Awake epilepsy surgery

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Awake epilepsy surgery, also known as awake craniotomy for epilepsy, is a surgical procedure used to treat epilepsy in cases where the seizure focus is located within or near critical brain regions responsible for essential functions, such as motor skills, speech, and sensory perception. This specialized form of brain surgery involves performing the operation with the patient awake and responsive.

Pre-surgical Planning: Prior to the surgery, extensive pre-surgical planning is carried out. This includes identifying the precise location of the seizure focus within the brain using neuroimaging (e.g., MRI or CT scans) and electroencephalography (EEG).

Brain Mapping: During the surgery, the surgeon makes an incision in the patient's scalp and creates an opening in the skull to expose the brain. Once the brain is exposed, the surgical team stimulates and monitors various areas of the brain using electrical currents. This helps identify critical functional regions, such as the primary motor cortex, sensory cortex, and language centers.

Patient Interaction: The patient is kept awake and responsive throughout the procedure. The surgeon engages the patient in tasks that require specific brain functions, such as speaking, moving limbs, or responding to sensory stimuli. These tasks help identify and protect critical brain regions.

Seizure Focus Resection: Once the functional areas have been mapped and identified, the surgeon can precisely target and resect the epileptic focus while avoiding damage to critical regions. The goal is to remove the seizure source while preserving essential functions.

Continuous Monitoring: During the entire procedure, the patient's brain activity, vital signs, and responses to stimulation are continuously monitored to ensure patient safety.

Awake epilepsy surgery offers several advantages:

Precise Localization: By mapping functional regions in real time, surgeons can precisely localize the seizure focus and minimize damage to essential brain functions.

Minimized Post-operative Deficits: Patients who undergo awake epilepsy surgery typically experience fewer post-operative deficits, such as weakness, speech impairment, or sensory loss, compared to traditional surgery.

Improved Seizure Outcomes: The likelihood of achieving better seizure control and improving the patient's quality of life is enhanced when the surgery effectively targets the seizure focus.

Customized Approach: Awake epilepsy surgery allows for a tailored, patient-specific approach to epilepsy treatment, taking into account the unique functional organization of each patient's brain.

Despite its advantages, awake epilepsy surgery is a complex and challenging procedure that requires a highly skilled surgical team and careful patient selection. It may not be suitable for all epilepsy cases, and the decision to pursue this approach is made on a case-by-case basis.

Comparative observational studies

Fifteen patients operated with awake epilepsy surgery were compared to 30 matched controls undergoing conventional/asleep epilepsy surgery. The groups were compared with regard to neurological complications, seizure control and location of resection.

Regarding seizure control, 86% of patients in the awake group reached Engel grade 1-2 compared to 73% in the control group, operated with conventional/asleep surgery, not a statistically significant difference. Neither was there a statistical significant difference regarding postoperative neurological complications. However, there was a significant difference in location of the resection when comparing the two groups. Of the 15 patients operated with awake intraoperative mapping, four had previously been considered as non-operable by epilepsy surgery centres, due to vicinity to eloquent brain regions and predicted risk of post-operative neurological deficits.

The results show that awake epilepsy surgery yields similar level of seizure control when compared to conventional asleep surgery, with maintained safety in regard to neurological complications. Furthermore, the results indicate that awake craniotomy in epilepsy surgery is feasible and possible in patients otherwise regarded as inoperable with epileptigenic zone in proximity to eloquent brain structures [1)].

In 144 cases of awake craniotomy with ECoG, 73 using circular grid and 71 with strip electrode. No significant differences were seen regarding preoperative clinical and demographic data, duration of ECoG recording ($p = 0.676$) and use of DES ($p = 0.926$). Circular grid was more sensitive in detecting periodic focal epileptiform discharges (PFEDs) ($p = 0.004$), PFEDs plus ($p = 0.032$), afterdischarges (ADs) per case ($p = 0.022$) at lower minimum ($p = 0.012$) and maximum ($p < 0.0012$) intensity stimulation, and seizures ($p = 0.048$). PFEDs ($p < 0.001$), PFEDs plus ($p < 0.001$), and HFOs ($p < 0.001$) but not ADs ($p = 0.255$) predicted electrographic seizures.

They demonstrate higher sensitivity in detecting ictal and interictal activity on ECoG during awake craniotomy with a novel circular grid compared to strip electrode, likely due to better spatial sampling during ECoG. We also found association between PFEDs and intraoperative seizures [2)].

Observational case series studies

Maesawa et al.examined five consecutive patients, in whom they performed lesionectomy for epilepsy with awake craniotomy, with postoperative follow-up > 2 years. All patients showed clear lesions on magnetic resonance imaging (MRI) in the right frontal (n = 1), left temporal (n = 1), and left parietal lobe (n = 3). Intraoperatively, under awake conditions, sensorimotor mapping was performed; primary motor and/or sensory areas were successfully identified in four cases, but not in one case of temporal craniotomy. Language mapping was performed in four cases, and language areas were identified in three cases. In one case with a left parietal arteriovenous malformation (AVM) scar, language centers were not identified, probably because of a functional shift. Electrocorticograms (ECoGs) were recorded in all cases, before and after resection. ECoG information changed surgical strategy during surgery in two of five cases. Postoperatively, no patient demonstrated neurological deterioration. Seizure disappeared in four of five cases (Engel class 1), but recurred after 2 years in the remaining patient due to tumor recurrence. Thus, for patients with epileptogenic foci in and around functionally eloquent areas, awake surgery allows maximal resection of the foci; intraoperative ECoG evaluation and functional mapping allow functional preservation. This leads to improved seizure control and functional outcomes [3)].

