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PROGRAMME : M.CH. NEUROSURGERY

MONTH & YEAR OF SUBMISSION : NOVEMBER 2004

PROJECT REPORT

TITLE OF PROJECT: A STUDY OF THE OUTCOME OF SURGERY FOR LESIONAL EXTRA-TEMPORAL EPILEPSY.

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CERTIFICATE

I, Dr Sunil Valentine Furtado, Resident in Neurosurgery, SCTIMST, hereby declare that I have carried out this project titled: **A STUDY OF THE OUTCOME OF SURGERY FOR LESIONAL EXTRA-TEMPORAL EPILEPSY.**

Thiruvananthapuram
1st. November 2004.

Dr.Sunil Valentine Furtado

FORWARDED: He has carried out the minimum requirements for the project.

Thiruvananthapuram
1st. November 2004

Prof R.N. Bhattacharya
Head of the Department
Neurosurgery.

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Dr. Sunil V. Furtado

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INTRODUCTION

Primary intracranial lesions and other structural lesions like vascular malformations are important aetiological factors in patients with partial seizure disorders[2]. These lesions may be associated with long-standing chronic seizure disorder refractory to anti-epileptic drugs (AED). In current terminology the extra-temporal excision or corticectomy for epilepsy is a removal within the frontal lobe, the sensory-motor cortex (supra-sylvian or central region), the parietal, or the occipital lobes. The excisions may be restricted within the lobes, comprise the entire lobe, or be bilobar or multilobar with portions of the neighbouring lobes excised, as in a partial or a complete fronto-temporal, fronto-central, fronto-centro-parietal, or parieto-occipital removal.

In extra-temporal resections because of the multiplicity of the epileptogenic lesions, the diagnostic complexities and the restrictions set by the need to safeguard eloquent areas; it is unlikely that complete relief of seizures will be achieved in every operated patient. However, even a partial improvement, that is, a reduction of seizure tendency, reduced frequency, intensity, duration, or postictal and interictal disturbances, is valuable for the patient, the relatives and the caregiver. A longstanding epileptogenic process does negatively influence cerebral functions, but the brain can also accommodate itself and acquire capacity to remodel and spatially shift some functions due to its functional plasticity. By removing the epileptogenic lesion, restorative capabilities are released which benefit the patient.

Consideration of extra-temporal epilepsy, excision may cause concern to the patient, relatives, caregivers or physician because of fear of new or accentuated neurological deficits. The concern may prejudice them against surgery. The excisions were initially usually made under local anesthesia to safeguard against neurological deficits from surgical intrusion into vital cortical areas. The same is used as in awake craniotomy and lesional resection now. The concordance between seizures and intra-operative findings is therefore important. The intricacy of an epileptogenic lesion can be defined by special preoperative and intra-operative investigations. Only such investigations can assess the surgical chances and risks accurately. Furthermore, it is easy to concentrate on the surgical risks, appearing within a short period of time and therefore easy to grasp, but this should not prevent the patient, their relatives or the treating physician acknowledging the chances of success and the possibility of living a normal life. The surgical risks should be balanced against the negative effects of the disease especially over a long period of time, ending up in a poor psychosocial situation, or early death. With growing knowledge it has become evident that neurological examination, electrophysiological studies, seizure type and response to AED may not be useful in predicting the nature of the underlying pathology. A long-standing indolent low-grade glioma may be clinically indistinguishable from a non-neoplastic lesion. Some lesional epilepsy cases may require surgery for the change in growth pattern, bleed or mass effect; other static & benign lesions for their intractable nature only.

AIMS AND OBJECTIVES

AIM: To study the outcome of surgery done for patients with refractory lesional extra-temporal epilepsy

OBJECTIVES:

1. To assess the overall seizure outcome of patients undergoing surgery for lesional extratemporal epilepsy.

2. To correlate and identify factors predictive of good seizure outcome.

3. To identify possible causes for poor outcome with respect to the pathology, site of lesion, pre-morbid factors, and the type of surgical resection.

4. To define and outline the complications.

5. To correlate the results with surgery done for patients with lesional temporal epilepsy

MATERIAL AND METHODS

Thirty-one patients operated in this institute between 1996 and June 2003 were studied. The data was analysed with respect to clinical presentation, radiological features, EEG findings, operative findings, post-operative morbidity, and seizure outcome. Data was statistically analyzed using Chi square test and Fisher's exact test when appropriate.

REVIEW OF LITERATURE

HISTORY:

In the early period of epilepsy surgery the cortical excisions for intractable focal epilepsy were overwhelmingly extra-temporal. During the first half of the 20th century the diagnostic facilities assisting the interpretation of clinical seizures were, plain radiographs of the skull, ventriculography (1918), cerebral angiography (1927), and electroencephalography (EEG)(1935). The intra-operative diagnostic method was a functional study of the brain and of the epileptogenic area, with electrical stimulation of the exposed surface already in use in the late 19th century (Horsley, 1897). From around the 1940s electrocorticography, EcoG, became a diagnostic part of the operative procedure. Pathological investigation of the specimens removed at operation was important, revealing post-traumatic, tumoral, post infectious or other structural lesions. Clinical information from the nature of the epileptic seizures and the neurological deficits could indicate lesions in the primary cortical regions (motor, sensory, auditory, visual), or in areas involved in speech production (Broca, 1886) or language comprehension (Wernicke, 1374).

Huglings Jackson determined that ictal behavior could indicate the localization of the underlying pathology[8]. He emphasized that a chronic seizure disorder could be the initial symptom of a glioma in a patient with partial epilepsy.The localization of the lesional area has been shown to be highly coherent to the epileptogenic zone. Penfield indicated that cortical localization of the lesion is predictive of the seizure tendency. Lesional epilepsy may be associated with simple partial, complex partial or secondarily generated tonic-clonic seizures. Primary brain tumours, hamartomas, i.e. vascular malformations and cortical dysplasias are the underlying pathology in approximately 30% of patients with intractable partial epilepsy[2].

William Gowers in 1881 provided a clear distinction between focal seizure due to demonstrable pathological lesion and generalized seizure constituting idiopathic epilepsies. Victor Horsley (1886) reported the landmark cases in which he surgically cured the patients of their focal epilepsy.

MECHANISMS OF EPILEPTOGENESIS ASSOCIATED WITH STRUCTURAL MASS LESIONS[12]:

The pathological mechanisms of epileptogenesis associated with intracranial mass lesions are poorly understood. Proposed mechanisms include impaired vascularisation of the surrounding cerebral cortex, direct irritation of the brain, denervation, and hypersensitivity due to partial isolation and transaction of a portion or the cerebral cortex[3].

Studies of arterio-venous malformations (AVM) showed neuronal loss, gliosis, demylelination and hemosiderin deposits, which may represent the structural substrate of an epileptogenic focus[4].

There is conflicting evidence regarding the contribution of hereditary predisposition in the development of epilepsy in patients with intra-cranial structural lesions.

Rasmussen defined a primary localization, which is the site of seizure initiation, and a secondary localization, which is the site of seizure generation and spread. This indicates the volume of tissue adjacent to the focus, which must be initiated to produce a clinical seizure[5].

PATHOLOGY

Classification of structural mass lesions associated with intractable epilepsy[12]:

VASCULAR:

AVM

CAVERNOUS ANGIOMA

INFLAMMATORY/INFECTIOUS LESIONS

TUBERCULOMA

CYSTICERCOSIS

DEVELOPMENTAL

GLIONEURAL HAMARTOMAS

FOCAL CORTICAL DYSPLASIA

NEOPLASTIC

GLIAL TUMOURS

PILOCYTIC ASTROCYTOMA

LOW GRADE ASTROCYTOMA

OLIGODENDROGLIOMA

MIXED NEURAL TUMOURS

OLIGOASTROCYTOMA

NEURONAL/GLIAL TUMOURS

GANGLIOGLIOMAS

DYSEMBRYOPLASTIC NEUROEPITHELIAL

TUMOURS (DNET)

GLIOSIS

An intractable mass lesion can be diagnosed and surgically verified in 10-20% of patients with long standing medically intractable epilepsy.

Neoplastic lesions:

Low-grade gliomas.

Seizures can occur in up to 50% of patients with intracranial neoplasm and is related to the tumour pathology and cortical localization. Low-grade slow growing tumours, which are well differentiated, are the most epileptogenic[3]. The incidence of seizures in glioblastomas is lower because of the shorter duration of the disease. Tumours in close proximity to the centro-temporo-parietal areas are most frequently associated with epilepsy. Nearly 70% of the lesions are located in the temporal lobe; probably due to its low seizure threshold.

Computed tomography (CT) studies done by Shorvon in patients with epilepsy demonstrated a neoplasm in 10-25% of the patients with seizure onset after the age of 40 years and 5% in children below 15 years age. Low-grade gliomas are the most frequent pathological lesions accounting for nearly 50-70% of all lesions and 70-90% of all neoplasms[12]. The distribution of neoplasms varied according to the histological criteria in identifying these lesions.

GANGLIOGLIOMAS:

These are mixed tumors that are composed of neoplastic glial and neuronal cell types. They are most commonly located in the temporal and frontal lobes and present for years before tumour detection.

DYSEMBRYOPLASTIC NEUROEPITHELIAL TUMOURS (DNET)

They are morphologically unique and surgically curable neuro-epithelial tumours and are included in the group of neuronal and glial tumours grade I. In a series by Wolf they constituted 8% of neoplasms in patients with medically intractable epilepsy[9]. Age at onset of seizures ranged from 1 to 19 years (mean 9 years) and duration of seizure prior to surgery averaged 9 years(range 2-18 years)[10].

HAMARTOMAS:

These comprise unusual proliferation of glial and neuronal elements.

In the case of tuberose sclerosis one finds peri-ventricular glial nodules or sub-ependymal tubers. These are foci of gliosis that include both glial and neuronal cells, with abnormal cell structure and tissue architecture.

ARTERIORVENOUS MALFORMATIONS (AVM):

Hemorrhage can account for 20% of presentations of patients with AVM[11].The incidence of seizures vaies between 17% and 40%[4]. The risk of developing epilepsy in a 20-year follow-up period in a large series of un-operated AVMs was 18%[5].The younger the patient is at the time of presentation the greater is the chance of developing epilepsy. Patients in the 10-19 years age group had a 44% risk compared with those over the age of 30 years[10].

Frontal lobe AVM are associated with generalized seizures without aura and parietal and occipital AVMs present with simple partial seizures.

CAVERNOUS ANGIOMA

They account for 5-16% of all intracranial vascular malformations and are being increasingly being recognized with wider use of radiological procedures. A review of 138 symptomatic cases, at the time of diagnosis one third had seizures[12]. Surgical excision of accessible lesions is advocated for haemorrhage, mass effect, intractable seizures and if a mass lesion cannot be excluded.

TUBERCULOMA:

In the early part of the twentieth century tuberculomas accounted for 20-40% of intracranial lesions, the incidence of which has declined. There has been a resurgence of the same in patients with immunodeficiency and drug resistant strains. In a study by Gulati in 1991 involving 170 children with chronic seizures with a suspicion of an underlying lesion MRI revealed findings of a tuberculoma in 64 children.

Paradoxical expansion of the lesion has been noted during the course of anti-tubercular therapy. It can also appear during or after the successful treatment of systemic or nervous system tuberculosis.

CEREBRAL CYSTICERCOSIS:

Seizures are the most frequent clinical manifestation of neuro cysticercosis, with 50-70% of patients presenting with the same. It is endemic in Central and South America affecting up to 2-4 % of the population. A diagnosis of cysticercosis should be entertained in patients with seizures and a cystic brain lesion even in those who do not eat pork and who have not traveled to an endemic area[12].

