# Descriptive Study: Anesthesia for Awake Craniotomy in Siriraj Hospital

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## ABSTRACT

**Background:** The purpose of awake craniotomy is to test neurological functions to ensure accurate lesion surgery and lessen postoperative neurological complications. There are several methods to provide anesthesia during awake craniotomy including local anesthesia infiltration, local anesthesia plus conscious sedation, general anesthesia and wake-up during surgery and sleep again (asleep-awake-asleep or AAA). Each method has its pro and con with different complications. In Siriraj Hospital, there was no prior study of anesthetic techniques and complications of awake craniotomy.

**Methods:** The retrospective descriptive study of awake craniotomy was carried out with 60 patients in Siriraj Hospital 2007-2011.

**Results:** There were 35 males (58.3%) with average age 40.7±12.6 years and weight 64.2±12 kilograms undergoing awake craniotomy. Twenty patients (33.3%) presented with seizure before surgery. Most diagnosis was oligodendroglioma in 25 patients (41.7%), mostly at the frontal lobe (44 patients or 73.3%). The most common position was supine (46 patients or 76.7%). ICU length of stay was 1.4±0.9 (0,6) days. Hospital stay was 11.1± 9 (4, 55) days. Total intravenous anesthesia (TIVA) was mostly used (52 patients or 90%) while 18 patients (30%) received scalp block. Most patients (85%) did not require nasal airways while 8 patients (13.3%) did, and only 1 patient (1.7%) required laryngeal mask airway (LMA) to help open up air passage. The drugs used during asleep1 and asleep2 were propofol together with dexmedetomidine and fentanyl in 34 patients (56.7%) and 23 patients (38.3%), respectively. While being awake (15 patients or 20%), dexmedetomidine and/or fentanyl were administered. Complications during anesthesia were hypertension (33.3%), hypotension (26.7%), upper airway obstruction (23.3%), bradycardia (15%), tachycardia (10%), seizure (1.7%) and nausea (1.7%).

**Conclusion:** The most common anesthesia method in Siriraj Hospital for awake craniotomy was TIVA (90%), using propofol together with dexmedetomidine and fentanyl. Only one patient (1.7%) received anesthesia via inhalation with LMA. Complications during anesthesia were mostly hypertension, hypotension and upper airway obstruction, respectively.

**Keywords:** Awake craniotomy, dexmedetomidine

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## INTRODUCTION

Awake craniotomy is getting popular for tumor removal surgery and to cure seizure. The benefit of awake craniotomy is the ability to test neurological functions to ensure accurate surgery and lessen postoperative neurological complications. The length of hospital stay for awake craniotomy is also shorter than general anesthesia.[1-3] The drawbacks of awake craniotomy are patients' incoherence, lack of cooperation, high anxiety, lying face-down surgery and the need for highly-skilled neurosurgeons.

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Awake craniotomy needs highly skilled anesthesiologist to administer sedation drugs, taking care of sleep condition, pain relief, breathing and blood circulation so that neurosurgeons could test neurological responses while performing surgery so as to lesson postoperative complications. There are several methods to provide anesthesia during awake craniotomy including local anesthesia, local anesthesia plus conscious sedation, general anesthesia and wake-up during surgery and sleep again (asleep-awake-asleep or AAA).[4-9]

At present, there is no standard anesthesia method for awake craniotomy. Each method has its pro and con as well as different complications[10] including upper respiratory obstruction and low oxygenated blood. There are several sedation drugs such as propofol with remifentanil or fentanyl.[11] However, remifentanil has not been used in Thailand at present.

Most sedation drugs used in Siriraj Hospital are propofol with fentanyl or dexmedetomidine with propofol and fentanyl. Other anesthesia methods depend on the anesthetist's expertise, taking into account of the pro and con of each particular drug and possible complications.

In Siriraj Hospital, awake craniotomy has been performed since 2002, but there has not yet been any studied compilation of anesthesia methods used and how to prevent/cure complications after successful surgery, as well as the success rate of sedation method without changing the method during surgery. The researchers hope that this study would help anesthetists select the appropriate anesthesia method for awake craniotomy.

### Objectives

The objective of this study was to study the anesthesia method in awake craniotomy in Siriraj Hospital. The secondary objective was to study the problems, complications and the success rate of each anesthesia method.