Retrospective cohort studies

Korkar et al. conducted a retrospective cohort study of 17 consecutive patients with intractable partial seizures of different aetiologies (non-lesional epilepsy [n=3], tuberous sclerosis [n=1], hypoxic ischaemic insult [n=1], dysembryoplastic neuroepithelial tumours [DNET] [n=2], focal cortical dysplasia type 2 [FCD] [n=4], and other malformations of cortical development [n=6]), located in eloquent language cortex (frontal [n=7], insular [n=5], and latero-temporal [n=5] regions). All patients were operated on between 2010 and 2019 for resective epilepsy surgery under awake conditions, with the aid of direct cortical stimulation. This report aimed to study the feasibility, efficacy and limitations of using the awake craniotomy technique for surgical resections of epileptogenic zones involving eloquent language cortex. Postoperative epilepsy control and neurological function were assessed and followed. The mean follow-up period was 5.7 years. In one patient, the surgery was aborted before resection. In the other patients, Engel Class I was achieved in seven patients (43.75%) and Engel Class II in four patients (25%), and worthwhile improvement (Engel Class I and II) was achieved in 11 patients (68.75%). Postoperative neurological deficits were encountered in four patients (23.5%). However, all these deficits were regressive and were absent at the last follow-up visit. Using the awake craniotomy technique, seizure freedom can be achieved in a high proportion of patients with epileptogenic zones located in language areas, who were previously considered only candidates for palliative measures [4)].

Descriptive case series studies

Vigren et al. reported four cases with different locations of epileptogenic zones as examples of possible safe and efficient resections.

The results of the resections on seizure control were Engel 1 (no disabling seizures) in all cases and no patient experienced significant neurological deficits [5)].

Case reports

Bajwa et al presented the first reported case from Pakistan of a 19-year-old woman who underwent awake epilepsy surgery to treat cortical dysplasia. She had a history of generalized tonic-clonic seizures since her childhood and was referred to our clinic due to an increase in seizure frequency. EEG and MRI identified the seizure focus, in the right parieto-temporal region. The patient underwent a neuro-navigation guided awake craniotomy and an excision of the epileptogenic focus in the right parieto-temporal region. Theprocedure was carried out using a scalp block and dexmedetomidine for conscious sedation, enabling the patient to remain awake throughout the surgery. Intraoperative neurophysiological monitoring and electrocorticography were used for complex multidisciplinary care. Post-resection corticography showed no spikes along the resected margins. The patient was discharged without any complications and remained free of symptoms a year after the surgery. Awake epilepsy surgery is a viable option for removing epileptogenic foci while preserving vital cognitive functions. However, it is seldom used in low- and middle-income countries such as Pakistan. The successful outcome of this case underscores the need for greater awareness and availability of epilepsy surgery in resource-limited settings. Cost-effective measures, such as using small subdural strips for intraoperative localization, can be implemented [6)]

1)

Vigren P, Eriksson M, Gauffin H, Duffau H, Milos P, Eek T, Dizdar N. Awake craniotomy in epilepsy surgery includes previously inoperable patients with preserved efficiency and safety. Int J Neurosci. 2023 Nov 6:1-11. doi: 10.1080/00207454.2023.2279498. Epub ahead of print. PMID: 37929598.

2)

Freund BE, Feyissa AM, Khan A, Sirven JI, Grewal SS, Sabsevitz D, Moniz-Garcia D, Quinones-Hinojosa A, Tatum WO. Enhanced sensitivity of electrocorticography during awake craniotomy using a novel circular grid electrode. J Neurooncol. 2023 Nov 7. doi: 10.1007/s11060-023-04495-0. Epub ahead of print. PMID: 37932608.

3)

Maesawa S, Nakatsubo D, Fujii M, Iijima K, Kato S, Ishizaki T, Shibata M, Wakabayashi T. Application of Awake Surgery for Epilepsy in Clinical Practice. Neurol Med Chir (Tokyo). 2018 Oct 15;58(10):442-452. doi: 10.2176/nmc.oa.2018-0122. Epub 2018 Sep 21. PMID: 30249918; PMCID: PMC6186762.

4)

Korkar GH, Isnard J, Montavont A, Catenoix H, Rheims S, Guénot M. Awake craniotomy for epilepsy surgery on eloquent speech areas: a single-centre experience. Epileptic Disord. 2021 Apr 1;23(2):347-356. doi: 10.1684/epd.2021.1275. PMID: 33926856.

5)

Vigren P, Eriksson M, Duffau H, Wretman A, Lindehammar H, Milos P, Richter J, Karlsson T, Gauffin H. Experiences of awake surgery in non-tumoural epilepsy in eloquent localizations. Clin Neurol Neurosurg. 2020 Dec;199:106251. doi: 10.1016/j.clineuro.2020.106251. Epub 2020 Sep 25. PMID: 33031989.

6)

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