

CONSCIOUS SEDATION FOR AWAKE CRANIOTOMY IN INTRA-OPERATIVE MAGNETIC RESONANCE IMAGING OPERATING THEATRE (IMRI OT) ENVIRONMENT

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Abstract

This technical report disrobes the first case in Intra-operative Magnatic Resonance Imaging operating theatre (iMRI OT) (BrainSuite®), of Awake Craniotomy. The procedure was for frontal lobe glioma excision in 24 y. old man. He was scheduled to undergo eloquent cortex language mapping intra-operatively. He was motivated and was excited to see the operating theatre. He requested to take his photos while operated upon. The authors adapted conscious sedation technique with variable depth according to Ramsey's scale , in order to revert to awake state to perform the intended neurosurgical procedure. Patient tolerated the situation satisfactory and was cooperative till the finish without any event. We elicit in this report the special environment of iMRI OT for lengthy operation in pinned fixed patient having craniotomy. The text shows the special environment, its demands and its possible difficulties.

Key words: Awake craniotomy; scalp block ; language mapping motor testing. Intra-operative Magnatic Resonance Imaging operating theatre (iMRI OT); BrainSuite®: Coil head protection. Neuroanesthesia; Neurosurgery.

Introduction

Intra-operative mapping, of intended areas of brain resection, constitutes an essential part of modern neurosurgery¹⁻⁴. It is well established that intra-operative stimulation of near speech and motor regions. Also using neuro-navigation and intra-operative MRI (iMRI) allows maximum resection of the tumor^{4,5}. This procedure requires an awake, cooperative patient to assess motor and verbal responses. Sometimes patient may be not cooperative during this procedure due to psychological profile or extreme fear from the notion of being awake during surgical intervention while the skull is fixed and then opened. The anesthetic technique has to satisfy three parties;

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patient, surgeon and anesthesiologist⁴. Many anesthesia techniques may help to produce favorable operating condition based on Scalp block with local anesthesia and various sedation and anesthesia based on propofol titrated sedation and short acting narcotics (ramifentanil and fentanyl)⁵⁻²⁰. This will allow stages of sleep-awake-sleep or sedation-awake-sedation.

This report describes the authors experience with (nine hours duration) of awake craniotomy, interrupted by session of iMRI, on a man who was motivated to be subjected to awake technique before and during testing language mapping. It was carried out under conscious sedation which was interrupted during sessions of mapping then continued to the end of the surgery.

Case Report

A 24 year old male (weight: 69 kg. Hight:168 cm) presented to the Neurosciences Department at King Fahad Medical City (KFMC).He complained of one sudden episode of seizure, for which a brain CT scan- was done reveling a left frontal lobe tumor. Awake craniotomy was planned including intra-operative brain mapping, for resection of epileptogenic foci close to eloquent cortex, i.e. motor and speech areas of the brain, for language and motor function.

In preoperative assessment he stated to be smoker of 20 cigarettes a day. Medically he was known to have mild intermittent bronchial asthma on treatment of β_2 agonist (salbutamol nebulizer).

On examination; the patient was conscious, oriented to place time and dates, alert, no signs of limbs weakness nore speech abnormalities. He was already seen by speech specialist and surgeon who informed him about all the expected operation and his role to reduce and prevent any side effects. Emphasis was put on that he is going to be awake during testing and he would have 2- 3 sessions of iMRI. Anesthesiologists answer all the questions regarding pain and sedation and being beside him all the operation. He was very excited about being operated upon in BrainSuite[®] theatre. He requested to have his pictures takrn during the procedures and he gave consent to use it for medical publications.

Vitals: HR:80 b.min⁻¹, RR: 20 b.min⁻¹, SPO₂: 97% room air, BP: 130/80 mmHg, temp:36.9 C°.

Laboratory investigations were all within normal ranges.

In iMRI OT, intravenous line was established and sedation using both propofol 1-2 mg iv. and fentanyl 25-50 μ g iv. Standard, Monitoring was initiated (ECG, NIBP , skin temperature and pulse oximetry).