SURGICAL CANDIDATES[14]:

Both children (from about 6 months of age) and adults, predominantly in their potentially productive years, with severe partial epilepsy may be candidates for extra-temporal excisions. Special consideration should be given to the early investigation of patients with focal epilepsy interfering with speech and motor function. Early surgery is advisable (less than a year - a few years duration of drug-resistant illness) in children younger than 5 years and able to recover speech, improve behaviour, mental capacities and sensory-motor functions. Adults, with neurological deficits from early lesions, or with late onset of intractable partial epilepsy due to microscopic structural lesions, should have their pre-surgical investigations after a few years of adequate drug treatment. Patients with a mild or moderate degree of mental retardation should also be accepted for investigation. If the epileptic lesion is well delineated they will have similar chances to other patients with regard to seizure outcome. Even a partial reduction of seizure tendency can be medically and socially worthwhile for the patient and also for the caregiver whose care load may lessen considerably.

GENERAL PRE-SURGICAL EVALUATION[12,14]:

Finding an intracerebral lesion in a patient with recurrent seizures does not necessarily mean that structural abnormality is producing the seizure activity. The main purpose of the pre-surgical evaluation in patients with intracranial lesions and intractable seizures is to confirm the lesion and the seizure foci. The occasionally may be incidental and bear no causal relationship to the epileptogenic focus. Therefore, the understanding of spatial and causal relationship between structural lesions of the brain and intractable epilepsy is essential in planning therapeutic strategies.

A careful history should be taken in all patients with particular attention to a history of febrile seizures; developmental milestones head trauma and previous neurological problems. Boon noted no significant difference in the frequency of febrile seizures in patients with intra- axial space occupying lesions and intractable seizures compared to the general population. A thorough neurological examination may reveal abnormalities such as mild hemiparesis or visual defects that may assist in clinically lateralizing the epileptic zone.

Although earlier studies found a low incidence of tumours in patients with onset of seizures before the age of 25 years, recent data suggest that refractory partial seizures, even before age 20 should also raise suspicion of an intracranial mass lesion. The majority of patients with lesional epilepsy previously considered for surgery have had seizures for more than ten years; no significant difference in the duration of seizures has been observed between patients with neoplastic and non-neoplastic lesions.

Lesional epilepsy may be associated with simple partial; complex partial or secondary generalized tonic-clonic seizures. Thirty-four of the 50 patients with intractable seizures associated with space-occupying lesions had auras-most frequently epigasrtic sensations. With the exception of visual auras in patients with occiptal lesions, the characteristics of the aura did not help in the localization of the lesion. The most frequent seizure type associated with lesional epilepsy is complex partial seizure (CPS). Among 50 patients CPS with lesional epilepsy; all those with a temporal lobe lesion had CPS. An equally good correlation was shown in patients with frontal and occipital lobe lesions but not in patients with parietal lobe lesions. Seizures originating in the parietal lobe can mimic frontal and temporal lobe seizures. A simple partial seizure as a manifestation of a lesional syndrome, either alone or with CPS or tonic- clonic seizures was found to be nearly always associated with neoplasms by several workers.

IMAGING:

Two structural neuroimaging modalities are used in the identification of potential candidates with intractable partial epilepsy for resective surgery: CT and MRI. The diagnostic yield of the neuroimaging studies depends on the anatomical localization of the epileptogenic area. The limitations of CT in detecting small, benign lesions usually associated with long standing medically intractable epilepsy soon became apparent. In the absence of an MRI, CT is a valuable part of the pre-surgical evaluation of patients with partial seizure disorders. All patients should have a non-contrast and contrast CT study on a third and fourth generation CT scanner if MRI is not available or cannot be performed. The use of reverse –axial images to enhance CT abnormalities within the temporal lobe was associated with an increased incidence of lesional pick-up. In developing countries where the availability of MRI is very limited, CT remains the radiological investigation of choice[1].

Magnetic resonance imaging is the structural neuro-imaging modality of choice in patients with intractable partial epilepsy. Neoplastic, vascular and infective mass lesions are almost always associated with an MRI-identified abnormality. Magnetic resonance imaging-based volumetric measurement of the hippocampal formation may provide additional information about the lesion[12]

ELECTROPHYSIOLOGY:

Epileptiform activity localized by scalp EEG distant from the site of a structural lesion is not uncommon. Poor interictal scalp localization has been attributed to the fact that the recorded focal abnormality may only be a part of a deeply localized, more extended focus that propagates to the surface. The occurrence of bilateral independent sharp waves and spikes in patients with epilepsy has been well recognized. However, it has been demonstrated that this EEG finding does not correlate with a poor outcome.

Intensive monitoring with simultaneous close circuit television (CCTV) and scalp EEG recording may reveal interictal focal paroxysmal epileptiform activity but may be normal or show non-specific changes. Continuous video-EEG monitoring with recording of habitual seizures and careful analysis of the recorded seizures and the simultaneous recorded EEG allows good correlation of clinical events with electrical phenomena. Proper classification of seizure type can be made on the basis of specific, stereotyped signs and symptoms during the attack and the findings on the scalp EEG. In most patients with intracranial lesions detected with neuroimaging, the additional information gathered by scalp EEG-video monitoring is sufficient to consider the lesion as the cause of the epilepsy, and those patients can proceed to surgery without invasive monitoring.

Patients may require invasive monitoring if the results from all previous procedures are conflicting. Invasive monitoring is defined as the long-term recording of EEG from subdural and or intraparenchymal brain areas using intracranial electrodes. This recording technique is generally required in patients with stereotyped partial seizures in whom no consistent epileptiform focus could be demonstrated during the non-invasive monitoring. In patients with lesions, a subdural or epidural grid consisting of a thin layer of silastic with numerous embedded electrodes is laid over the cerebral cortex in proximity to the neuroimaging identified lesion.

However, in addition to morbidity, the apparent lack of sensitivity in localization, especially when subdural grids are placed directly over the epileptogenic lesion is well documented. Cascino et al studied a group of 11 patients with seizures associated with lesions in the parietal lobe. Out of five patients with parietal lesion who underwent intracranial monitoring with depth and or subdural electrodes in an attempt to localize the region of ictogenesis, parietal lobe origin was documented only in two. Magnetic resonance imaging detected the lesion in all. The authors recommended lesionectomy without chronic intracranial monitoring as an effective and safe surgical procedure in patients with partial epilepsy related to parietal lobe lesions[3].

The importance of physiological identification of functionally important areas is being increasingly recognized in neurosurgery. Functional imaging of the brain may provide information that may be complimentary to that provided by EEG and structural neuroimaging studies. In addition when, neurosurgical procedures are planned in neocortical sensory, motor or speech areas functional mapping is performed to circumscribe these areas and avoid an unacceptable neurological deficit post surgically.

Cortical mapping before tumour resection may be required to identify regions involved in critical functions. Cortical stimulation techniques have been applied during resection of AVM's and tumours within the language-dominant hemisphere of patients with medically intractable epilepsy. Mapping may be done intra-operatively, but this requires that the surgical procedure be carried out under local anaesthesia.

Alternatively, mapping may be done preoperatively using an implanted subdural electrode array to record both interictal and ictal EEG and to stimulate the cortex at different contact points. A major advantage of the grid system is that the patient can fully cooperate in a non –surgical environment and a more elaborate series of functional tasks can be evaluated. Subdural grids of electrodes have also been used for recording cortical somatosensory evoked potentials by stimulating a peripheral nerve to locate the primary somatosensory cortex and to delineate the location of the central fissure[18].

Controversy exists regarding the usefulness of intra-operative electrocorticography (EcoG) to identify and resect the seizure foci vs. tumour removal alone. Multiple vs. single seizure foci were more likely to be associated with a longer preoperative duration of epilepsy. Postoperatively, 41% of the adults and 85% of the children were seizure-free without any anti-convulsant medication, with a mean postoperative follow-up of over 50 months. All patients with intractable epilepsy and neuro-imaging –detected lesions should be referred to comprehensive centers for surgical consideration. Several years of poly-pharmacy with AED is not required to define intractability of the seizures. Although a period of two years of observation on adequate AED coverage is advocated prior to consideration of epilepsy surgery, infrequent seizures that are potentially injurious and socially disabling, even of 1-year duration, may necessitate a referral for surgery.

DIAGNOSTIC OPERATIONS FOR EXTRATEMPORAL INVESTIGATIONS:

Invasive EEG investigations of the frontal lobe are carried out with electrodes placed under general anaesthesia epidurally, subdurally, or intracerebrally. Intraosseal (epidural peg) electrodes may also be used. The antiepileptic drugs, AEDS, are reduced cautiously when the seizures are frequent and generalized.

Epidural strip or plate electrodes[16]:

These electrodes are positioned after a flap craniotomy covering a suspected unilateral lateral frontal lesion and surrounding areas. The epidural placement has the advantage of not causing meningo-cortical adhesions. Intra-operative transdural EcoG and electrical stimulation may be carried out to localize the epileptogenic area and to identify an exposed portion of the motor cortex. The positions of the electrodes are photographed for localisational purposes. The electrode wires are tunneled out via separate skin incisions, and anchored to the skin. The patient is given antibiotics for a few days. Plain X-Ray films or CT scan of the electrode positions facilitate the localization of ictal and interictal EEG discharges.

Subdural strips[1,12,16]:

These are positioned through burr holes on the lateral and medial surfaces of the frontal lobe, and may even be curved sub frontally. The burr holes may be unilateral or bilateral para-sagittal and/or latero-frontal depending on the problem in each individual case, and strips of various lengths are inserted through them. An alternative to placing unilateral orbito-frontal electrodes is to advance them through a burr hole above the sphenoidal wing via a fronto-temporal skin flap and an incision in the temporal muscle to avoid facial nerve damage. Additional strip electrodes may be placed through separate burr holes on, and beneath the anterior temporal lobes if complex partial seizures are involved.

Subdural mats[1]:

Mats of different sizes may be inserted via a craniotomy. The exposure is often unilateral but also allows for the placement of bilateral medial frontal electrodes facing the contra lateral inter-hemispheric cortex or falx. The lateral and orbito-frontal cortices may be covered with additional plates. Their positions are photographed and intra-operative ECoG and electrical stimulations may be carried out before closing. These observations may be compared with later video- EEG monitoring of spontaneous and electrically elicited seizure discharges. Functional cortical mapping of speech and sensory-motor functions with electrical stimulation is performed and the patient reports the effects. Electrically evoked somatosensory potentials via stimulated afferent nerves in the extremities can localize segments of the sensory cortex. If the anterior speech area is studied, the electrodes should cover it and its surroundings. Systematic electrical stimulation of each electrode contact (bi-or monopolar) at intervals during EEG recording will define the area within which aphasia/dysphasia is evoked. Since the implanted sub-dural strips leave a faint impression on the cortex, noticeable in the following exploration, the metal contacts through which aphasia was evoked can mark the extent of Broca's area. An investigation using sub-dural electrode study may last for a few days.

OUTCOME:

The beneficial effect of epilepsy surgery in patients with medically refractory partial seizures associated with structural lesions is well established. Postoperative seizure-free rates of up to 83% have been reported, with many of the remaining patients showing a significant improvement in seizure control[7].

