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ORIGINAL ARTICLE

Surgical Outcome of Perirolandic Gliomas Resection using Pre and Intraoperative Brain Mapping Techniques

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ABSTRACT

Background: Surgical removal of perirolandicgliomatumours aims at maximal tumor resection while preserving motor function. The potential benefit of resection using pre and intraoperative brain mapping techniques either under awake craniotomy or general anesthesia (GA) for motor preservation is yet unidentified.

Objective: To evaluate the clinical outcomes of patients who underwent surgery for perirolandicgliomas while either awake or under GA.

Methods: We evaluated 24 patients in the period between 2017 and 2019, had undergone resection of hemispheric perirolandicgliomas within or adjacent to descending motor pathways, preoperative brain mapping with functional MRI (FMRI) and Diffuse Tensor Imaging (DTI) and intraoperative mapping with direct cortical subcortical stimulation for awake craniotomy cases or transcorical/subcortical motor evoked potential (TcMEP,TscMEP) Neuromonitoring for G.A cases.

Results: Results showing that with direct cortical subcortical stimulation for both awake and general anaesthetized craniotomy achieved gross total resection in 45.7%, and study technique was associated with early postoperative new or worsened deficit in (29.2%) which remained permanent after 3 months in only in (8.3%).

Conclusions: Brain mapping allows surgeons to identify the descending motor pathways during resection of tumors in perirolandic regions and to attain an acceptable rate of morbidity in these high-risk cases.

Keywords: Brain mapping, Awake craniotomy, Electrophysiological monitoring, Motor function

INTRODUCTION

Gliomas around or within the motor cortex represents a great challenge for neurosurgeons, due to its surgical resection complexity. Preoperative work-up, diagnostic and preoperative mapping techniques, microsurgical skills and intraoperative stimulation and neuromonitoring are crucial for operating safely. Also multidisciplinary approach for surgical intervention is essential so to reach the best surgical outcome [(1)]

Surgery for intra-axial tumors around motor eloquent areas is troubled with the risk of worsening of motor function in the postoperative period. For the maximal extent of resection and minimal post- operative permanent neurological deficit, pre-operative brain mapping with functional MRI (fMRI), and diffuse tensor images (DTI) respectively,offer the opportunity to identify preoperatively the location of functional sites at cortical subcortical tracts levels [(2)].

A craniotomy with direct cortical/subcortical electrical stimulation either awake or under general anesthesia (GA) presents two approaches for removing the perirolandic region gliomasintraoperatively[(2)(3)].

Nowadays for the maximal extent of resection and for better functional outcomes during surgical management of peri-rolandicglioma, neurosurgeons prefer using pre-and intra-operative brain mapping techniques.[(2,3,4,5)]

MATERIAL AND METHODS:

A prospective study of 24 cases with gliomas in/adjacent to sensori- motor areas treated in Neurosurgery department, Zagazig University Hospitals, Egypt during two years duration (from March 2017 to March 2019) for evaluation of the surgical outcome with pre and intra intraoperative brain mapping techniques. Patients were assigned

to undergo craniotomy while awake or under GA according to the inclusion and exclusion criteria.Written informed consent was obtained from all participants and the study was approved by the research ethical committee of faculty of medicine Zagazig University. The work has been carried out in accordance with the code of Ethics of the world medical association (Declaration of Helsinki) for studies involving humans.

Inclusion criteria:

All patients admitted to our department during the study period, with peri-rolandicglioma (3cm anterior or posterior to the motor cortex) suspected by pre-operative imaging and proved by post-operative histopathological examination.

Patients with the following inclusion criteria will be operated under Awake craniotomy, with intraoperative cortical and subcortical stimulation technique, age >12<70 years old, and stable cardiopulmonary. Fluent in speaking and understanding without preoperative cognitive impairment Mini Mental State Examination (MMSE more than 24). Don ‘t show severe anxiety or emotional instabilityState-Trait Anxiety Inventory (STAI score less than 55), patient is accepting and understanding the technique and the type of procedure. If patient doesn’t meet this criteria, will be operated under GA Total Intravenous Anaesthesia (TIVA) protocol, with intraoperative direct cortical subcortical MEP (motor evoked potential) neuromonitoring.