## MATERIALS AND METHODS

This research was a retrospective descriptive study of 60 patients who underwent awake craniotomy in Siriraj Hospital from 1 January 2007 to 31 December 2011.

The following data were recorded: gender, age, weight, height, ASA physical status, diagnosis, tumor location and removal, as well as anesthesia method including premedication, monitoring, sedation, drugs, oxygen delivery device, surgery duration, anesthetic duration and complications such as upper airway obstruction, low oxygenated blood ($SpO_2 < 90\%$), bradycardia (HR <60/min), tachycardia (HR >100/min), hypotension (SBP <90 mmHg), hypertension (SBP >160 mmHg), seizure and nausea.

### Statistical analysis

The data were analyzed using SPSS version 15. Qualitative variables were presented as mean and standard deviation, and median and interquartile range. Quantitative variables were reported as number and percentage.

## RESULTS

Sixty patients received awake craniotomy in Siriraj Hospital from 1 January 2007 to 31 December 2011, of which 35 were males (58.3%) and 25 females (41.7%). Average age was 40.7±12.6 years, the youngest was 14 and the oldest was 74. Average weight was 64.2±12 kilograms, and the heaviest was 108. ASA physical status 2 comprised 33 patients (55%), ASA physical status 1 comprised 24 patients (40%) and ASA physical status 3 comprised 3 patients (5%). Seizure before operation was found in 20 patients (33.3%). Diagnosis showed oligodendroglioma in 25 patients (41.7%), mostly at frontal lobe 44 patients (73.3%). The most common lying position was face-up (46 patients or 76.7%), on one side (10 patients or 16.7%) and half-sitting (4 patients or 6.7%). Average ICU stay was 1.4±0.9 (0,6) days, and average hospital stay 11.1±9 (4,55) days. (Table 1)

Premedication comprised 55 patients, (91.7%) with antiepileptic 52 patients, (86.7%), with antacid 20 patients, (33.3%) with steroid 16 patients, and (26.7%) with analgesics 15 patients (25%). Most common anesthesia method used was total intravenous anesthesia (TIVA) (54 patients or 90%) while scalpblock was used on 18 patients (30%). Monitoring devices, apart

**TABLE 1.** Profile of patients undergoing awake craniotomy.

| | Number or average |
|---|---|
| **Gender** | |
| Male (n,%) | 35 (58.3) |
| Female (n,%) | 25 (41.7) |
| **Age (yrs)** (mean±S.D.) (min, max) | 40.7±12.6 (14,74) |
| **Weight (kgs)** (mean±S.D.) (min, max) | 64.2±12 (44,108) |
| **Height (cms)** (mean±S.D.) (min, max) | 164.6±6.9 (147,180) |
| **ASA I/II/III** (n,%) | 24/33/3 (40,55,5) |
| **Seizure** (n,%) | 20 (33.3) |
| **Comorbidity** | |
| Hypertension (n,%) | 9 (15.0) |
| Diabetes (n,%) | 1 (1.7) |
| **Diagnostics** | |
| Oligodendroglioma (n,%) | 25 (41.7) |
| Astrocytoma (n,%) | 15 (25.0) |
| Glioblastomamultiforme (n,%) | 10 (16.7) |
| Metastasis (n,%) | 4 (6.7) |
| Others (n,%) | 6 (10.0) |
| **Tumor location** | |
| Frontal (n,%) | 44 (73.3) |
| Parietal (n,%) | 11 (18.3) |
| Temporal (n,%) | 5 (8.3) |
| **Lying position** | |
| Face-up (n,%) | 46 (76.7) |
| On one side (n,%) | 10 (16.7) |
| Half sitting (n,%) | 4 (6.7) |
| **ICU stay (days)** (mean±S.D.) (min, max) | 1.4±0.9 (0,6) |
| **Hospital stay (days)** (mean±S.D.) (min, max) | 11.1±9 (4,55) |

from electrocardiogram (ECG), noninvasive blood pressure (NIBP), arterial oxygen saturation ($SpO_2$), were urine output (98.3%), End-tidal $CO_2$ ($EtCO_2$) (96.7%), invasive blood pressure (IBP) (70%). Length of surgery was 216.8±70 (105,400) minutes. Length of anesthesia was 273.2±74.8 (150,480) minutes. Length of asleep1 was 89.3±30.3 minutes. Length of awake was 84.7±43.4 minutes. Length of asleep2 was 98.4±40.8 minutes. Most patients did not need airway assist devices (85%) while nasal airway was used in 8 patients (13.3%). Practically all patients could breathe by themselves (59 patients or 98.3%). Oxygen was delivered through cannula (43.3%), mask with bag (35%). (Table 2) .