The outcome of the surgery treatment of lesional epilepsy is influenced by the nature of the underlying pathology, the completeness of resection of the structural lesion and the extent of the removal of the functionally defined associated epileptic foci. The relative contributions of these factors and their interactions are difficult to delineate. Moreover the outcome results from the published series are difficult to compare because of different methods of patient selection, pathological classification, surgical technique and follow-up. Seventy percent patients with astrocytomas and other low-grade primary intracranial neoplasms became seizure free or had a marked reduction in seizures, whereas complete seizure control was unlikely in malignant astrocytomas. Tumour recurrence was often heralded first by a recurrence of seizures after a seizure-free period of variable length. Surgical excision of indolent intra-axial tumours such as gangliogliomas and DNET's are associated with a likelihood of complete or near-complete relief of seizures in nearly 90% of patients[6]. There is a higher incidence of more benign lesional pathology in intractable temporal rather than extra-temporal epilepsy.

It is more difficult to judge the outcome of surgery in patients with vascular malformations from the available literature. Yeh et al, reported 21 out of 27 patients who became seizure-free or had auras following surgical excision, corroborating the good outcome described by Rasmussen. These good results contrast with the apparently disappointing results contrast of the effect of the surgical removal of vascular malformations. It is not unusual for EcoG to record epileptiform activity at a distance from the site of the vascular malformation. Independent epileptic foci were noted in the amygdala and hippocampus with an AVM located in the posterior region associated with an excellent result following anterior temporal lobectomy. It appears that in patients with medically intractable seizures due to an AVM particular consideration should be given to the delineation and a need for more extensive excision of the epileptogenic foci surrounding the AVM and in some circumstances, remote from it.

Treatment with AEDs and anti-cysticercal drugs results in the control of seizures in the majority of patients with epilepsy due to neuro cysticercosis. Surgical removal of the cyst is occasionally indicated for obstructive hydrocephalus or to relieve the localized pressure effects. The outcome of patients with medically intractable epilepsy due to neuro cysticercosis and the beneficial effect of surgery on their seizure outcome are uncertain, but since the pathology is multifocal, resection of a single lesion would be unlikely to be beneficial.

Medical treatment with anti-tuberculous drugs is the treatment of choice for tuberculomas of the brain. In regions where intracranial tuberculomas are uncommon, confirmation of the diagnosis by open or stereotactic biopsy is sought. The majority of patients in countries where tuberculomas are common are treated medically and followed up by serial neuroimaging .A series of patients who showed single, small, enhancing CT lesions with or without perifocal oedema has been reported from India. Most of these lesions resolve spontaneously with no treatment other than anticonvulsants. Stereotactic or excision biopsy in twenty-five consecutive patients with lesions showed a majority of them where found to be caused by cysticercosis.

The relationship between outcome and extent of the resection of the lesion is complex and is influenced by the pathology and the extent of the removal of any co-existing epileptic focus. Complete lesion resection with or without the epileptic focus was associated with a higher chance of a seizure free outcome than incomplete removal of the lesion. Many patients undergoing resective surgery for mass lesions have congruent epileptic foci. In patients with medically intractable seizures associated with AVMs, excision of the epileptogenic foci close to the AVM was associated with better seizure control.

The factors predictive of a good prognosis in resective surgery for intractable epilepsy guided by subdural electrode arrays and operative EcoG were reported for 64 patients[16]. In their study after one year, 70% of the patients with a temporal ictal focus were seizure free, compared to 55% of patients with an extra-temporal focus. Patients with no post-resection spikes had a better prognosis than with patients with residual post resection spikes evaluated by operative Ecog. Other factors such as age gender, duration of epilepsy prior to surgery, extent of temporal lobe resection and structural abnormality as determined by MRI were not correlated with a favourable seizure outcome after surgery. However, there are several case reports or small series of patients with congruent epileptogenic foci who became seizure free after surgery limited to the site of structural lesion. The goal of epilepsy surgery is to render the individual seizure-free without producing surgical morbidity. The primary aim of the treatment should be the removal of the lesion. If complete removal of the lesion cannot be achieved without added risk and morbidity, incomplete lesion removal may provide equally satisfactory results. Many of the tumours associated with medically intractable epilepsy are indolent, with no tendency to progress. In these cases adjuvant tumour therapy does not appear to be necessary. The relative merits of simple lesionectomy vs. additional removal of the epileptic focus in patients with lesional syndromes need further investigation.

LESIONAL EPILEPSY:

BASED ON INDIVIDUAL LOBES:

Frontal Lobe Seizures[12]:

Knowledge about epileptic auras and clinical seizures of frontal lobe origin stems from clinical observations, neuro-radiological findings and electrophysiological data. Interictal behavioural data derive from clinical and neuropsychological observations.

The diversity of auras and seizures indicates that the epileptic discharges originate from different parts of the frontal lobe, if they remain localized, or are projected to other lobes within the same hemisphere, or to the contra lateral frontal lobe. New data from Hospital Sainte-Anne in Paris, and the Montreal Neurological Institute, MNI, report auras from different regions of the frontal lobe as; forced thinking (anterior), olfactory (orbital), gustatory (opercular), psycho-emotional (cingulate), visceral (orbital), visual (dorsolateral), and as cephalic, somatosensory, dizziness, epigastric, fear, auditory, visual, dreamlike, other (dorsolateral).

Seizures of orbito-frontal origin, according to the Sainte- Anne data, have olfactory hallucination and illusions, visceral sensory symptoms, gestural disorders, respiratory and cardiovascular disorders, etc. Seizures from the anterior cingulum express themselves as fear, screaming, aggression, emotions, complex motor behaviour, or partial loss of consciousness, etc. Seizures of the intermedial region lead to absences, speech or motor arrest, conjugated deviation of eyes and head, complex motor seizures, abduction of the arm, or tonic/clonic generalization, etc. seizures of the motor and premotor areas appear as isolated myoclonic jerks, partial Jacksonian motor seizures, epilepsia partialis continua, speech arrest, vocalization, adversive movements, abduction of the contra-lateral arm etc. Complex partial seizures of medial intermediate frontal origin have defects in consciousness; conjugate eye deviation and head adversion, abduction of the upper limb, autonomic manifestations, automatisms and tonic/clonic generalization. The multi-centre study mentioned, stated that the complex partial seizures of frontal origin are shorter than those of temporal origin. An early arrest reaction followed by oro-alimentary automatisms is said to represent temporal lobe seizures. In the book on Surgical Treatment of the Epilepsies, seizures from the dorsolateral cortex are described as generalized tonic/clonic, from the SMA as asymmetric tonic seizures, from the cingulum as absences, and from the orbital cortex as complex partial seizures, though not identical to those of temporal lobe origin.

The aetiology of frontal lobe seizures in the recent Sainte- Anne material of 100 patients was unknown in 37%, neonatal anoxia in 18%, encephalitis in 15%, postnatal traumatic in 15%, and miscellaneous causes in 15%. Radiological findings in patients with frontal lobe lesions may be demonstrated with CT and/or MRI. Cranial vault asymmetries or posttraumatic sequelae are sometimes seen on plain skull radiographs. Post infectious, postencephalitic, cavernous angioma, tuberose sclerosis, Sturge-Weber, glial tumours, porencephalic cysts, or cortical dysplasia are well made out both on CT scan and MRI. Interictal PET may show hypo-metabolism, which may not be spatially concordant with the epileptogenic region.

The electrophysiological work up of some patients with frontal lobe epilepsy can be accomplished with scalp EEG. However, invasive recordings are often necessary. Surface or depth electrodes are implanted into selected regions, often bilaterally. Video-EEG recording of ictal activity preceding the clinical seizures is performed until data have been collected about the location and size of the epileptogenic lesion, and the possible projection of its activity. The chronic electrodes also allow repeated investigations with electrical stimulation to study the auras or seizures and other cerebral functions.

Discriminative neuropsychological testing of frontal lobe capacities is important in the pre-surgical work up. Together with the intra carotid Amytal test for hemisphere speech and memory the investigation defines capacities, which may be impaired in patients with frontal epileptogenic lesions.

THERAPEURIC EXCISIONS IN THE FRONTAL LOBE[19]:

If local anesthesia is used, motor, sensory, and speech / language function may be studied in cooperation with the patient. Under general anesthesia, movements can be elicited with electrical surface stimulation of the motor strip, and evoked somatosensory responses can be recorded from the sensory cortex. However, if stimulation of Broca's area has not been carried out during pre surgical investigation, the stimulated motor strip, (two opercular gyri in front of the motor gyrus, extending about 3 cm above the Sylvian fissure). Spontaneous ictal and interictal epileptic discharges are looked for and localized. The mapping should start only when the effect of the muscle relaxant agent, Vecuronium, has worn off. The excision may be within the polar, lateral, orbital or para-sagittal regions.

SURGICAL RESULTS:

The outcome of extra-temporal excisions with regard to seizures does not match those of the temporal lobe probably since vital cortical areas limit the extent of the excisions. Unacceptable neurological deficits must be avoided (aphasia, paresis). In spite of the risks, excisions are recommended, especially if a well-delineated epileptogenic lesion can be removed.

In 1975 Rasmussen reported the outcome of 257 frontal patients operated at the MNI, 26% becoming seizure free, 30% obtaining a marked reduction, and 40% a lesser reduction in seizure tendency. In 1983 he described the outcome of frontal excisions for non-tumoral lesions in 239 patients, 17% of them becoming seizure free (32). In 1991 Rasmussen correlated the outcome of 253 frontal cases with the anatomical location of the excision. An anterior frontal excision gave the best outcome, 47%

becoming seizure free, while a para-sagittal removal had the least favourable outcome, and 18% of those patients becoming seizure free[17].

The over-all success of frontal excisions in 100 patients from Sainte-Anne in 1992 was 55%. Patients in whom it had been possible to delineate epileptogenic regions with SEEG had the best chance, 85%, to benefit from surgery. The outcome was detailed as; seizure free 23%, rare seizures 32%, markedly improved 21%, and failure in 19%. When seizure outcome was related to the anatomical location of the resection a successful result, > 75%, decrease in seizure frequency was seen in 45% of the prefrontal, 35% of intermedio-frontal, 14% of the fronto-temporal, and 49% of medial frontal excisions. The improved seizure situation is usually accompanied by a behavioural improvement. The Sainte-Anne material reveals a neuropsychological improvement in 40%, and the disappearance of behavioural disorders. However, the disorders could persist despite the disappearance of seizures.

Turmel et al. reported the surgical outcome of 21 frontal cases, 38% becoming seizure free.

The outcome of Silfvenius with regard to seizures is; 19% are seizure free, 23 % markedly improved, 26% have benefited even less, and 32% are unimproved. One third of the unsuccessful results were among the tumour patients. Re-operations were undertaken in six cases, with a marked improvement in three patients[17].

Chronic encephalitis:

A surgical report from Montreal Neurological Institute (MNI) in the Frontal Lobe Seizures and Epilepsies describing 39 cases of Rasmussen's encephalitis, which underwent cortical excisions, showed that 69% had a frontal lobe or a combined extra-frontal excision. However, the removals did not influence the course of this severe disease.

Complications:

In 1963 Rasmussen reported no mortality in 117 patients operated after 1945. The 1987 global survey on the complications of extra-temporal excisions lists no mortality among 432 cases, and morbidity in 2%. The 1992 Sainte-Anne frontal lobe material included non diagnostic complications, with a mortality of 5%, and a morbidity of 32% consisting of; infection / inflammation, aphasia, reduced verbal fluency, accentuated motor deficit, akinesia, or increased sensory deficit. Turmel et al. reported morbidity or an aggravation of existing deficits, or new ones detected neuropsychologically, in most of their 21 patients, despite a marked reduction in seizures[17].