Exclusion criteria:

Patients with severe motor deficit despite preoperative trial of dexamethasone and mannitol therapy (less than grade 3 according tomedical research council (MRC Scale).Patients withGlasgow Coma Scale (GCS) score less than 13, and need emergency intervention.Patients with multiple lesions or proved not to be glioma post-operatively.Patient refuse to give consent to participate in the study.

Clinical Characteristics

The medical records of the study patients were reviewed to collect data on demographics, comorbidities, presenting symptoms, preoperative neurological examination, operative course, intraoperative electrophysiological mapping and monitoring values, immediate and late postoperative neurological status, length of stay (LOS), and volumetric image analysis of pre- and postoperative magnetic resonance imaging (MRI) studies. The Karnofsky Performance Scale (KPS) was used to assess preoperative and postoperative functional status. Pathology was determined according to the World Health Organization (WHO 2016) criteria. Muscle strength score on a scale of 0 to 5/5 was based on the physical examination data. Each patient’s postoperative outcome within 3 mo after surgery was recorded and classified as immediate (within 3 d) and late (3 mo postoperatively) symptoms. Electrophysiological mapping and monitoring data included the minimal electrical current needed to elicit motor (direct cortical motor evoked potential [dcMEP] threshold) or for estimation of proximity to the subcortical pyramidal structures (subcortical motor evoked potential [scMEP] threshold).

Intra-operative anaesthetic protocol:

For awake cases. Awake craniotomy under local anaesthesia and monitored conscious sedation protocol was used. The patient is comfortably positioned with a neck support, a pillow under the knee, and a warm-air blanket (3M Corp.) was used to keep the patient warm to avoid shivering and allow for an optimal patient temperature between 36.0° and 37.0°C for mapping. The electrocardiogram, oxygen saturation and direct arterial pressure were monitored continuously and oxygen (2 L /min) was administered through a nasal canula. After securing intravenous access, antiemetic was given, then intravenous midazolam (1–2 mg) and fentanyl (50–100 mcg) were administered to tolerate the circumferential scalp block requiring multiple injections. Circumferential scalp block was then reinforced with a field block in the region of the incision.

The goal formonitored anaesthesia care(MAC) sedation is to provide a safe level of sedation under spontaneous respiration, while adequately controlling anxiety and pain from the surgical procedure. Typical agents used for sedation are infusions of propofol or dexmedetomidine, plus fentanyl.The sedation was reduced or stopped approximately 15–30 min prior to testing according to the depth of sedation. At the completion of brain mapping or surgical resection, the sedation regimen was resumed or deepened during closure.

For asleep cases (TIVA protocol).The primary anaesthetic concern with patients undergoing general anaesthesia is the avoidance of halogenated inhaled anaesthetic agents, which can increase the latency and decrease the amplitude of evoked potentials. Total intravenous anaesthesia (TIVA) using a combination of amnestic/hypnotic and analgesic agents is the common method of inducing and maintaining general anaesthesia without the use of inhalational agents. Low to moderate dose propofol or dexmedetomidine, used separately or in combination is typically used. Additionally. Propofol TIVA without the addition of narcotics, which can cause respiratory depression. The sedation was reduced or stopped approximately 15–30 min prior to testing

according to the depth of sedation. At the completion of brain mapping or surgical resection, the sedation regimen was resumed or deepened during closure.

Intraoperative brain mapping technique:

Surgical position and approach was according to a careful and concise preoperative surgical planning, assessment of the preoperative imaging and functional tests, our anatomic basic knowledge and most important patient comfort. General rules for a good position and surgical approach were employed as facilitating the venous return, the patient´s limbs were not forced, an optimal angle and vision of the field for the surgeon and good space for all the neurosurgical team. All care was employed to ensure that the patient is as comfortable as possible. A rigid head fixation with pins (Mayfield- skull clamp, schaerer, Mayfield USA, Inc.) was used after administration of a local anaesthetic (in awake cases) or after TIVA in G.A cases, especially when optical computer aided navigation was used (Brainlab curve navigation system, Brainlab AG). Avoidance of rigid pin fixation and using horse shoe headrest was used in some cases either awake or asleep according to the protocol described by (Morsy, Ng; 2015)[(4)].For more patient comfort and safer airway.