Drugs administered during asleep1 and asleep2 were propofol with dexmedetomidine and fentanyl for 34 patients (56.7%) and 23 patients (38.3%) respectively, followed by propofol and fentanyl 23 patients (38.3%) and 19 patients (31.7%) respectively. Dosages for asleep1 were propofol 62.5 mcg/kg/min (11.2,194), dexmedetomidine 0.5 mcg/kg/hr (0.12,1.08), fentanyl 100 mcg (25,250), and for asleep2 propofol 51.5 mcg/kg/min (4.6,153.9), dexmedetomidine 0.39 mcg/kg/hr (0.08,0.82), fentanyl 50 mcg (15,125). Most patients 35 (58.3%) did not receive sedation drug during awake. (Tables 3, 4)

Complications often found during anesthesia were hypertension (33.3%), hypotension (26.7%), upper respiratory obstruction (23.3%), bradycardia (15%), tachycardia (10%), seizure (1.7%) and nausea (1.7%). During asleep1, upper respiratory obstruction, hypotension, hypertension and bradycardia

**TABLE 2.** Anesthesia method used during awake craniotomy.

| | Number or average |
|---|---|
| **Anesthesia method** | |
| TIVA (n,%) | 54* (90.0) |
| Inhalation (n,%) | 6 (10.0) |
| Scalp block (n,%) | 18 (30.0) |
| **Monitoring devices** | |
| Urine (n,%) | 59 (98.3) |
| EtCO2 (n,%) | 58 (96.7) |
| IBP (n,%) | 42 (70) |
| Temperature (n,%) | 2 (3.3) |
| BIS (n,%) | 1 (1.7) |
| **Sedation (min)** (mean±S.D.) (min, max) | 273.2±74.8 (150,480) |
| Asleep1 (mean±S.D.) (min, max) | 89.3±30.3 (45,165) |
| Awake (mean±S.D.) (min, max) | 84.7±43.4 (30,225) |
| Asleep2 (mean±S.D.) (min, max) | 98.4±40.8 (45,270) |
| **Surgery (min)** (mean±S.D.) (min, max) | 216.8±70 (105,400) |
| **Respiration assist devices** | |
| None (n,%) | 51 (85.0) |
| Nasal airway (n,%) | 8 (13.3) |
| LMA (n,%) | 1 (1.7) |
| **Respiration** | |
| Spontaneous (n,%) | 59 (98.3) |
| Assist/control (n,%) | 1 (1.7) |
| **Oxygen delivery devices** | |
| Cannula/Mask with bag/Mask (n,%) | 26 (43.3)/21 (35.0)/13 (1.7) |

**Note:** One patient (1.7%) was switched to inhalation with LMA (obese patient with upper airway obstruction).

were found. During awake, hypertension and tachycardia were found. During asleep2, patients exhibited hypotension and brady cardia. (Table 5)

## DISCUSSION

Awake craniotomy needs patient's cooperation. A patient who is too young may not be able to cooperate fully during anesthesia. However, the youngest patient (14) in this study could cooperate successfully in awake craniotomy. Archer's[12] study revealed the youngest successful awake craniotomy aged 12. The researchers believe that age is not the primary factor, as long as the patient can cooperate with neurosurgeons and anesthetists.