Re-operations:

Re-operations may be carried out after unsuccessful outcomes. In 1963 Rasmussen reported results of frontal excisions in 250 cases. Thirty-two cases were re-operated, 2/3 of them becoming seizure free or markedly improved. Salanova in 1991 reported the MNI results of 39 re-operated patients with frontal lobe epilepsy[14]. In the re-evaluation of surgical failures and re-exploration for patients of lesional fontal lobe epilepsy published by Mosewich, follow-up was available for 35 patients. Only 1 patient was seizure-free since discharge and 6 other patients became seizure-free after early attacks. An additional 31% had very few attacks, 11% had late recurrence of occasional seizures and 20% had no more than two seizures a year. Thus, the main factors correlating with favorable outcome were absence of or reduction in spiking on post-resection ECoG and the anatomical group involved[10].

Contraindications:

Patients with generalized seizures associated with bilateral lesions and widespread bilateral EEG discharges are considered unsuitable for an excision

Neuropathology:

The histopathological findings of removed frontal lobe specimens are reported separately by some authors, or included among the results of excisions in other cortical areas. Rasmussen in 1983 described the histopathology of 40 frontal cases as; meningo-cerebral cicatrix in 50%, cicatrix or gliosis in 33%, hamartoma or dysplasia in 8%, while 10% had other findings (32). A recent, detailed account of the MNI findings in non-neoplastic surgical specimens from 180 frontal cases, was specified as; meningocerebral-cicatrix 33%, neuronal loss and gliosis 33%, cortical dysgeneses 15%, contusions 11%, gliosis 4%, meningo-encephalitides 3 %, miscellaneous 3%, and abscess 1%.

Lesional Frontal lobe epilepsy:

Frontal lobe epilepsy (FLE) is associated with several specific problems with respect to epilepsy surgery. Seizure origins may not be limited to a circumscribed anatomic region, and seizures can be widespread within the frontal lobe and even on the contralateral side. Interictal and ictal surface electroencephalographic (EEG) recordings are often nonspecific, because of either the absence of epileptogenic activity or the rapid spread of epileptiform discharges to ipsilateral frontal or temporal regions. The classification of frontal lobe seizures is difficult, because a considerable number of different seizure subtypes can be involved. It has been repeatedly noted that the results of surgery for FLE are not as rewarding as those for temporal lobe epilepsy[20].

For the resections the extent of lesionectomies was guided by the definition of the epileptogenic zone. A lesionectomy was usually supplemented by a corticectomy of the surrounding cortex (at least 0.5 cm, to a maximum of 1 cm), unless hindered by eloquent cortex.

Class I outcomes were achieved in 54% of the cases and Class II outcomes in 18%; therefore, significant improvements were achieved in 72% of the cases. The differences between the histological subgroups were not significant when Classes I and II were considered together, i.e., tumors, dysgenetic cases, vascular malformations, and glioses did not differ in outcomes when good results were assessed. However, when freedom from seizures was the only criterion, patients with dysgenetic lesions fared much better than did those with vascular malformations, tumors, or gliosis. Prognostic factors for outcome in frontal lesional epilepsy include complete lesion excision, disappearance of spikes in postoperative electrocorticographic assessments, presence of a MRI-detectable lesion, lesser extent of lesion and extent of resection' focal pathological features, circumscribed resections and later onset of seizures.

Megdad M. Zaatreh analysed 37 patients with frontal lobe tumoral epilepsy. Mean age at seizure onset was 31.6 years, and at tumor diagnosis was 36.2 years. Mean duration between onset of seizures and tumor diagnosis was 6.1 years. Seventeen patients had auras. Seizure frequency averaged 7.6 seizures per week, with 58% of patients having more than one seizure type. All patients used anticonvulsants, with 90% eventually using polytherapy. Only 13 (35.1%) patients were class I. Twelve (32.4%) patients were class II, seven (18.9%) class III, and five (13.5%) class IV. No statistically significant differences were seen between good and poor long-term seizure outcome in relation to specific tumor pathology, seizure types, or type of resection[20].

They concluded that long-term surgical outcomes in tumoral frontal lobe epilepsy are more favorable than those in nontumoral intractable frontal lobe epilepsy (65% class I or II) and less favorable than those in other tumoral epilepsy (overall, 70% class I). Also, frontal location of intracranial neoplasm may predict a less favorable long-term epilepsy prognosis than tumoral epilepsy in general.

Tailoring of Cortical Excisions for Frontal Lobe Epilepsy[14]:

By the end of 1980, 402 cases of frontal lobe epilepsy had accumulated in the series at MNI. These 402 patients include 119 patients with tumoral epileptogenic lesions of the frontal lobe predominantly indolent slow growing gliomas. These patients who masqueraded as ordinary seizure problems, and were operated upon as such, constitute 29% of the frontal lobe series. Post-natal trauma was the most common presumed etiological factor and involved 113 patients, 40% of the 283 patients with non-tumoral frontal epileptogenic lesions. Post-inflammatory brain scarring was the presumed cause in 39 patients.

The sensory-motor cortex:

The simple partial seizures arising from epileptogenic lesions within or adjacent to the sensory-motor cortex are stereotyped and easy to diagnose. They are motor and/or sensory, may advance along the sensory-motor cortices and may terminate as secondarily generalized attacks. Post-ictally there may be a transient paresis. Patients with partial status epilepticus, epilepsia partialis continua of Kojewnikov, may have seizures continuing for days or longer. The investigation should determine if the seizures' originate from a lesion within the sensory-motor cortices proper, or from adjacent, frontal, temporal, or parietal gyri. A longstanding structural epileptogenic lesion in a portion of the motor/sensory cortex may lead to neurological deficits within the face, hand, arm, or leg areas. However, the lesion may not be visible with brain imaging. In such a case a microdysgenetic lesion can be suspected.

If non-invasive neuro-physiological studies fail to localize the epileptogenic lesion, the region should be explored. This may involve a flap exposure and implantation of epidural or sub-dural strip/plate electrodes. Information about the start, location and spread of the focal epileptic activity and the functional characteristics of the sensory-motor cortex involved in the epileptic manifestations will be obtained during the exploration. If the intra-operative investigation is insufficient, a postoperative study is made using video- EEG, electrically evoked epileptic after discharges, evoked movements, and sensory evoked responses. The region from which the patient's habitual seizures, or similar seizures, are evoked by low intensity cortical stimulation is assumed to be the epileptogenic region. Such an analysis has the advantage of giving the patient the opportunity to report phenomena not asked for, or recalled previously. If expertise and technology is available, SEEG explorations can be performed.

Surgical technique:

When surgery is carried out under general anaesthesia and the motor cortex is to be electrically stimulated, a short acting muscle relaxant (vecuronium) should be used in order to allow for functional mapping of the motor cortex. Under local anaesthesia, the sensory cortex is first explored functionally, the patient describing the sensations elicited. The functional identification of the motor cortex is done after ECOG recording, in combination with electrical stimulation to provoke after discharges. The functional subdivisions of the sensory-motor cortex are defined with electrical surface stimulation. The study is made with precision (a few square mm at a time), registering movements in individual muscles on the contra-lateral side of the body. Functional mapping of the sensory cortex under general anesthesia, can utilize somatosensory responses evoked via afferent nerves of the upper or lower extremity. Once the epileptogenic lesion and the sensory-motor cortex have been marked with numbers or letters, the exposure is photographed.

The excision is tailored in relation to the sensory-motor cortex. A lesion involving the lower lateral portion with the tongue-face area may be excised, with a possible transient paralysis as a consequence. The upper border of an excision should be at the thumb-finger subdivision of the motor cortex. An excision in the premotor gyrus, anterior to the motor face region can be done in the non-dominant, but not in the speech-dominant hemisphere, i.e. within or near the Broca's area. Similarly, a cortical excision immediately-posterior to the sensory face area may be carried out in the non-dominant, but not in the speech-dominant side, as it belongs to the parieto-temporal language zone (Wernicke). It is particularly important in planning excisions in and around the suprasylvian sensory-motor cortex to obtain conclusive findings from the intracarotid Amytal speech test. An excision within other parts of the sensory-motor area will lead to permanent neurological deficits, the degrees of which are related to the size and function of the somatotopic division removed or interfered with.

Results of cortical excisions in the sensory-motor cortex[17]:

Clinical considerations restrict the excisions in the sensory-motor cortex, and the seizure outcome is therefore less favourable than of those in the temporal lobe. Pooling the central, parietal and occipital results from 203 patients, Rasmussen concluded that 34% had become seizure free, 23 % almost seizure free, or markedly improved, and 44% had a less reduction of seizure tendency.

Insular ablation:

Cortical excisions of structural epileptogenic lesions in the hidden insular cortex are sometimes carried out without an anterior temporal lobe excision.

Morrell's operation, cortical undercutting:

The microsurgical undercutting of cortical fibres in vital epileptogenic areas has been described. The rationale is to cut horizontal intracortical fibres, thereby spread of the epileptic activity, but not the vertical incoming and outgoing fibres. Lesions in indispensable cortical areas (speech, language, and sensory-motor) can be treated surgically without permanent neurological deficits.

The Parietal Lobe:

Epileptic lesions within the non-dominant parietal lobe may be clinically "silent" or present with seizures symptomatic of the adjacent lobes, like simple partial, sensory-motor, visual, or complex partial seizures. Parietal lobe seizures of the speech-dominant hemisphere may interfere with language and other cognitive capacities. Structural epileptogenic lesions of the parietal lobe visible on brain imaging include atrophic cysts, cortical dysplasia, glial tumours, tuberous sclerosis, cavernous angiomas, gliosis, Sturge-Weber, etc. The presence of radiologically invisible microdysgenesis should be kept in mind. In some cases invasive video-EEG monitoring becomes necessary, with subdural or intracerebral techniques, especially in the language-dominant lobe.

When the epileptogenic lesion is near or within the Wernicke area the area may be defined by electrical stimulation of implanted electrodes or, if the middle cerebralartery supplies Wernicke's area then Amytal may be injected into individual branches of the artery selected by catheterization.

Surgical technique:

Excisions in the non-dominant parietal lobe may be radical, i.e. extend from the sensory cortex, without causing neurological deficits, except for visual field defects that may occur if the underlying temporo-parietal white matter is interfered with. Prior to the excision the sensory-motor cortex is defined. The removal may extend forward to the sensory cortex. The medial portion of the parietal cortex may be excised, respecting the large bridging veins. On the speech-dominant side, the excision must not encroach upon the lower parietal cortex below the motor thumb-finger area. The intraparietal sulcus has been suggested as the lower lateral boundary for an excision.

Results of Excision:

The parietal lobe excisions result in freedom from seizures in 45%, and marked improvement in 20%, while 35% do not benefit from them.

Complications:

The neurological deficits and complications from parietal lobe excisions are reported as minor and transient. No Gerstmann syndrome occurs if the excision is above the language zone in the speech-dominant lobe.

The Occipital Lobe[17]:

Occipital lobes are the least frequent lesions comprising 5% of the series of Rasmussen. Bidzinski et al. reported that their 1957-1989 material of 502 patients included 2% with an occipital lesion. The clinical seizures consist of visual symptoms, ictal blindness, visual hallucinations, or of seizures typical for the surrounding cortical areas. Rasmussen has listed the etiology of extemporal epileptogenic lesions as birth trauma or anoxia, postnatal trauma, post-inflammatory scarring, tumour and vascular lesion.

Surgical technique:

A lateral occipital craniotomy, approaching the midline, will give access to an ECOG recording from the lateral, as well as the medial and basal occipital surfaces and allow electrical stimulation for functional mapping (sensory-motor responses), or evoking afferent visual responses. A radical occipital excision leads to contra-lateral hemianopia. This risk is discussed in detail with the patient and relatives before the operation, especially if there is no visual field defect. An excision involving the visual radiation to the superior calcarine cortex will cause a contra-lateral lower quadrant hemianopia, while an excision of the inferior radiation leads to a contra-lateral upper quadrant hemianopia. Excising occipital lesions in the speech-dominant hemisphere is possible, but must be made posterior to the parietal language area in order not to produce dysphasia or dyslexia.