For awake cases; A bipolar stimulator with the tips 5mm apart was used (ISIS, IOM system, INOMED, Inc) 50-60Hz constant current biphasic square wave and duration of (1-2s) per stimulation were used. Stimulation was started with 2mA increased to a maximum (6-10) mA until motor function was established then sterile numbered tickets marked cortical areas of positive response. While cortical mapping, stimulation of motor areas induced either contralateral involuntary movement of the face, arm or leg or impaired motor function during active movement by the patient. Parasthesia of the face, trunk, arm or leg was reported on primary sensory area stimulation. For subcortical stimulation; same stimulation parameter were used with the same motor or sensory responses according to the lesion site and its relation the white matter tracts. Subcortical stimulation was started when the resection was carried to the depth on level with the bottom of sulcus, serial subcortical stimulation was performed with each advancing 2-3mm of resection.

For patients underwent surgery under G.A (TIVA protocol) Motor evoked potentials, phase reversals were attached to the patients prior to surgery, stimulation was started with 4 mA increased to 20 mA increased to 20 mA maximum, A side from equipment and parameters for stimulation, there were no additional equipment or surgical differences between awake or asleep cases.

Microsurgical resection:

The microsurgical resections were performed using standard techniques and instruments. Intraoperative navigation system was used, plus intraoperative ultrasonography (IOUS) (EUB-405 plus ultrasound scanner, HITACHI) was used in all cases for locating the lesions, choosing the shortest route, defining their margins and evaluating the extent of resection. Once the mapping phase had been done, the area of cortical resection was then outlined. The main aim in all cases was maximal resection with minimal neurological deficit. The tumour boundary close to the eloquent areas was kept to be resected last, during the resection, continuous examination of motor during resection. If impairment occurred, the resection would be stopped and motor functions were re-assessed. If the impairment was confirmed and did not improve within 5 minutes (and other factors of impairment had been excluded) the resection would not be resumed. If the impairment subsided, however, continuation or termination of the resection was dependent on surgical goals, nature of deficit and prior discussion with the patient.

Quantitative assessment of extent of resection:

Early postoperative MRI (with standard sequences, for example, T1, T1 - contrast, T2, FLAIR, DWI) was performed in all cases within 72h and at 3months follow up to document the extent of resection and identify any complication as haemorrhage, oedema, or infarction. The extent of tumour resection (EOR) was calculated using (3D Slicer version 4 software , BWH and 3D Slicer contributors) and was graded as follows:1- gross total resection (GTR) indicated more than 98 % resection of the enhancing mass in enhancing tumours as high grade gliomas, or high-signal lesion in T2/FLAIR in non-enhancing lesions as low-grade gliomas; 2-near total resection when there was more than 90% resection, 3-subtotal resection (STR) when there was 50 to 90% resection, and 4- partial resection (PR) when it was less than 50%.

Statistical analysis:

Data collected throughout history, basic clinical examination, laboratory investigations and outcome measures coded, entered and analyzed using Microsoft Excel software. Data were then imported into Statistical Package for the Social Sciences (SPSS version 20.0) (Statistical Package for the Social Sciences) software for analysis. According to the type of data qualitative represent as number and percentage, quantitative continues group represent by mean ± SD, the following tests were used to test differences for significance; difference and association of qualitative variable paired by Mac Nemmar. Differences between

quantitative paired groups by paired t test. P value was set at <0.05 for significant results &<0.001 for high significant result.

