>Hypertension</td>
<td>36</td>
<td>27</td>
</tr>
<tr>
<td>Hypotension</td>
<td>13</td>
<td>10</td>
</tr>
<tr>
<td>Clinical Seizures</td>
<td>22</td>
<td>16</td>
</tr>
<tr>
<td>Treated Seizures</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>Emergency intubation</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>Vomiting</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>Apnea</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Agitation</td>
<td>8</td>
<td>6</td>
</tr>
</tbody>
</table>

LMA for emergency airway management

Placement of LMA in lateral position
High success rate of LMA placement (e.g. 29/30, 74/80); more rapidly and readily establishes airway control than attempts at endotracheal intubation

Placement of intubating LMA in lateral position
High success rate of intubating LMA placement in lateral position and high success rate (85%) first attempt blind intubation via device (R or L)

Placement of LMA with head fixed
High success rate even with head immobilized

Predictors of inability to cooperate during intraoperative language mapping. Lee G et al: Epilepsy and Behaviour 1:327-332, 2000

<table>
<thead>
<tr>
<th>UNCOOPERATIVE PTS <strong>DIFFERENT</strong> FROM COOPERATIVE PATIENTS</th>
<th>UNCOOPERATIVE PTS <strong>NOT DIFFERENT</strong> FROM COOPERATIVE PATIENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>IQ (LOWER)</td>
<td>AGE, SEX, HANDEDNESS</td>
</tr>
<tr>
<td>EDUCATIONAL ATTAINMENT (LOWER)</td>
<td>SEIZURE TYPE, SITE OF FOCUS, OR AGE AT ONSET</td>
</tr>
<tr>
<td>DEPRESSION SCALE SCORES (HIGHER)</td>
<td>PSYCHIATRIC HISTORY</td>
</tr>
</tbody>
</table>

Preliminary surgical evaluation and informed consent.
Detailed description of awake craniotomy and mapping procedures.

N=20

Step 1. Language and cognitive tests.
- Language criteria for eligibility: < 30% of error at naming test.
- Cognitive criteria for eligibility: sufficient scores on neuropsychological test and no frontal behaviours

Only patients meeting both criteria in step 1 are eligible for awake surgery

N=18

Step 2. Psychological questionnaires and psychophysiological recording
- Psychological questionnaires: PASS-20, BDI, STAI-Y
- Psychophysiological recording: baseline, warning, math tasks, rest, relaxation.

Step 3. Intraoperative assessment
- Interview to evaluate pain and fear during the awake procedures at the following phases: 1. anaesthesiologist’s preparation, 2. head fixation, 3. craniotomy, 4. initial cortical mapping, 5. end of cortical mapping, 6. end of operation.

Intraoperative scores for pain and fear. 1 anesthesia preparation, 2 head fixations, 3 craniotomy, 4 initial cortical mapping, 5 end of mapping 6 end of operations

• Two failures: discomfort & pain, needed sedation for extreme anxiety, delay in procedure, no repeat mapping
• Warning signs failure were preoperative fear of pain and anxiety and poor self-control
# Physical & Emotional Stress

<table>
<thead>
<tr>
<th></th>
<th>General Anesthesia</th>
<th>Awake Function Controlled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postoperative Pain</td>
<td>More</td>
<td>Less</td>
</tr>
<tr>
<td>Anxiety</td>
<td>More</td>
<td>Less</td>
</tr>
<tr>
<td>Hospital Stay</td>
<td>Longer</td>
<td>Shorter</td>
</tr>
<tr>
<td>Nausea &amp; Vomiting</td>
<td>More</td>
<td>Less</td>
</tr>
</tbody>
</table>

Patient Experience


- 16 patients assessed for PTSD using a self-developed questionnaire based DSMIV PTSD criteria
- 50% of patients reported repetitive or distressing dreams after surgery
- None of the patients had psychological sequelae that are similar to PTSD after an awake surgery.
Patient Experience

Goebel S et al Neurosurgery 67;594, 2010

• Intraoperative experience
  – 61% highly satisfied
  – 39% some dissatisfaction
    • Pain, seizure, anxiety, exhaustion

• 88% would undergo procedure again

Danks et al Neurosurgery 42;28, 1998

• Intraoperative experience
  – 57% entirely satisfied
  – 30% minor difficulties
  – 20% moderate difficulties

• 87% would undergo procedure again
THANK YOU