The patient was placed in supine position. Oxygenation while breathing air was enriched through a nasal oxygen catheter, was delivering 2 l.min⁻¹. Conscious sedation was maintained with continuous infusions of:

- Propofol (20-40) μ g.kg⁻¹.min⁻¹.

- Fentanyl at the rate of 2 μ g.kg⁻¹.h⁻¹ Infusion rates.

Depth of sedation was adjusted by the attending anesthesiologists according to patient comfort, hemodynamic and respiratory parameters and was kept ar 2-4 Ramsay's sedation scale.

Scalp Block was established, with the use of 80 ml of 0.125% bupivacaine and 5 μ g.ml⁻¹ of adrenaline, by the surgeon.

Concern in managing patient in iMRI theatre environment.

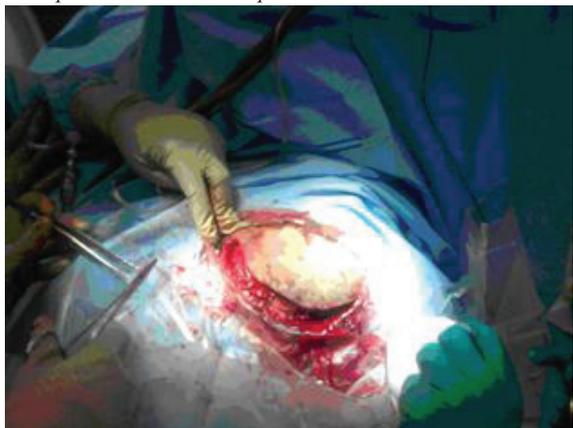
MRI environment would dictate strict obedience to instruction and warnings for MRI compatibility.

Fig. 1

The patient after scalp block and under conscious sedation pinned to the table and draped ready for craniotomy



*Fig. 2
Scalp incision under scalp block and conscious sedation*



*Fig. 3
Patient's ears are plugged with earphones with recitation of quran as he requested to help him coping with iMRI noise*



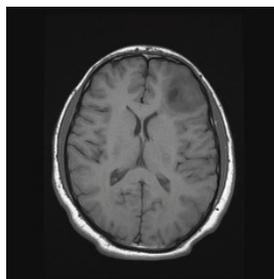
*Fig. 4
Patient's head covered with head shield (coil) after ears are plugged with earphones with recitation of quran as he requested to help him coping with iMRI noise. The airway is protected by keeping the patient in conscious sedation (Natural airway).*



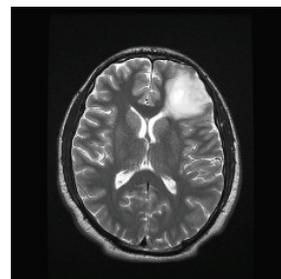
*Fig. 5
Patient's movement carried on surgical table top to and from MRI tube with extreme care for connected monitored and intravenous lines. One of the authors [FS], is pictured in the far right caring for the patient.*



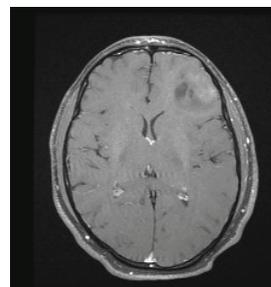
*Fig. 6a
Pre operative: Left frontal lobe mass lesion, low signal in T₁ WI, and High signal intensities in T₂ WI, with homogeneous enhancement and necrotic area in Post Gad T₁ WI*



T1_WI_pre_op (A)
Left frontal lobe mass lesion showed hypo intense signal intensity in T1 W Image



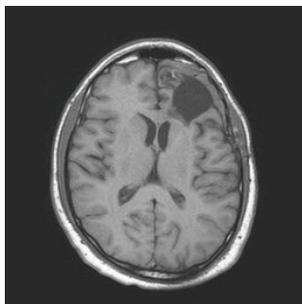
T2_WI_pre_op (B)
Left frontal lobe mass lesion showed high signal intensities in T2 W Image.