(Table1):Demographic analysis of Age, Sex, and clinical characteristic of studied group: (N=24)

24 patients were included in our study, 14 (58.33 %) were male and 10 (41.67%) were female, mean age was 37.2±12.2 years ranging from 12-61 years old, all cases had tumours in relation with eloquent motor cortex, also our

(Table2). Tumor Characteristic of 24 patients underwent a surgical resection of glioma tumours within or adjacent to motor pathways with electrophysiological monitoring, 2017-2019

Study reported majority of the cases (37.5 %) were glioblastoma G (IV) on histopathological grading.

(Table3).Postoperative outcome of 24 patients underwent a surgical resection of glioma tumors within or adjacent to motor pathways with electrophysiological monitoring, 2017-20119

Only 1(4.1%) case of them was permanent at 3 months follow up(sig p-value0.050**).

(Table4).Volumetric analysis of tumors of 85 patients underwent a surgical resection of glioma tumors within or adjacent to motor pathways with electrophysiological monitoring, 2017-2019

The mean extent of resection for the GA group was 79.6% and 86.3% for the AC group (P = .136).5 cases (20.8%) cases had intraoperative.

(Table5). Intraoperative characteristics of 24 patients underwent a surgical resection of glioma tumors within or adjacent to motor pathways with electrophysiological monitoring, 2017-2019

Intensity needed to evoke responses from the motor cortex (dcMEP threshold) was significantly lower than the intensity in the GA patients (**5.2±0.96** vs**12.1±2.7** mA, respectively,***P* = .0001**; Table 5). There was no significant group difference regarding the lowest subcortical motor threshold (min scrtMEP) used to assess the proximity of the tumor to the corticosponal tracts (9.9 ± 6.5 mA for the awake group and 12 ± 7 mA for the GA group, ***P* = .19**).

Case presentation

Male patient 34y old operated with intraoperative assessment of motor power while patient is awake for. (Zagazig University Hospital).**figure1**

-12 years old female, operated with intraoperative identification of motor cortical/ subcortical pathway (intraoperative MEP neuromonitoring under TIVA protocol). **Figure2**

Table 1: Demographic and Clinical Characteristic of 24 Patients Underwent a Surgical Resection of glioma tumor Within or Adjacent to Motor Pathways With Electrophysiological Monitoring 2017-2019

Age	**Mean± SD**	**37.2±12.2**	**Median (Range)**	**36.0 (12-61)**
Sex	female	10 (41.67%)	male	14 (58.33%)
Co-morbidities	N	%	Symptoms	N/ %
Diabetes mellitus	4	16.67%	Headache	18 (75%)
Hypertension	5	20.83%	Seizure	16 (66.66%)
Ischemic heart diseases	1	4.2%	Motor weakness	15 (62.5%)
Obstructive/restrictive airway diseases	1	4.2%	Sensory	8 (33.33%)
			Dysarthria/ dysphagia/ gait difficulties/ cognitive/ visual	15 (62.5%)
Preoperative GCS score and KPS score	Median	15	80± 8.6SD	
Preoperative motor power assessment	Right side deficit	6 (25%)	Left side deficit	9 (75%)

Table 2: Tumor Characteristic of 24 Patients Underwent a Surgical Resection of glioma Tumors Within or Adjacent to Motor Pathways With Electrophysiological Monitoring, 2017-2019

Tumor side	**Right side**	**15 (62.5%)**	**Left side**	**9(37.5%)**
Preoperative tumor volume cm3	Mean ±SD	39.4±12.2		
Tumour volume(cm3)	No	%		
Up to 20 cm3	2	8.33%		
>20 – 40 cm3	15	62.5%		

Tumor side	Right side	15 (62.5%)	Left side	9(37.5%)
>40 – 60 cm3		4	16.66%	
>60 – 80 cm3		3	12.5%	
Tumor pathology			N	%
		Glioblastoma	9	37.5
		Anaplastic astro	4	16.66
		Anaplastic oligod	1	4.6
		Pleomorphic xanth	1	4.6
		Fibrillary astr	6	25
		Gemistocytic	2	8.3
		Oligodendroglipma	1	4.1

Table 3: Intraoperative Characteristics of 24 Patients Underwent a Surgical Resection of glioma Tumors Within or Adjacent to Motor Pathways With Electrophysiological Monitoring, 2017-2019