Results:

Bidzinski et al. reported a very good result in 10 of their 12 patients operated for an occipital epileptogenic lesion.

Complications:

If the posterior language zone is impaired by surgery, aphasia and dyslexia may follow.

Multilobar excisions:

Large epileptogenic lesions extending beyond any extra- temporal lobe require bilobar or multilobar removals, i.e. fronto-temporal, fronto-central, fronto-centro-parietal, or fronto-perisylvian excisions, etc. A fronto-temporal excision in the non-dominant side, may involve most of the two lobes. A corticectomy in the speech-dominant hemisphere must avoid the two-speech/language zones. A fronto-central excision in the non-dominant hemisphere may include the frontal lobe and the portion of the suprasylvian motor and/or sensory face areas. Large lesions in the parietal region demand excisions of surrounding areas like, parieto-temporal, parieto-central, or parieto-occipital removals. The extent of the excisions is guided by the position of eloquent cortex.

Extratemporal excisions in children[11]:

Extra-temporal excisions can be carried out in infants and children. A lesion secondary to an intrauterine injury may lead to neurological deficits, with or without mental retardation. If surgery is carried out early i.e. within a year or two after the onset of intractable, drug-resistant epilepsy, the excision will have the highest chances of being beneficial, and cause the least neurological deficits.. Goldring in 1987 reported extra-temporal excisions in 41 children out of whom 63% had a good outcome, becoming seizure free or experiencing early sporadic seizures.

COMPLICATIONS OF EPILEPSY SURGERY

Complications of epilepsy surgery are difficult to define and no universal definition exists. Authors have recorded complications during the pre-surgical invasive workup and also with various therapeutic procedures. A complication is defined as minor if it resolves within 3 months and major if it persists for longer than 3 months[17].

Complications like hematoma, infection or lead dislocation (minor) were reported to be 6.3%in a study of 205 patients who underwent invasive monitoring pre-operatively[17]. In our study 13(41%) patients had developed post-operative complications, with some of the patients developing more than one complication.

Minor complications include CSF leak, meningitis, hematoma, wound infection, CSF leak, lung or urinary infection.

Major complications include neurological deficits that include motor, sensory or visual. Non-neurological cardiac complications, deep venous thrombosis, pulmonary embolism.

Behrens reported a major complication rate of 4.3% in patients who underwent extratemporal resections[16]. Bertil reported a rate of 4.9%[17]. Inoue(5.1%)[17]

Complication rates for different surgical procedures:[17]

Extratemporal resections:	9.9%	4.9%
	Minor	Major
Frontal lobar resection	8.1%	3.2%
Parietal lobar resection	6.6%	6.6%
Occipital lobar resections	0	0

There was a clear correlation between age and severity of complications. More complications are reported in those above the age of 35 years. Probably with the emergence of atherosclerosis, hypertension and cardiac problems.

As per the definition of Bertil Rydenhag

A complication has been defined as minor if it resolves within 3 months and major if it affects activities of daily life and lasts longer than 3 months.

Major complications also include any significant neurological deficits, even if they do not affect activities of daily life.

Of the 654 surgical procedures primary therapeutic surgical procedures were performed in 375 patients, minor complications were reported in 8.9% of the cases and major complications were reported in 3.1% cases. Complications were divided into surgical and neurological complications. Among the minor surgical complications, infections were most prevalent.

Behrens et al. reported complication frequencies in the same range when they analyzed 708 procedures in Bonn. In their series, complications were subdivided into transient and permanent complications that approximately correspond to the definitions of minor and major complications. Permanent deficits occurred in 4.3% of the extra-temporal resections (versus 4.9% major complications in the paper published by Bertil. There was a clear correlation between age and severity of complications. To a large extent, the low complication rate for small children may be attributed to the advanced neuroanesthetic competence available. The extra-temporal group resulted in 7.4% neurological complications in the paper published by Elga Behrens et al

RESULTS

Thirty-one patients operated in this institute between 1996 and June 2003 was studied. Some of the patients were on review in this institute from 1992.The data was analyzed with respect to clinical presentation, radiological features, EEG findings, operative findings, post-operative morbidity, and seizure outcome. The data was statistically analyzed suing SPS 10.2 statistical analysis software system.

Patients were evaluated pre-operatively with a thorough history and clinical examination as detailed in the proforma. Importance was given to any neonatal events (seizures, trauma, meningo-encephalitis). The same was used to evaluate the influence on seizure outcome.

A documentation of the pre-operative Engel's score was documented along with any deficits that the patient had. Pre-operative MRI was performed in all the patients and the probable type of lesion on radiological analysis and the site were recorded.

The scalp EEG and Video EEG (localized or generalized), with the type of recording were analyzed to note whether there was a bearing on the outcome.

Invasive monitoring was done wherever applicable for extra-operative mapping of the ictal zone and the surrounding areas or if the scalp or Video EEG was non-localizing.

The date of surgery along with the procedure was noted. Some patients underwent awake craniotomy if the lesion was found to be close to an eloquent area.

A question that can be asked is whether all patients with extra-temporal lesions who present in Neurosurgery/ Neurology OPD are to be considered as lesional extra-temporal cases. They cannot be considered as

1. They may not be medically refractory and
2. The concordance of the lesion with respect to radiological, electrophysiological and clinical findings may not be known.

The post-resection ECOG was noted to check for the reduction in the spikes post-operatively. The same was used to check for significance with respect to the seizure outcome.

Complications post-operatively were grouped into minor or major based on the criteria provided by Bertil Rydenhag and the same was used in this study for evaluation. Post-operative Engel's score was recorded and patients were placed in two divisions. The first division consisted of patients with Engel's seizure score (post-operative) from 0 to 4 (Defined **as Excellent Outcome-non-debilitating seizures**) and the other group consisted of patients with seizure score of more than 4 (**Poor outcome**).

The other division consisted of patients with seizure score of 0 to 1(Defined as **Good Seizure outcome-Seizure free**) and more than 1(**Poor outcome**).

The Engel's score was recorded till the last follow-up. The minimum follow-up was for a period of one year.

EEG was done at an interval of 3 months, 1 year, 2 years and 3 years whenever applicable.

The site of the lesion and type of lesion on histopathological evaluation were analysed to correlate with the outcome.

The seizure outcome score was as per the Epilepsy Surgery Outcome Protocol used by the Comprehensive Epilepsy Centre at SCTIMST.

Seizure Frequency	Score
Seizure-free, off AED	0
Seizure-free, need of AEDS uncertain	1
Seizure-free, need AED	2
Auras only	3
Non-disabling nocturnal seizure only	4
1-3/year	5
4-11/year	6
1-3/month	7
1-6/week	8
1-3/day	9
4-10/day	10
>10/day	11
Status without barbiturate coma	12

The patients were divided into 2 divisions:

Division 1: Good outcome group, with score from 0 to 4

Poor outcome group, with score more than 4

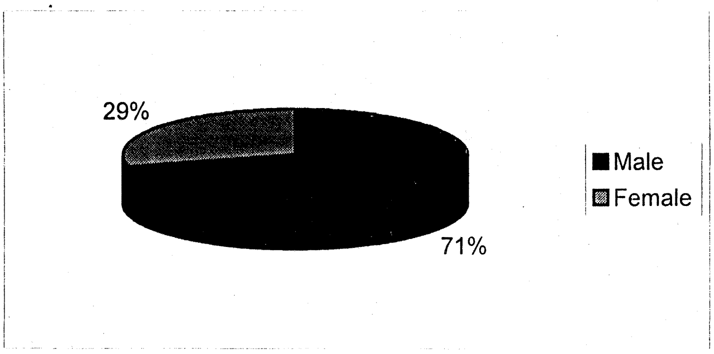
Division 2: Good outcome group, with score from 0 to 1

Poor outcome group, with score more than 1

The above results were analyzed with respect to data in both these divisions to check for correlation of outcome in both the divisions with various variables.

Analysis: There were 31 patients.

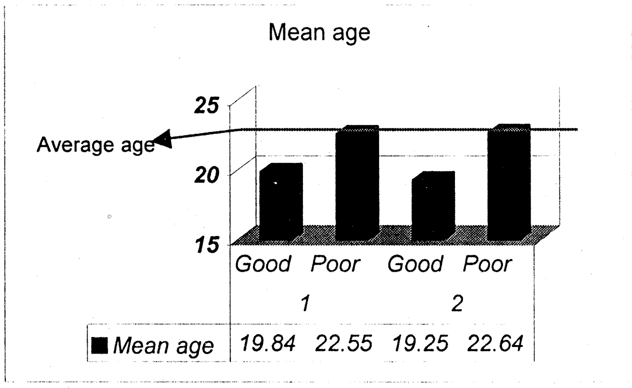
22 males and 19 females.



Gender had no relation to outcome of seizures.

Age of patients:

The average age of the patients was 20.83



The patients in Division 1:

Patients with good outcome average age was 19.84 years

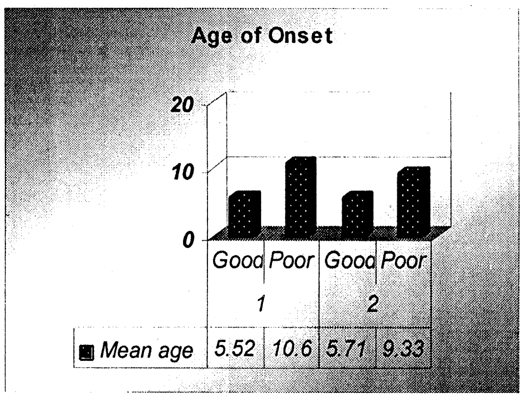
Patients with poor outcome average age were 22.55years.

The patients in Division 2:

Patients with good outcome average age were 19.25 years.

Patients with poor outcome average age was 22.64years

Age of onset:



Average age of onset was 7.4 years.

The patients in Division 1:

Patients with good outcome average age of onset were 5.52 years.

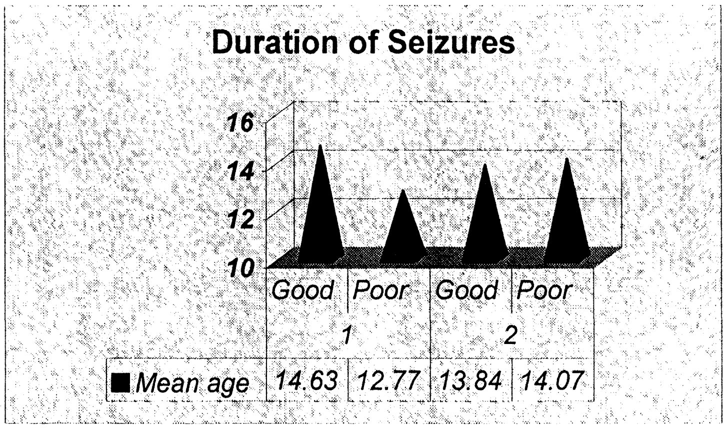
Patients with poor outcome average age of onset were 10.64 years.

The patients in Division 2:

Patients with good outcome average age of onset were 5.71 years.

Patients with poor outcome average age of onset were 9.33 years.

Duration of seizures:



Average duration of seizures was 13.95 years.

The patients in Division 1:

Patients with good outcome average duration of seizures were 14.63 years.

Patients with poor outcome average duration of seizures were 12.77 years.