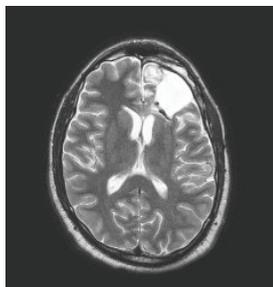
Post_Gad_T1_WI_pre_op (C)
Left frontal lobe mass showed inhomogeneous enhancement and necrotic area in Post Gad T1 W image

Fig. 6b

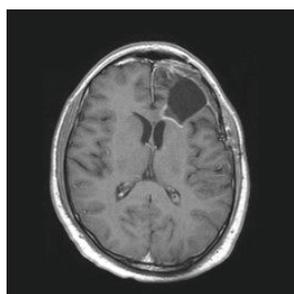
Post Operative: Left frontal surgical cavity (Encephalomalacia) at previously removed frontal lobe mass in post GAD T1 WI with minimal linear enhancement representing reactive enhancement with no residual mass.



T1_WI_post_op (D)
Left frontal surgical cavity (Encephalomalacia) at previously removed frontal lobe mass showed low signal intensity (CSF intensity) in T1 W image



T2_WI_post_op (E)
Left frontal surgical cavity (Encephalomalacia) at previously removed frontal lobe mass showed high signal intensity (CSF intensity) in T2 W image



Post_Gad_T1_WI_post_op (F)
Left frontal surgical cavity (Encephalomalacia) at previously removed frontal lobe mass with minimal linear enhancement in post GAD T1 WI represent reactive enhancement without residual mass.

Fig. 6

iMRI images with radiologist's report

Patient before entering the MRI tube should wear ear plugs to protect his ears from the noise. Also the head would be covered by head shield coil to protect it from all possible contact inside the tube or incidental projectiles.

The patient was planned for three iMRI sessions and he was prepared this way each time.

Care was critically applied when the operating table top was moved to and from the MRI tube.

Duration of the procedure: It took six hours operation and mapping, and three hours iMRI sessions

Speech-Language pathologist's role in Awake Brain Mapping of Dominant hemisphere protocol followed in this case

Pre-Operative language assessment:

Within the same week of surgery, a full language and cognitive-linguistic assessments were done. Additionally, a trial of intra-operative assessment using pictures naming task (50 pictures or more) was done the same day. Patient presented with normal receptive and expressive language skills along with a normal cognitive-linguistics skills. Results were documented as patient's pre-operative baseline. After that patient was counseled regarding the intra-operative assessment that he will undergo.

Intra-operative language assessment:

Speech-language pathologists attended the surgery after the bone flap for the sensorimotor mapping. Speech-language pathologist arranged with the neurophysiologists and neurosurgeons regarding the timing and type of stimulation. The patient was asked to perform counting (regularly from 1 to 10 over and over) and provide naming (preceded by the carrier phrase "this is a....."). The two tasks were used to identify the essential language sites known to be inhibited by stimulation. (SLPs were observing for any disturbance in language functions during the stimulations and alerting the surgeon to it). During the tumor resection, patient continued to count and/or name pictures when the resection became closer to the subcortical language structures.

Post-operative language assessment:

The patient was assessed 2-days post surgery by the speech-language pathologist using the same language and cognitive-linguistics assessment tools that were used preoperatively. Assessment showed intact receptive and expressive language skills.

Discussion

The iMRI OT is newly established at KFMC²¹. Two years have passed and various difficult neurosurgical operations were performed with great success⁵. Awake craniotomy was done to benefit from intra-operative MRI and navigation facilities²¹. The surgeon would operate with advantage of dynamic imaging navigation allowing proper tumor tissue resection with elimination of brain tissue shift effect, which is experience in brain surgery. The updated pictures are projected on wall mounted huge screen

and satellite screens in front of the eye of the surgeon and his assistants²¹.

Surgical team operate outside the effect of MRI influence put again they should observe MRI compatibility code.