	All =24 mean ±SD	Awake N =15	G.A+ TcMEP. TscMEP N=9	p-value
TcMEP threshold mA.	7.67±1.77	5.2±0.96	12.1±2.7	0.001
Minimum TscMEP threshold mA.	11.0± 1.62	9.9 ± 6.5	12.0 ± 7.0	0.19
Intraoperative induced seizure	5(20.8%)	2 (33.3%)	3 (13.3%)	0.24
Operative time	All (N=24)	Awake N =15	G.A+ TcMEP. TscMEP N=9	p-value
mean/SD (min).	276±24.5	268±35.6	265±27.5	0.67

Insignificant p-value >0.05. Significant p-value <0.05

Table 4: Postoperative Outcome of 24 Patients Underwent a Surgical Resection of glioma Tumors Within or Adjacent to Motor Pathways With Electrophysiological Monitoring, 2017-20119

Hospital stay (days) mean/SD	All (N=24) 3.66±2.74	Awake (2± 2.7)	G.A 5±2.7	P-value 0.24
ICU stays (hrs.) mean/SD	All (N=24)16.12±9.23	Awake (8.4±9.23)	G.A 19.12±9.23	P-value 0.24
Early Postoperative symptoms (3 days)		p-value		
Motor deficit	7 (29.17%)	0.52		
Sensory impairment	1 (4.2%)	.61		
Visual/cognitive/urinary	0 (0%)			
Hematoma/infection/CSF leak	6 (25%)	.61		
KPS score	80± 10.7SD	0.70		
High ICP/ headache	1 (4.2%)	.4		
Seizures	6 (25%)	0.61		
Systemic complications	4 (16.7%)	.22		
late Postoperative symptoms (3 months)	2 (8.3%)	0.050**		
motor deficit	0 (0%)			
Sensory impairment	0 (0%)			
Seizures	0 (0%)			
Visual/cognitive/urinary	95.5 ± 10.7SD	.46		
KPS score	0 (0%)			
High ICP/ headach				

Insignificant p-value >0.05. Significant p-value <0.**05**

Table 5: postoperative Volumetric Analysis of Tumors of 85 Patients Underwent a Surgical Resection of glioma Tumors Within or Adjacent to Motor Pathways With Electrophysiological Monitoring, 2017-2019

Extent of resection Mean (range) 94.3% (65.3-100)	All(N=24)	Awake N =15	G.A+ TcMEP. TscMEP N=9	P value
GTR> 98%	11(45.83%)	8(53.3%)	3(33.33%)	0.595
NTR>90-98%	8(33.33%)	4(27%)	4(44.44%)	
STR 50-90%	5(20.8%)	3(20%)	2(22.22%)	
PR < 50%	0	0	0	

Insignificant p-value >0.05. Significant p-value <0.05

Figure 1

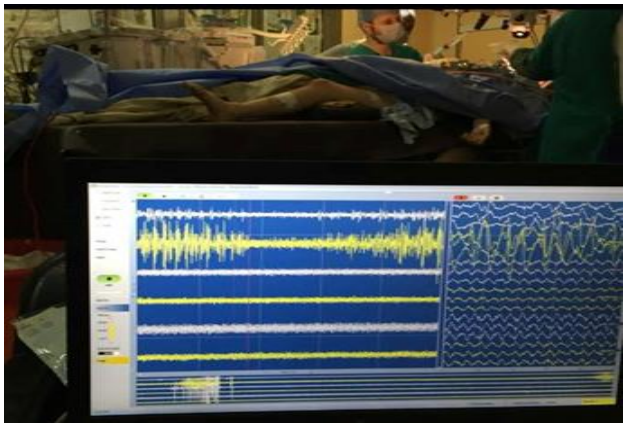

Figure 2

DISCUSSION

Regarding motor function changes of 15 (62.5%) cases preoperatively presented with motor deficit, 11 (45.9%) cases improved or still at the baseline (p= 0.00**). and from 9 (37.5%) cases with preoperative intact motor system 3 (12.5%) cases developed a new deficit only 1(4.1%) case of them was permanent at 3 months follow up. This was in keeping with literature as most reports have indicated a range (4% to 32%) of early postoperative neurological deficit after perirolandicgliomas resection.