The most common anesthesia method used in Siriraj Hospital was TIVA (90%), which is widely used at present.[4-8] Propofol was used together with dexmedetomidine and fentanyl, followed by propofol and fentanyl during asleep1 and asleep2. Dexmedetomidine induces sleep, lessens anxiety and pain while not suppressing breathing,[13] which reduces the need for analgesics and local anesthesia.[14] During asleep1, propofol 62.5 mcg/kg/min (11.2,194), dexmedetomidine 0.5 mcg/kg/hr (0.12,1.08), and fentanyl 100 mcg (25,250) were administered. Different dosages varied depending on anesthetists. Anesthetic time was 273.2±74.8 (150,480) minutes. Surgical time was 216.8±70 (105,400) minutes. One patient (1.7%) was switched to inhalation with LMA because the patient who had received TIVA during asleep1 showed upper airway obstruction, which needed LMA intervention. Although volatile anesthetics have been widely used in neurosurgery, they

**TABLE 3.** Drug dosages during awake craniotomy.

| Sedation drugs | n | Median (min, max) | Mcg/kg/min (propofol) or Mcg/kg/hr (dexmedetomidine) |
|---|---|---|---|
| **Propofol (mg)** | 59 | 550 (50,1200) | 36.6 (2.8,78.9) |
| Asleep1 | 57 | 300 (80,800) | 62.5 (11.2,194) |
| Awake | 0 | 0 (0,0) | 0 (0,0) |
| Asleep2 | 52 | 275 (30,610) | 51.5 (4.6,153.9) |
| **Dexmedetomidine (mcg)** | 39 | 88 (20,160) | 0.3 (0.06,0.6) |
| Asleep1 | 37 | 50 (20,100) | 0.5 (0.12,1.08) |
| Awake | 15 | 20 (5,48) | 0.23 (0.08,0.38) |
| Asleep2 | 38 | 32 (10,70) | 0.39 (0.08,0.82) |
| **Midazolam (mg)** | 4 | 2.5 (1,3) | |
| Asleep1 | 3 | 1 (1,2) | |
| Awake | 0 | 0 (0,0) | |
| Asleep2 | 2 | 2.5 (2,3) | |
| **Sevoflurane (%)** | 6 | 2 (1,2) | |
| Asleep1 | 6 | 2 (1,2) | |
| Awake | 0 | 0 (0,0) | |
| Asleep2 | 3 | 2 (1,2) | |
| **Fentanyl (mcg)** | 60 | 137.5 (25,280) | |
| Asleep1 | 60 | 100 (25,240) | |
| Awake | 15 | 50 (25,75) | |
| Asleep2 | 48 | 50 (15,125) | |

**TABLE 4.** Timing of drug administration.

| Period | n | Percentage |
|---|---|---|
| **Asleep1** | | |
| Propofol+Dexmedetomidine+Fentanyl | 34 | 56.7 |
| Propofol+Fentanyl | 23 | 38.3 |
| Dexmedetomidine+Fentanyl | 3 | 5 |
| **Awake** | | |
| None | 35 | 58.3 |
| Fentanyl | 10 | 16.7 |
| Dexmedetomidine | 10 | 16.7 |
| Dexmedetomidine+Fentanyl | 5 | 8.3 |
| **Asleep2** | | |
| Propofol+Dexmedetomidine+Fentanyl | 23 | 38.3 |
| Propofol +Fentanyl | 19 | 31.7 |
| Dexmedetomidine+Fentanyl | 5 | 8.3 |
| Propofol+Dexmedetomidine | 8 | 13.3 |
| **Others** | 5 | 8.3 |

**TABLE 5.** Problems and complications during anesthesia.

| Complication | n (%) | Anesthetic period | | | |
|---|---|---|---|---|---|
| | | Asleep1 | Awake | Asleep2 | Total |
| Airway obstruction | 14 (23.3%) | 14 (23.3%) | 0 (0%) | 1 (1.7%) | 15 (25%) |
| Hypertension | 20 (33.3%) | 8 (13.3%) | 17 (28.3%) | 2 (3.3%) | 27 (45%) |
| Hypotension | 16 (26.7%) | 8 (13.3%) | 4 (6.7%) | 6 (10%) | 18 (30%) |
| Tachycardia | 6 (10%) | 0 (0%) | 6 (10%) | 0 (0%) | 6 (10%) |
| Bradycardia | 9 (15%) | 5 (8.3%) | 2 (3.3%) | 3 (5%) | 10 (16.7%) |
| Seizure | 1 (1.7%) | 0 (0%) | 0 (0%) | 1 (1.7%) | 1 (1.7%) |
| Nausea/Vomiting | 1 (1.7%) | 0 (0%) | 1 (1.7%) | 0 (0%) | 1 (1.7%) |

