Research Article

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Challenges in Awake Craniotomy for Intrinsic Brain Tumors in Eloquent Cortex

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Abstract

Introduction: *Surgical treatment of brain tumors in the eloquent areas has high risk of functional impairment like speech or motor. These tumors represent a unique challenge as most of the patients have a higher risk of treatment related complications. A wake craniotomy is a useful surgical approach to help to identify and preserve functional areas in the brain and maximizes tumor removal and minimizes complications.*

Methods: *Selected patients admitted with intrinsic brain tumor between from July, 2011 to August, 2016 in the eloquent area of brain like speech or motor area were chosen for awake craniotomy. A retrospective analysis was done. A preoperative assessment was also done. These patients were presented with seizure and or progressive neurological deficit like speech or motor. A standard anesthesia monitoring was done during surgery. Long acting local anesthesia (Bupivacaine) was used for scalp block. The surgeries were performed in a state of asleep-awake-asleep pattern, keeping the patients fully awake during tumor removal. Propofol and Fentanyl was used as anesthetic agents which was completely withdrawn prior to tumor removal. The speech and motor functions were closely monitored clinically by verbal commands during tumor resection. No brain mapping was performed due to lack of resources. All patients underwent noncontrast computed tomogram head in the first post-operative day.*

Results: *A total of 35 patients were included in the study. The oldest patient was 55 years and youngest being 24 years (mean 36 years). 20 (57.14 %) were females and 15(42.85 %) males. 20 (57.14%) patients presented with predominantly seizure disorders and rest with progressive neurological deficit like speech or motor. 30 (85.71%) patients were discharged on second post-operative day. Complications were encountered in 4 (11.42 %) patients who developed brain swelling intraoperatively and 5(14.28 %) deteriorated neurologically in the immediate post-operative period however managed successfully and discharged in a week's time. 5(14.28%) patients require ICU/ HDU care for different reasons. There was no mortality during the hospital stay. Histopathology revealed 25 (71.42 %) patients as low grade glioma, 8 (22.85%) as high grade glioma and 2 (5.71%) of them were metastases.*

Conclusion: *A wake Craniotomy is a safe surgical management for intrinsic brain tumors in the eloquent cortex although surgery and anesthesia is a challenge. It offers great advantage towards disease outcome. However long follow up and more studies are required.*

Keywords: Awake Craniotomy, Eloquent Areas, Intrinsic Brain Tumor, Operative Techniques

Introduction

Resection of brain tumor in the eloquent cortex always carries a high risk of potential impairment of speech, motor or sensory system. Overcautious surgery causes inadequate tumor removal whereas aggressive removal may cause irreversible neurological deficit to the patient. To overcome the risk a wake craniotomy has been proposed as surgical technique to facilitate maximum tumor removal with minimum neurological impairment. There is evidence that aggressive tumor removal improves disease free progression and life expectancy. Although awake craniotomy had been tried in the nineteenth century for epilepsy under local anesthesia but it did not gain popularity due to lack of advancement of anesthetic and surgical procedure. Due to progressive advancement in facilities the same old awake craniotomy has been revitalized to the present form [1].

Methods

A careful preoperative evaluation is mandatory for a wake craniotomy. The patients were evaluated in terms of medical co-morbidities, age, background, neurological status and possible cooperation during surgery. The neurosurgeon and the anesthetists explained the necessity of a wake surgery and expectations from the patients during the surgery. Patients were informed about potential risks, safety measures and stages of the procedure. Preoperative evaluation encompassed a complete clinical examination. Evaluation must include upper airway, epilepsy, degree of raised intracranial hypertension, nausea and vomiting, hemorrhagic risk and degree of co operation and tolerance. Patients with history of sleep apnea are a contraindication for the surgery. Profound dysphasia and confusion is a contra indication for a wake surgery [2].Obesity is also a relative contraindication of surgery. Raised intracranial tension should be taken seriously as intraoperative brain swelling is difficult to control with spontaneous breathing.

All patients underwent MRI brain with or without Gadolinium as a part of investigations. A baseline blood investigations, X-ray chest and ECG was done for all patients. The anesthetic management for the surgery included sedation, analgesia, hemodynamic control and well responsive co-operative behavior during the tumor removal. No premedication drug was prescribed except acid reflux prophylaxis, steroids, anticonvulsants and medication for medical co morbidities like hypertension. A prophylactic antibiotic was administered in all patients just before the skin incision. In the surgery a asleep-awake-asleep (A-A-A) pattern is followed keeping the patient fully awake during tumor removal. Standard anesthesia monitoring was done. A wide bore intravenous cannula and an arterial line was inserted .Foleys catheter was not used in any patients to avoid discomfort and judicious fluid intake was allowed. Mannitol was also avoided. Carbon dioxide monitoring was not done. Anesthetic drug was planned in such a way to maximize co operation from the patient. Also to prevent nausea and vomiting which may contribute raised ICP and hemodynamic stability. Short acting drugs are used for acute control of sensorium. Sedation was performed using Fentanyl 100-200 microgram and Propofol 20-50 mg Intravenous bolus and then infusion at the rate of 1.5 -3 mg/kg body weight / hour. Oxygen saturation was maintained 95 % or above. Due to lack of resources cortical mapping was not performed in any patients. So the patients were kept awake during the entire period of tumor removal.