In comparison to recent study by **Moiyadi et al,.**[5] Thirty patients remained stable (n ¼ 23) or improved (n ¼ 7) postoperatively. Neurologic worsening occurred in 10 patients (25%). Of the 9 patients with immediate neurologic worsening, 6 recovered by the time of discharge (transient deficits, 60%) and the remaining 3 improved by 3 months (prolonged, 40%). One patient who was neurologically stable immediately postoperatively developed gradual worsening of motor power after 24 hours, which was prolonged and recovered by 3 months. There was no permanent neurologic deficit (persisting beyond 3 months) in any of the patients. And **Han et al.,**[6] reported a motor deficit was present in 89 patients (13%) prior to surgery. Subcortical stimulation mapping was performed in all patients, and subcortical motor tracts were successfully identified in 300 cases (43%). A total of 210 patients (30%) developed a new or worsened motor deficit within 24 hours after surgery. Of these patients, 161 (77%) recovered to normal or their preoperative baseline function by the 3rd postoperative month. The remaining 49 patients, representing 7.0% of the entire cohort, were considered to have a long-term deficit. Patients in whom the subcortical motor pathways were localized by stimulation mapping were more likely to develop a new or worsened motor deficit postoperatively than those in whom the subcortical mapping did not identify the pathway (45% vs 19%, respectively, p < 0.001).[17].[18].

In **Krainik et al**,.[8]Study, recovery of motor deficits developed after cerebral glioma surgery began 2-21 days after surgery (mean, 6.8 ± 5.9 days) and was complete between 30-120 days after surgery. That mean deficit persist more than 3 months usually considered as permanent deficit. .

Keles et al.,[9] Summarized the incidence of additional temporary and permanent motor deficits as they relate to intraoperative and histopathological findings, and the presence of a preoperative neurological deficit. Patients with identifiable subcortical pathways were more prone to experience an additional (temporary or permanent) motor deficit than those in whom subcortical pathways could not be identified

(27.5% compared with 13.1%, p = 0.003). This was also true when only additional (permanent) motor deficits lasting more than 3 months were considered (7.4% when subcortical pathways were found compared with 2.1% when subcortical pathways were not found; p = 0.041). Patients in whom a motor deficit was present before surgery were more likely to have an additional motor deficit postoperatively compared with those whose motor functions were intact (25.8% compared with 16.5%, p = 0.046). Therefore, these results indicate a 4.7-fold increase in the odds of a new temporary deficit in patients who had a preoperative deficit and in whom a subcortical pathway was found during surgery. For permanent motor deficits, the only statistically significant risk factor was presence of an identifiable subcortical site, which increased the risk 3.8 times (95% CI 1.02–13.81).[19].

Nearly the same finding reported by **Carrabba et al.,**[3] were motor strip was found in 133 patients 99% and subcortical motor tracts in 91 patients' 62.3%. New immediate postoperative motor deficit were documented in 95.3% of patients in whom a subcortical motor tract was identified intraoperatively and in 10.9% of those in whom subcortical tracts were not observed permanent deficit were observed in 6.5 and 3.5%, respectively.[20].

In our study, more motor deficit reported for G.A cases (TIVA protocol) with MEP neuromonitoring than those whom operated under awake craniotomy with DES (11.1% vs 6.67%) but it was statistically insignificant (p-0.703). The finding of higher cortical thresholds for the identification of the motor cortex in anaesthetized patients may suggest an inhibitory effect of anaesthetic agents on motor function. **Zelitzki et al.,**[9] for surgical removal of intra-axial brain tumours aims at maximal tumour resection while preserving function reported postoperative motor deficits were more common in the anaesthetized patients at 1 wk (P = .046), but no difference between the groups was detected at 3 mo.[21].