The patients in Division 2:

Patients with good outcome average duration of seizures were 13.84 years.

Patients with poor outcome average duration of seizures were 14.07 years.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
AGE	Equal variances assumed	1.121	.299	-.797	28	.432	-2.70	3.391	-9.650	4.243
	Equal variances not assumed			-.731	16.179	.475	-2.70	3.697	-10.534	5.127
ONSETAGE	Equal variances assumed	1.174	.288	-2.680	28	.012	-5.12	1.908	-9.025	-1.206
	Equal variances not assumed			-2.506	17.127	.023	-5.12	2.041	-9.419	-.812
DURATION	Equal variances assumed	.148	.703	.570	28	.573	1.86	3.255	-4.811	8.523
	Equal variances not assumed			.555	19.376	.585	1.86	3.342	-5.130	8.843

Division1:

Using Levine's test for equality of variances and t-test for equality of means the age of onset of seizure has a bearing on seizure outcome. The age of the patient and duration of seizure has no bearing on outcome.

Independent Samples Test

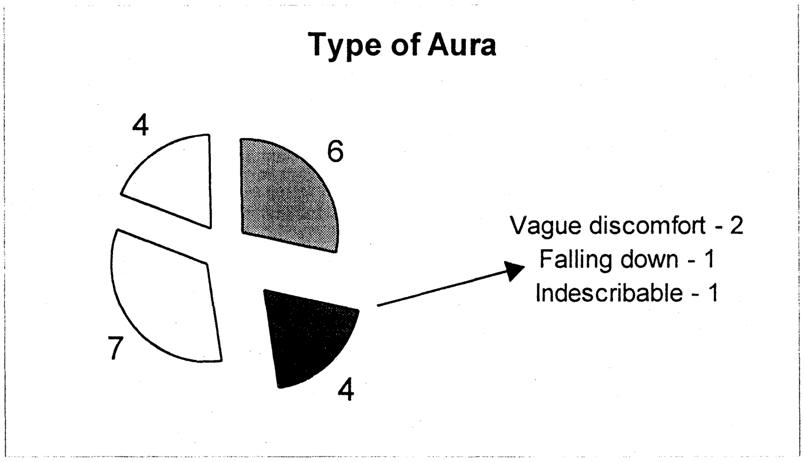
		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
AGE	Equal variances assumed	1.944	.174	-1.044	28	.305	-3.39	3.250	-10.050	3.264
	Equal variances not assumed			-1.020	22.882	.319	-3.39	3.328	-10.279	3.493
ONSETAGE	Equal variances assumed	2.530	.123	-1.858	28	.074	-3.62	1.950	-7.616	.372
	Equal variances not assumed			-1.820	23.603	.082	-3.62	1.991	-7.734	.490
DURATION	Equal variances assumed	1.442	.240	-.073	28	.942	-.23	3.162	-6.707	6.246
	Equal variances not assumed			-.072	23.667	.944	-.23	3.227	-6.896	6.434

Division 2:

Using Levine's test for equality of variances and t-test for equality of means the age of onset of seizure, the age of the patient and duration of seizure has no bearing on outcome

21 patients had history of aura.

The auras were divided as:



Sensory	6
Visual	4
Cephalic	7
Others	4

2 patients gave a sense of vague discomfort

1 patient had a sense of falling down

1 patient had an indescribable aura.

The presence of aura had no relation to the outcome of seizures in both the groups.

Type of seizures:

20 (64.5%) patients presented with CPS with secondary generalization

10 (32.25%) patients presented with SPS

1 (3.2%) patient presented with CPS only.

The type of seizure had no relation to the seizure outcome in both the divisions.

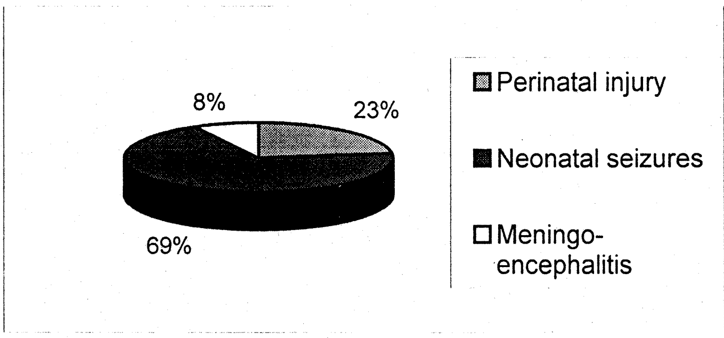
The presence of patients having secondary GTCS had no relation to the seizure outcome.

1 patient had history of status epilepticus.

3 patients had history of perinatal injury

9 had history of neonatal seizures.

1 had neonatal meningoencephalitis.



The above data was included under the heading of neonatal insults and were analyzed together to check for any bearing on seizure outcome. The presence of neonatal seizures, meningo-encephalitis, or perinatal trauma individually and as a neonatal injury group had no bearing on the outcome in both the divisions.

The presence of perinatal insults had no bearing on the outcome in both the divisions.

Pre-operatively eight patients had motor or visual deficits, out of which 4 had limb weakness and 3 had visual deficits. One patient had both limb weakness and visual deficits.

All patients had undergone scalp EEG, out of which 24 patients had their scalp EEG localized to a particular area.

Frontal	13 (41.9%)
Parietal	1 (3.2%)
Occipital	2 (6.4%)
Temporal	4 (12.85)
Central	1 (3.2%)
Parieto-occipital	2 (6.4%)
.Parietal/central	1 (3.2%)
Multifocal	1 (3.2%)
Frontal/Central	1 (3.2%)
Frontal/temporal	1 (3.2%)

There was no relation to the site of EEG localization to seizure outcome.

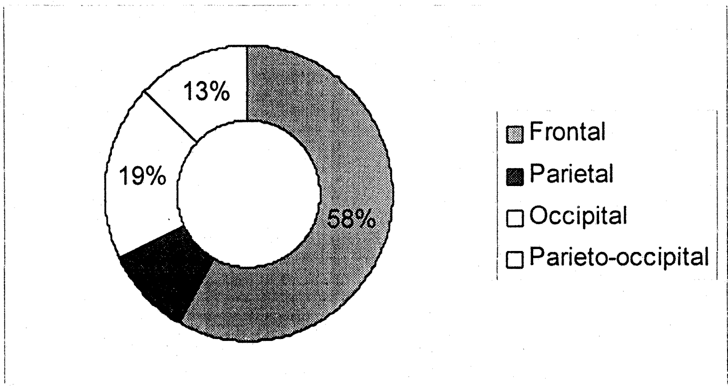
WADA test:

Seven patients had undergone WADA testing in the pre-operative period.

Brain MRI was done in all the patients.

The division of the site of lesion on MRI was:

Frontal	18 (57.6%)
Parietal	3 (9.6%)
Occipital	6 (19.2%)
Parieto-occipital	4 (12.8%)
Central	0



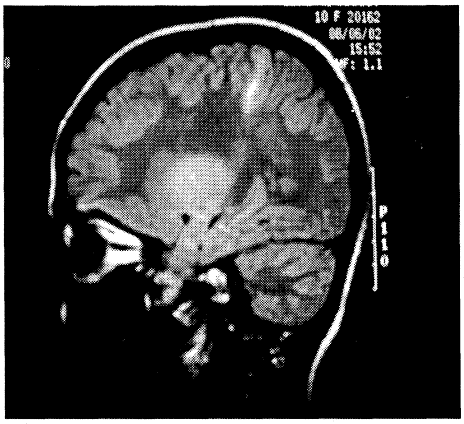
In one patient the lesion was recorded as bilateral (gliosis). The video-EEG was localizing to the left mesial occipital area.

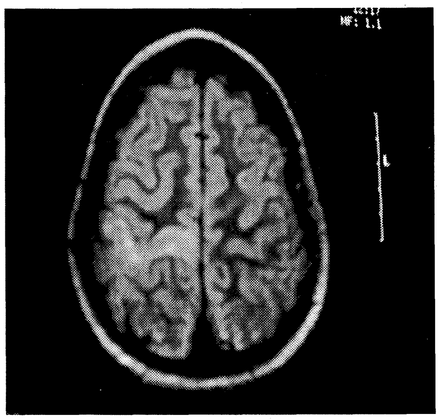
The site of lesion on MRI had no bearing on the seizure outcome.

Invasive monitoring:

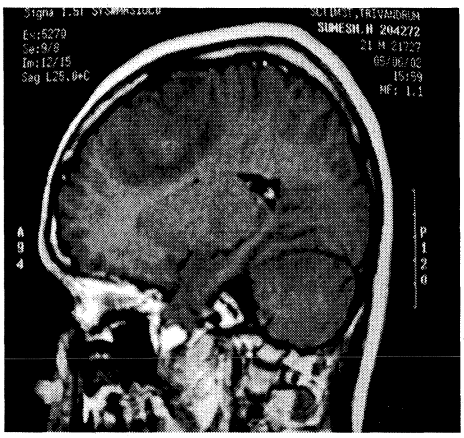
Thirteen patients had undergone invasive monitoring before actual surgical resection of the epileptic region.

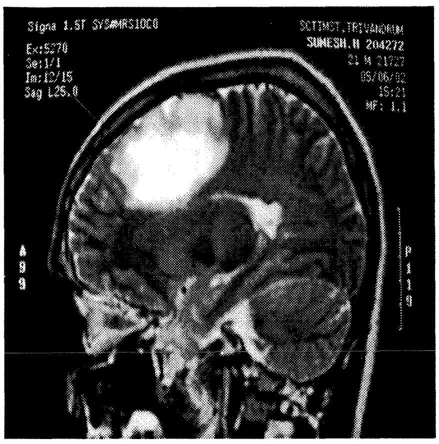
Rt. Motor area glioma





Rt. Premotor area glioma





The reasons for Pre-operative invasive monitoring were:

Non-localizing on EEG	7
Extra-operative mapping	1
Both the above reasons	5

Eleven of these patients underwent total resection of the lesion and 3 underwent partial resection.

The presence of pre-operative invasive monitoring had no bearing on the seizure outcome.

11 of the thirteen patients had more than 50% reduction in the spikes on ECOG recording in the post-resection recording.

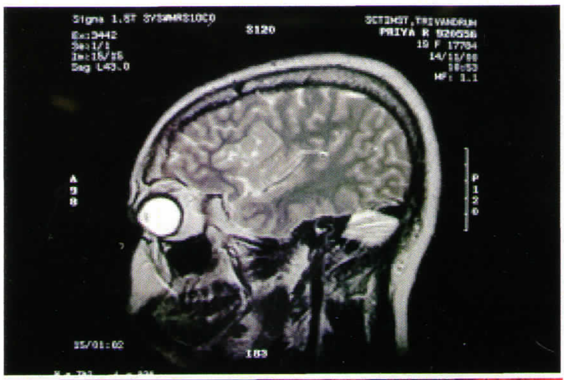
The degree of reduction (less than 50% or more than 50%) after resection had no bearing on the seizure outcome in both the groups.

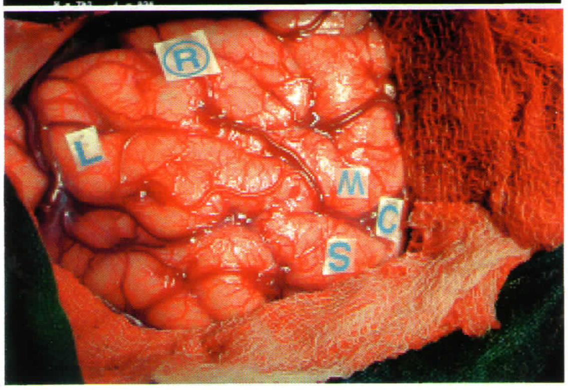
6 patients underwent resection under awake craniotomy and the remaining 25 under General anaesthesia.