Following the intravenous access and standard anesthesia monitoring patients head was rested in a head ring or horse shoe. Three pin fixations were not done in any case. After sedation was administered scalp block was done meticulously. A local anesthesia was performed using Bupivacaine (0.25 % - 0.5 %) with or without Epinephrine in 1:200000 concentration about 10 minutes prior to skin incision .Local anesthesia used in the anatomical sites of the seven nerves on either sides and in the surgical incision site. Supra-orbital, supra-trochlear, lesser and greater occipital, zygomatico- temporal and auriculotemporal nerves were blocked. Anaesthetist was vigilant to rule out complications of local anesthesia. Patient tolerance of an awake craniotomy relies on effective analgesia of the surgical field. Endo tracheal tubes or Laryngeal masks were not used in any patients. Sedation was continued till opening of the dura and thereafter all sedations were withdrawn. The tumor was removed keeping the patient fully conscious performing tasks on commands like motor movements or speech. This was monitored by anesthetist and neurosurgeon. Following tumor removal patients were sedated. Closure of duramater, bone flap and skin was performed under sedation. As a routine no patient was intended to keep in ICU unless there were intraoperative complications. Patients were shifted to neurosurgery ward or high dependency unit. Non contrasts computed tomograms were performed for all patients on first post-operative day.

Results

A total of 35 patients were included in the study. The oldest patient was 55 years and youngest being 24 years (mean 36 years). There was female dominance in this series.20 (57.14 %) were females and 15 (42.85 %) males. 20 (57.14%) patients presented with predominantly progressive seizure disorders and rest with progressive neurological deficit like speech or motor. Following surgery 30 (85.71%) patients were discharged on second post-operative day. Complications were encountered in 4 (11.42 %) patients who developed brain swelling intraoperatively and 5 (14.28 %) patients deteriorated neurologically in the immediate post-operative period. These patients deteriorated in terms of dysphasia or hemiparesis. However managed successfully and discharged in a week's time. 5 (14.28%) patients require ICU/ HDU care for different reasons like intraoperative complications. There was no mortality during the hospital stay. Histopathology revealed 25 (71.42 %) patients low grade glioma, Grade II, 8 (22.85%) high grade glioma, Grade III and IV and 2 (5.71%) metastases.

Discussion

Awake craniotomy is indicated mostly for supratentorial lesions within eloquent regions of the brain like the sensori-motor cortex and the language areas. Some of the earlier reports of awake craniotomy include surgeries for seziures and supratentorial lesions [3,4]. Awake craniotomy has been recommended for better resection of grade 2 (low grade) gliomas [5]. Patients with eloquent region tumors first undergo preoperative functional brain-imaging techniques, like positron emission tomography (PET), functional magnetic resonance imaging (fMRI), or magneto encephalo graphy (MEG) and the eloquent areas are mapped. This in turn is combined with frameless navigation system and matched with a preoperative 3D-MRI using an automatic image-fusion algorithm for guidance to tumors within eloquent areas. A combination of these techniques has been shown to be useful for radical resection of such tumors [6,7].Intraoperative language maps are different for well circumscribed lesions as compared to diffusely infiltrating ones [8]. The cortical sites for languages varied on comparing functional with electrical stimulation [9].The reliability of preoperative brain mapping with functional MRI is undergoing constant improvement [10].

Preoperatively, intraoperative electrical stimulation is used to identify eloquent areas before proceeding with tumor resection. Neural navigation combined with functional MRI mapping, intraoperative electrical stimulation along with clinical monitoring of brain functions helps in defining the path of dissection with minimal functional damage to brain thereby preserving brain tissue while at the same time allowing wider resection of lesion. This is particularly useful for preserving language function in tumors involving the language areas [11]. It has been shown that gross total resection is achieved in almost 57% of patients using these techniques in tumors of eloquent areas [12].Most of the techniques like functional MRI preoperatively combined with intraoperative electrical stimulation are expensive and time consuming. In many instances the functional mapping of MRI of the eloquent areas can vary in different verbal tasks done over three different sessions. Studies have shown that the reproducibility of functional MRI brain mapping for language within subject varies as a function of the activation task and the region of interest for language [13]. Studies have also shown that mapping identified eloquent cortex in only 22.5% of patients [14]. Elaborate cortical mapping techniques does not necessarily guarantee reduced postoperative deficits in eloquent area tumor resections [15]. Also the "brain shift" which occurs in the craniotomy can not only interfere with ideal results but can be dangerous in eloquent area tumor resections [16].