The delayed KPS mean was 80.4±6.2 (P = 0.72). Immediately after surgery on postoperative day 1, the study group was found to have a mean postoperative KPS of 78.9±4.7 (P = .705). This is was in keeping with the same literature by**Brennum et al.,**[1] reported the delayed KPS, obtained months after surgery, for the GA patients was 81.1±4.7 and for the AC patients was 93.3±4.7 (P = .040). The mean follow-up time for the delayed KPS was 3.9 months in the GA patients and 2.8 months for the AC patients (P = .172). Immediately after surgery on postoperative day 1, the GA study group was found to have a mean postoperative KPS of 77.4 and the AC patients KPS was 78.9 (P = .705). Similar results by Chambless, Lola B., et al (2015) [10] showed improvement in Karnofsky scores postoperatively, 116/183 patients (63.4%) same scores and 23/183 patients (12.6%) worse scores. Also by **McGirt, M. Jet al.,** [12] study, Karnofsky scores improved immediately and delayed after surgery and this was statistically significant (p < 0.05), but our results reported less insignificant immediate karnofsky score result due to extensive and maximal resection for tumour removal of all cases was tried. the mean EOR was 94.37%±6.6 for the entire cohort gross total resection (>98%) was performed in 11 cases (45.8%), 8 cases (33.3%) had near total resection (>90%) and 5 cases (20.8%) had subtotal resection (<90 -50%) with no cases had partial resection (< 50%) p-value (0,595).The mean postoperative tumor volume was (39.4±12.2) cm3. Almost similar result reported by **Eseonu et al.,**[13] one hundred percent tumour resection was seen in 2 (6.5%) of the GA cases and 7 (25.9%) of the AC cases (P=.041). Near total resections (≥95%, <100%) were seen in 11 (35.5%) of the GA cases and 10 (37.0%) of the AC cases (P = .902). Subtotal resections (<95%) were seen in 18 (58.1%) GA cases and 10 (37.0%) AC cases (P = .410). The mean preoperative and postoperative tumour volumes for the GA and AC patients were found to be similar. The mean extent of resection for the GA group was 79.6% and 86.3% for the AC group (P = .136). The length of hospitalization was calculated based on the duration from the day of surgery till the day of discharge. In our study the mean for hospital stay was 3.66±2.74days and for ICU stay was 16.12±9.23hrs, and it was relatively more for G.A cases. In contrast to **Taylor et al,.**[13]In their series reported a 2-day postoperative stay using these techniques. Similar results by by**Eseonu et al.,**[13] analysis (LOH) and (NICU) For the GA patients, the mean length of stay (LOS) was 7.9 days, while for AC patients, the mean LOS was 4.2 days (P = .049;). LOS in the neurocritical care unit (NCCU) was 3.0 ±1.0 days for GA patients and 1.1±0.4 days for the AC patients (P = .003). 5 (20.8%) cases had intraoperative seizures, and easily controlled by iced cold ringer irrigation with small bolluspropofol without further affection of brain mapping techniques and neurological monitoring. Furthermore our result reported higher incidence of intraoperative seizure among asleep cases (8.3%vs12.5%), but it was statistically insignificant, similar result by **Zelitzki et al.,**[9]reported higher prevalence of intraoperative seizures occurring during G.A (2.3%vs7.3%) resections of perirolandic lesions. This percentage was within the range published in the literature as

Sartorius et al,.[13]Reported a 5%–20% rate of intraoperative seizures. **Serletis et al.,**[15]Reported a seizure rate of 4.9% in a large cohort of 511 patients underwent awake craniotomy.[19).(20|)]

CONCLUSION

A craniotomy with direct cortical/subcortical electrical stimulation either under awake or general (GA) presents two approaches for removing the perirolandic region glioma with a reported higher prevalence of intraoperative seizures occurring during G.A (2.3%vs7.3%) resections of perirolandic lesion. For this reasons both awake craniotomy with direct electrical stimulation or G.A and MEP intra-operative neuromonitoring has been reported in most of the literature to be associated with better neurological outcome, more extensive tumour resection, and shorter length of stay in hospital.

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