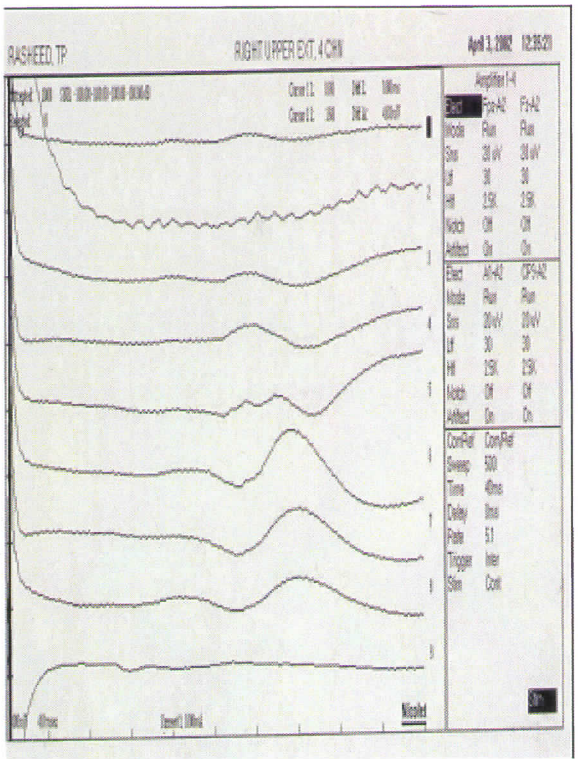
The site of the resected lesion:

The site to be resected was decided on clinical, radiological and electrographic concordance.

INTRA – OP MONITORING

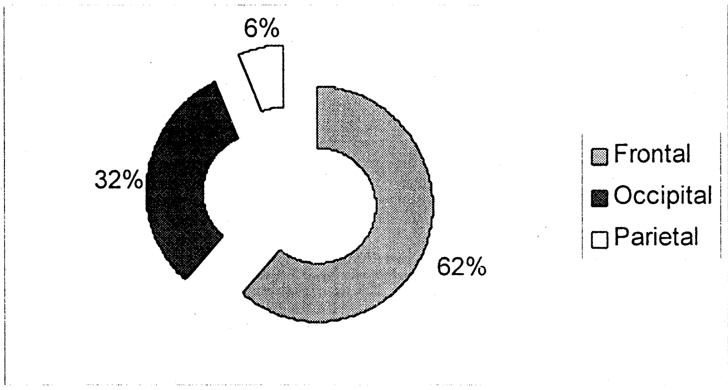






The site of the lesion was divided as:

Frontal	19 (60.8%)
Occipital	10 (32%)
Parietal	2 (6.4%)



The site of the resected lesion had no bearing on the seizure outcome.

Division 1:

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.818[a]	2	.403
Likelihood Ratio	1.918	2	.383
Linear-by-Linear Association	1.513	1	.219
N of Valid Cases	30		

a. 3 cells (50.0%) have expected count less than 5. The minimum expected count is .73.

Taking the frontal and parietal lesions together and the comparing with the occipital lesional resection, there was no significant correlation with seizure outcome (p=0.2465)

Division 2:

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.696[a]	2	.428
Likelihood Ratio	1.735	2	.420
Linear-by-Linear Association	1.602	1	.206
N of Valid Cases	30		

a. 3 cells (50.0%) have expected count less than 5. The minimum expected count is .93.

Taking the frontal and parietal lesions together and the comparing with the occipital lesional resection, there was no significant correlation with seizure outcome (p=0.2602)

Comparing the outcome of patients with frontal and occipital lesions in both the divisions there was no significant difference in the outcome between the two divisions.

The average post-op Engel's score at the end of 1 year was 3.41 (30 patients)

The average post-op Engel's score at the end of 2 years was 1.54 (13 patients)

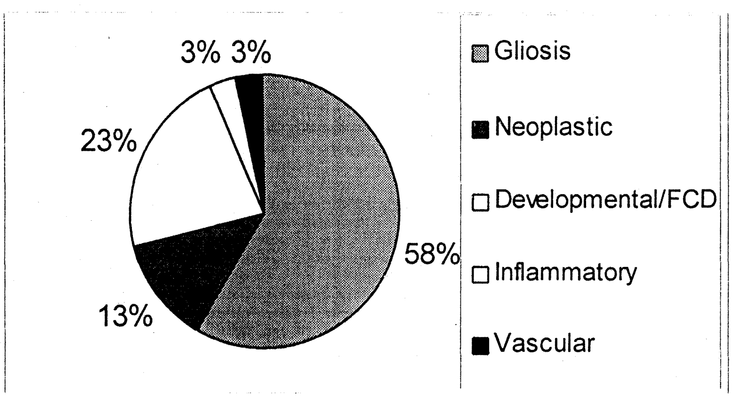
27 patients underwent post-operative scalp EEG at the end of 3 months out of which 11 patients had persistent spikes.

27 patients underwent post-operative scalp EEG at the end of 1year out of which 15 patients had persistent spikes. 5 patients underwent post-operative scalp EEG at the end of 2 years out of which 2 patients had

persistent spikes.

In both division 1 and division 2 there was no relation between the presence of post-operative spikes at the end of 3 months, 1 year and 2 years, on Scalp EEG and seizure outcome.

The type of lesions on histopathological examination:



Gliosis 18 (58%)

Neoplastic 4 (13%)

Developmental/FCD 7 (23%)

Inflammatory 1 (3%)

Vascular 1 (3%)

Division 1:

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.841[a]	4	.304
Likelihood Ratio	5.681	4	.224
Linear-by-Linear Association	.540	1	.462
N of Valid Cases	30		

a. 8 cells (80.0%) have expected count less than 5. The minimum expected count is .37.

The type of lesion had no bearing on the outcome. However patients with developmental disorders/FCD had a higher percentage of patients in the better outcome group in comparison to the other lesions.

Division 2:

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.703[a]	4	.319
Likelihood Ratio	5.546	4	.236
Linear-by-Linear Association	.764	1	.382
N of Valid Cases	30		

a. 8 cells (80.0%) have expected count less than 5. The minimum expected count is .47.

The type of lesion had no bearing on the outcome. However patients with developmental disorders/FCD had a higher percentage of patients in the better outcome group in comparison to the other lesions.

Gliosis:

Comparing the outcome of those patients with gliosis with other lesions there was no significant correlation with outcome in both the divisions.

Comparing the outcome of a gliotic lesion versus a developmental/FCD there was no significance if in the outcome of patients in the two divisions with respect to the seizure outcome.

Eloquent Area lesion:

11(35.2%) of the 31 lesions were in eloquent areas.

There was no significant correlation of the seizure outcome and the presence of lesion in an eloquent area.

Division 1:

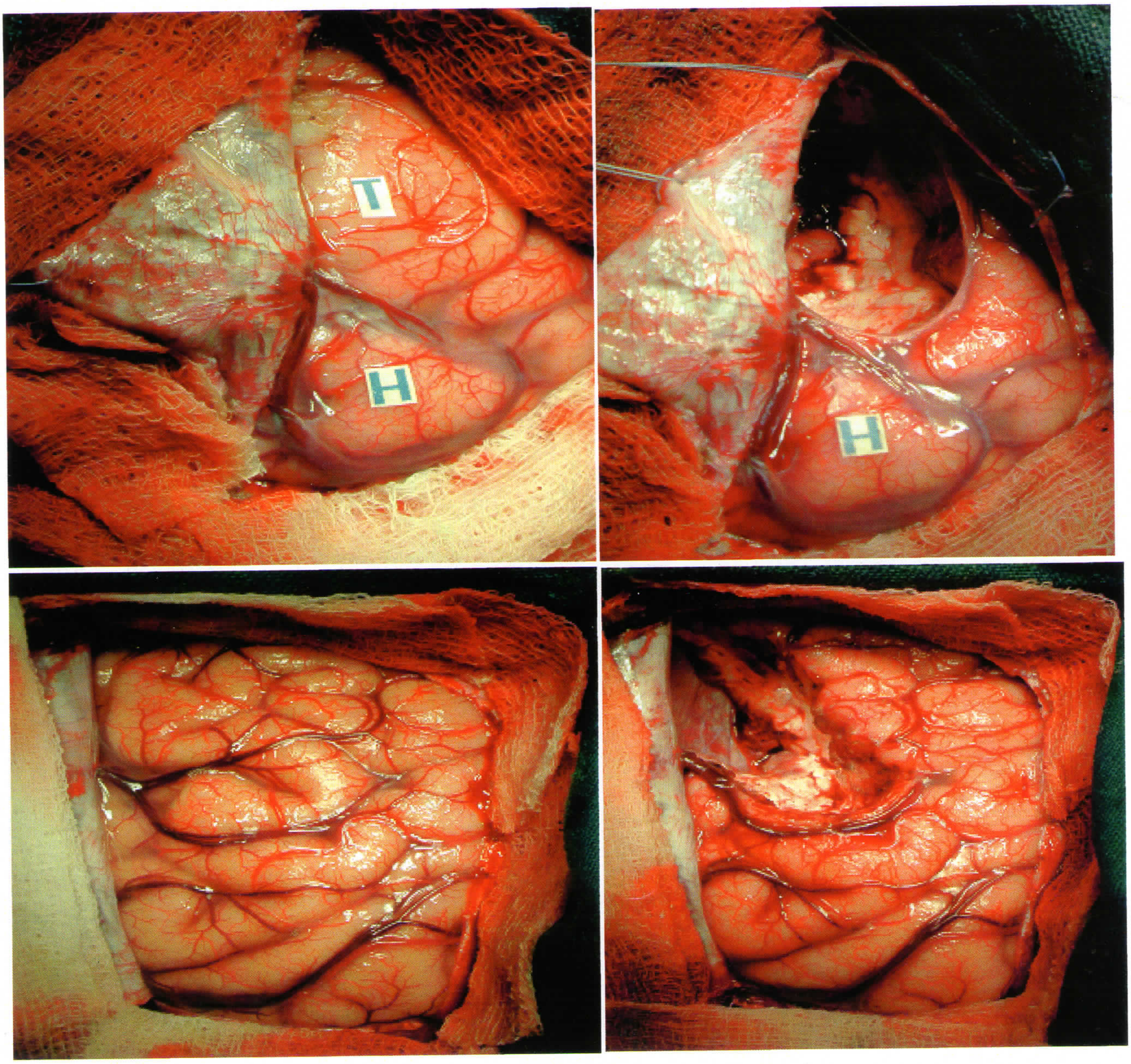
Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.578[b]	1	.447		
Continuity Correction[a]	.135	1	.714		
Likelihood Ratio	.572	1	.449		
Fisher's Exact Test				.696	.354
Linear-by-Linear Association	.558	1	.455		
N of Valid Cases	30				

a. Computed only for a 2x2 table

b. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 4.03.

RESECTION UNDER AWAKE CRANIOTOMY



T-Tumour
H-Hand area

Division 2:

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.010[b]	1	.919		
Continuity Correction[a]	.000	1	1.000		
Likelihood Ratio	.010	1	.919		
Fisher's Exact Test				1.000	.610
Linear-by-Linear Association	.010	1	.921		
N of Valid Cases	30				

a. Computed only for a 2x2 table

b. 0 cells (.0%) have expected count less than 5. The minimum expected count is 5.13.