A wake craniotomy is being increasingly used at our center for intrinsic brain tumors in the region of eloquent areas. This is a single surgeon's experience and a retrospective study it has been shown that using a wake craniotomy techniques the tumor resection is more aggressive and safer. At our center, the surgeries were performed in the state of asleep- awake- asleep technique (AAA) using appropriate short acting mild sedation and ensuring patient is fully awake and cooperative enough during the procedure using monitored anesthesia care (MAC) techniques. We did not use functional MRI mapping or intraoperative cortical stimulation mapping. Clinical monitoring of limb function and language monitoring was continuously done during tumor resection while the patient is kept awake during the surgery under local anesthetic using bipolar stiumulation and observing for functional defects. This technique has been demonstrated to be useful in aggressive resection of gliomas without language deficits [17].Functional brain tissue can be found within the tumors and hence brain stimulation is more reliable in reducing functional morbidity [18].

However this poses a challenge for the patient, anesthetist and surgeon. The patients are chosen carefully after fully explaining the procedure and their consent is required. Important patient factors like level of consciousness, hypertension, recurrent seizures, respiratory disease, anxiety, effects of raised intracranial pressure all influence patient selection.

The anesthetist also focuses more on maintaining a good airway as all cases at our center are done without endotracheal intubation. The need for converting an a wake craniotomy under nasal oxygen and mild sedation to oral intubation has to be next to negligent and also the anesthetist should be confident on maintaining adequate airway with minimal sedation, ensuring patient cooperation during the procedure. The patient is kept alert enough to cooperate in the neurological assessment during the surgery using smart anesthesia techniques including short acting anesthetics like fentanyl and propofol. The anesthetists assess the risk of aspiration, apnea, difficult airways (in case a patient needs emergency intubation during the procedure), pain tolerance and most importantly the degree of cooperation of the patient before giving the go ahead for awake craniotomy. In most awake craniotomies, airway is secured with either a laryngeal mask or endotracheal intubation. However in our series, all 35 patients were carefully chosen and airway maintained with nasal oxygen only. The bipolar cauterisation is kept to a minimal and the craniotomy is minimalistic using high speed drills.

The dura is incised and once the cortex is exposed, the patient is woken up from sedation by withdrawing the sedation. All patients are loaded with appropriate anticonvulsants and steroids to reduce any brain swelling. Mannitol is used as a standby is some cases. All parameters are constantly monitored ensuring normal blood pressure levels and oxygen saturation levels. Once the anesthetist is comfortable, we use bipolar cortical stimulation to stimulate the cortex of the eloquent areas and elicit motor, sensory or verbal response from the patients in their local lingo. After ensuring that our MRI location matches with the surgical location, we prefer trans-sulcal approaches to below cortex lesions. In instances where there is cortical discoloration suggestive of lesion, the dissection is easier with the neurological assessment. The assessments are done periodically both by anesthetist and surgeon during tumor resection and is terminated in case of patient discomfort, speech disturbance, paraesthesia in limbs or any minimal limb weakness.

In our series, we had brain swelling in 4 (11.42%) during the procedure and the surgery was terminated. In 5 patinets (14.28%) we observed neurological deterioration in the immediate post-operative period which was managed with antiedema measures. Five patients (14.28%) required slightly prolonged intensive care due to other co-morbidities, but all were mzanaged successfully and discharged within 7 days. Others have reported peroperative complications like hypertension, seizures, brain swelling and apnea and cough [19].

Histopathology revealed that in 25 patients (71.42%) patients had low grade glioma, 8 patients (22.85%) had high grade glioma and 2 patients (5.71%) had metastases. We have shown that awake craniotomy is safe and feasible for the surgical management of brain tumors in eloquent areas and recommend its use for all supratentorial lesions where indicated. Awake craniotomy and has been shown to be safe in supratentorial tumor resections [14]. A surgery for lesions in the left dominant inferior parietal lobule is challenging due to both sensorimotor and language areas and that a wake craniotomy with cortical stimulation is the safer practice in these lesions [5]. In patients with low grade gliomas, it is important to use a wake craniotomy with electrical stimulation in order to improve the extent of resection without neurological deficit, maintaining a good "onco-functional" balance [20]. The limitation of this study is it is retrospective study. To overcome this patient whose complete data available are incorporated in this study. Another limitations of this study we do not very large number of patients.

Conclusion

A wake craniotomy is a safe and effective operative method for tumor nestled close to the eloquent area of the brain. Though there are many challenges both to the surgeon and anesthetist, the minimal risk of anesthesia, minimal or no functional damage, better resection, short hospital stay and rapid recovery provides a great advantage for better patient outcomes. Long term follow up with close look at recurrence are showing improved results but need to be studied further.

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