Operating inside this environment necessitate adaptation of MRI compatibility and other anesthesia technique adjustments [Table 1, 2].

Awake craniotomy for seizure foci resection is currently popular since it allows a complete resolution of seizures foci without increasing neurological deficit¹⁷⁻²⁰. This requires “asleep, awake, asleep” anesthesia technique to keep an awake, comfortable patient who cooperates with intra-operative testing.

Anesthetic drugs are selected according to their short half-lives and ease of titration. Propofol and fentanyl were selected in this case in accordance of reported success in literature¹⁷⁻²⁰.

Table 1
Issues of concern to anesthesia staff in iMRI OT

Issues	Anaesthetic Considerations
Ferromagnetic Objects	Implant devices: Aneurismal clips. Prosthetic heart valves. Tissue expanders with metallic ports. Cardiac pacemakers. Also antable defibrillators/cardioverters and implantable infusion pumps. Metallic based substancespens, key chains, scissors, stethoscope, non lithium batteries etc.
Noise	It comes from scanner due to torque of wire have gradient currents induced in them during RF pulses. This cause vibration and audible noise.
Occupational Exposure	There are no reports of harmful tissue contact with the magnetic fields.
Anaesthesia Machines Ventillators	Safety. Proper functioning in the magnetic field. No effect on MRI image quality.
ECG Monitor	can cause image degradation of MRI scans from the wire leads acting as antennas.
Pulse Oximetry	Burn to finger.
Blood Pressure Monitoring	Adjustment and MRI compatible measuring screens. Some irregular measurements transmission.

Mohammad Bilal Delvi et al, *MEJ ANESTH*, 19 (1), 2007 [21].

Table 2
The key components of the BrainSuite® iMRI

1. **Navigation System. Automatic Image Registration** Vector Vision software.
2. **Microscope** Zeiss OPMI Neuro NC4 MultiVision.
3. **Data Billboard** BrainSuite and Data Management System.
4. **BrainSuite iMRI** system: high-field MRI scanner (1.5 Tesla Siemens Magnetom Espree).
5. **Rotating Operating Room (OR) table** with integrated head clamp and coil.
6. **Operating room (OR) lights** with integrated video camera, ceiling supply unit, anesthesia equipment.
7. **BrainSuite iMRI** RF shielded OR cabin.

MSM Takrouri, *The Internet Journal of Health*, 2007 Volume 6 [22].

Using such drugs concurrently can cause powerful respiratory depression. Neuroanesthesia team should be vigilant for such events like: hypoventilation, apnea, and chest wall rigidity.

Several options are available for airway management during awake craniotomy including endotracheal intubation, LMA, nasal airway and non intubation technique preserving natural airway^{23,24}.

Adverse events during awake craniotomy can include nausea, intraoperative anxiety, seizures, and brain engorgement^{7,24}.

Nausea and/or vomiting may result in significant morbidity. We chose to reduce this risk, by administering ranitidine, ondansetron, metoclopramide, dexamethasone, and glycopyrrolate.

Appropriate patient selection is critical to success. In this case it was an ideal patient for the technique. Nevertheless a detailed pre-operative explanation of the anesthesia plan was important for operators to go ahead. Our efforts focus on reassure the patient followed by supplements of sedo-analgesics regimen and we explained, to the patient, that there would be no pain when he will be subjected to testing. Intraoperative urgent intubation is technically difficult and slow to secure, in case of seizures, should be in the mind of anesthesia team. Although, it did not happen in this case, the plan for its control swiftly should be in mind i.e. surgeon’s application of ice water irrigation

and discontinuation of stimulation., anticonvulsants intravenously and if respiratory instability occur, intubation and controlled ventilation.

In conclusion, a careful approach by supporting psychological aspect and motivation of the patient in order to tolerate the procedure the current analgesia and anesthesia techniques during awake craniotomy can be adjusted quickly to the benefit to a controlled operative time, this case may open the field to operate on co-operative patient.

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