reduce vascular resistance resulting in increased cerebral blood flow and intracranial pressure (ICP). The increased ICP from inhaled anesthetics in patients who already had elevated ICP can make the surgery more difficult, thereby increasing the risk of ischemic cerebral insults. However general anesthesia by inhalation needs airway device which can stimulate patient during insert and removal from airway. Total intravenous anesthesia (TIVA) using propofol and analgesic drugs (fentanyl) and excluding simultaneous administration of any inhaled drugs is being used in patients undergoing craniotomy because of its potential to reduce ICP and ease access to the operative site. Occasionally, avoidance of general anaesthesia is advisable for medical reasons and confidence with the awake craniotomy technique allows local anaesthesia with sedation to be considered as an option.[15]

Airway assessment may affect decisions regarding intraoperative positioning, and early communication with the surgical team is essential in this regard. However the other main objective of positioning is to maintain access to the airway and adopt a comfortable position for the patient, while avoiding airway obstruction if sedation is necessary. To achieve this, a lateral or semi-lateral position might be preferred with minimal rotation of the neck. Other (often competing) considerations are the visibility of the patient to the anaesthetist during intraoperative functional testing and allowing the surgeon and assistant adequate surgical access.

The patient can be prepared as for a conventional craniotomy according to the custom of the anaesthetist. In the unlikely event of a conversion to general anaesthetic, full monitoring would be required. In addition, capnography can be attached to sample the expired gas. This is best used as a monitor of respiratory rate and to detect apnea, as end tidal $CO_2$ concentrations are likely to be considerably under-read.

With accurately placed scalp blocks, most operations are painless and all patients can be reassured that the majority of the operation will be comfortable. Scalp blocks can decrease amount of sedation drugs during awake craniotomy. Sometimes brief periods of discomfort may be experienced at certain stages, but it must be emphasized that this "headache" does not represent a problem. Some sedation is usually necessary for the performance of the scalp blocks as this can be painful. We prefer to use the drugs intended for intraoperative sedation while he or she is being closely observed during performance of the blocks. In this way, the optimal dosage required to tolerate mild discomfort can be determined well prior to head pin placement and draping.

It is our custom to premedicate our patients about an hour prior to the anaesthetic. This offers anxiolysis and blood pressure stability without compromising alertness during the testing phase.[16]

Scalp block helps to reduce sedation drug dosage, which in turn lessens high dosage complications such as upper respiratory obstruction. In this study, in only 30% scalp blocks were performed. This may be due to surgeons often applying local anesthesia, or no record was kept if done by surgeons, or anesthetists lacking scalp block expertise. Monitoring devices, apart from ECG, NIBP, $SpO_2$ were urine output (98.3%), $EtCO_2$ (96.7%), IBP (70%), which corresponded with other studies.[6,8] Most patients could breathe by themselves without the need for airway clearance device while oxygen was delivered via cannula (43.3%).[8]

ICU stay was 1.4±0.9 (0, 6) days, and hospital stay was 11.1±9 (4,55) days, which was near See JJ's[5] study of 9-day hospital say. However, Peruzzi P's[2] study showed ICU stay 1 day, and hospital stay 3.5 (3-5) days.

Complications during anesthesia were hypertension (33.3%) found mostly during awake (28.3%), upper respiratory obstruction 14 patients (23.3%), which was near See JJ's[5] study at 24%. In this study, during asleep1, nasal airways were used on 8 patients and 1 patient needed LMA. One 1 patient (1.7%) exhibited seizure, which other studies reported 5-20%.[8] The patient's seizure manifested during alseep2, which also had presented before surgery. Seizure was cured and the operation was successful.

The limitation of retrospective study is small complications might not be recorded on anesthesia sheet such as urination urge, aching, fever, slight nausea. Such reported complications may be less than reality.

## CONCLUSION

The most common anesthesia method in Siriraj Hospital for awake craniotomy was TIVA (90%), using propofol together with dexmedetomidine and fentanyl. Only one patient (1.7%) received anesthesia via inhalation with LMA. Scalp block use was 30%. Complications during anesthesia were mostly hypertension, hypotension and upper respiratory obstruction, respectively.

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