Type of surgeries performed:

Decompression of lesion: 2

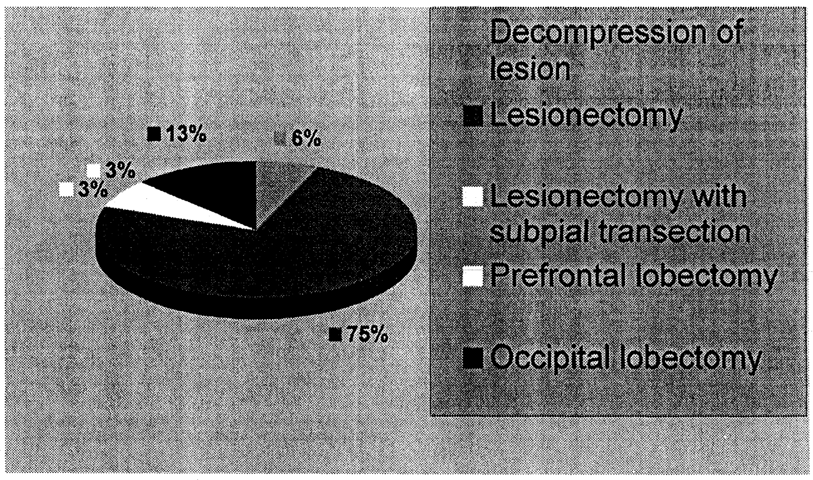
Lesionectomy: 23

Lesionectomy with subpial transection: 1

Lobectomy:

Prefrontal 1

Occipital 4



In both the divisions there was no significant correlation between the type of resection (for varying reasons) performed and the seizure outcome.

MORBIDITY: 13(41%) patients had developed post-operative complications, with some of the patients developing more than one complication.

We have divided the complications into minor if it resolves within 3 months and major if it affects activities of daily life and lasts longer than 3 months.

9 patients (32.25%) had developed major complications, which were permanent; which is high in comparison to the data (4.3%) published Bertil Rydenhag, for epilepsy surgery in general.

Major complications:

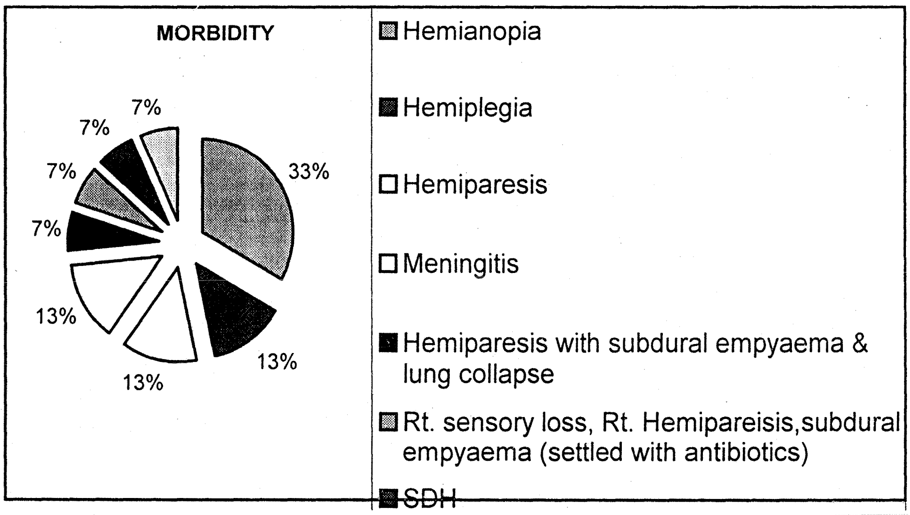
Type	No. of patients
Hemianopia	5
Hemiplegia	2
Hemiparesis	2

One patient who developed right-sided weakness on the second post-operative day was found to have a left sided subdural empyaema (on the operated side). The patient had a subdural grid placement done 10 days before resective surgery. He underwent emergency re-exploration and evacuation of the empyaema. He also developed lung collapse (consolidation-collapse) while in ICU for which he underwent bronchoscopic evaluation and removal of the obstructive plug. His weakness continues to be present on follow-up.

Another patient with a small subdural empyaema and fever settled on conservative management with antibiotics and aspiration through operative site burr-hole.

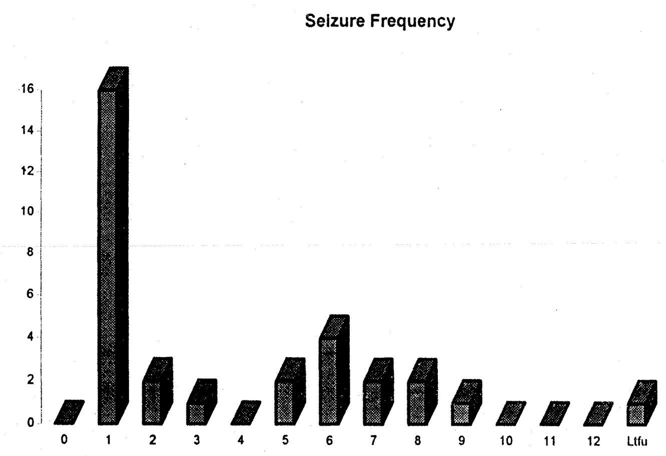
Minor Complications:

Type	No. of patients
Meningitis	2
SDH	1
UTI	1



Outcome of Surgery

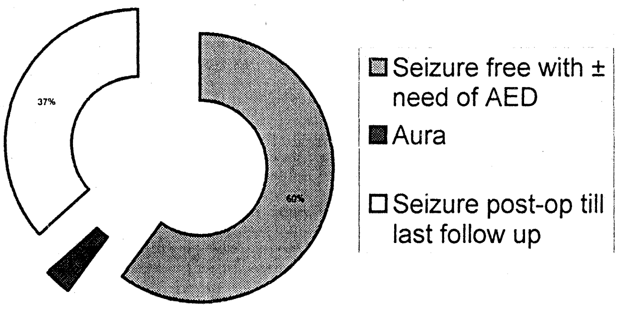
Seizure frequency with score	Number
Seizure-free, off AED (0)	0
Seizure-free, need of AEDS uncertain (1)	16 (51%)
Seizure-free, need AED (2)	2 (6.4%)
Auras only (3)	1 (3.2%)
Non-disabling nocturnal seizure only (4)	0
1-3/year (5)	2 (6.4%)
4-11/year (6)	4 (12.8%)
1-3/month (7)	2(6.4%)
1-6/week (8)	2(6.4%)
1-3/day (9)	1(3.2%)
4-10/day (10)	0
>10/day (11)	0
Status without barbiturate coma (12)	0
Lost to follow-up	1(3.2%)



18 (57.6%) patients were seizure free with or without the need of AEDs.

1 patient had auras only in the post-operative period

11 (36.3%) patients continued to have seizure post-operatively till last follow-up.



DISCUSSION

PRE-OPERATIVE VARIABLES:

Age of onset and duration of seizure:

In the paper by Hennessy *et al* a long duration of epilepsy was an adverse prognostic feature, with remission in 88% of those with duration of epilepsy of less than 10 years and 57% if this was more than 20 years. One of the persistent features of most epilepsy surgery series is that the median duration of epilepsy in patients who are referred is 15-20 years. Given the low likelihood of remission of epilepsy with pharmacological treatment if seizures have continued despite trying two or three antiepileptic drugs over 2 years, the case for much earlier consideration of epilepsy surgery is clear. A change in the current referral practice of patients from paediatricians and adult neurologists to epilepsy surgery centers is warranted. It is estimated that 3% of all people who develop epilepsy,those with refractory partial seizures that are arising from a discrete and non-crucial part of the brain would benefit from surgical treatment. The same has also been elucidated by **Gashlan M[13] et al,**

EEG:

In a paper published by **J. Janszky et al[7]**, on the EEG predictors of outcome for frontal lesional epilepsy, found that only the absence of generalized EEG signs (IED or slowing) could be held as an independent predictive factor. However in the cases evaluated by us there was no generalized EEG changes noted which could be used for analysis.

Secondary GTCS: In the same paper by **J. Janszky**[7] et al, the presence of secondary GTCS was associated with a poor outcome. However, in our analysis the presence of secondary GTCS in patients having seizures had no positive or negative correlation with outcome.

Presence of lesion: Rossi GF retrospectively reviewed 138 surgically treated epilepsy patients and found that the presence of a lesion did not predict surgical outcome. **J. Janszky**[7] **and Megdad M. Zaatreh**[20] independently, in separate studies elucidated the same in his analysis of outcome for lesional frontal epilepsy. We have not compared our outcome to an extra-temporal non-lesional epilepsy group.

Type of lesion:

Histopathologic lesions are likely to differ in their epileptogenic properties, however, and these differences should influence the surgical approach. For example, anatomically well-defined lesions such as DNETs have been shown to have restricted epileptic zone.

In our study the maximum number of lesions in our study were gliotic in nature (18/31). But patients with focal cortical dysplasias tended to have a good outcome though they were not significant statistically. This could be because of the site of the lesion in a non-eloquent area, which allowed full excision of the involved area. **J. C. Edwards**[6] concluded that there was a trend toward better seizure outcome following extra-temporal resections than temporal resections for focal cortical dysplasia; but the difference was not significant. Also the percentage of patients with postoperative seizure-free outcome tended to decrease progressively from childhood through adolescence and adulthood, but differences were not significant. Early epilepsy surgery may be appropriate in selected cases to minimize the adverse effects of continued seizures on the developing brain.

Henessey had reported that the good outcome of surgery for FCD induced epilepsy was in the order of 40% whereas DNET had a 76% outcome rate.

However the average age of our patients with FCD was 17.14 yrs and does not completely agree with the argument of early surgery for FCD.

The importance of performing a complete resection has significant implications for surgical planning and patient counseling.

However we have not found any significant relation to long-standing lesions such as gliosis, which was independently evaluated for outcome.

F Cendes[13], has published an association of dual pathology with extra-temporal lesions, in his study, frequency of hippocampal atrophy with low-grade tumors (2%) and vascular lesions (9%) was low. Dual pathology was far more common in patients with Neuronal migration disorders (25%), porencephalic cysts (31%), and reactive gliosis (23.5%). He hypothesized that common pathogenic mechanism during pre- or perinatal development may explain the occurrence of concomitant mesial temporal sclerosis and other structural lesions because of either (1) associated developmental abnormalities or (2) predisposition to prolonged febrile convulsions.

The presence of dual pathology was not comprehensively reported in our MRI data analyzed.

Invasive monitoring:

The use of pre-operative invasive monitoring either to map the lesional area or to localize the site of onset of seizure, which was not localized on SEEG or VEEG, had no bearing on the outcome of seizure. This could be explained by the fact that non-localisation of lesion or presence of a lesion in an eloquent area, precluded complete resection of the lesional focus.

According to Arthur Cukiert[1], extensive subdural electrode coverage seems to be an effective way to investigate patients with Refractory Extra-temporal epilepsy with normal or non-localising MRI findings. However, we have used invasive monitioring to identify areas which were non-localising on EEG and for extra-operative mapping of the lesion with respect to eloquent area. MRI showed lesions in all cases.

Site of lesion:

Many reviews are based on individual lesional or non-lesional frontal, parietal, occipital lobar resections for extra-temporal epilepsy individually. We have tried to analyze the results of all extra-temporal lesional epilepsy as a group and then tried to correlate the results individually and together. References for the whole group were difficult to get, based on the above cause.

The break-up of the lesion with respect to site of onset of seizures in 2177 patients operated at the Montreal Neurological Institute were as follows:

	Number	**Percentage**
Temporal	1210	56%
Frontal	402	18%
Central	151	7%
Parietal	141	6%
Occipital	30	1%
Large multilobar	243	11%

10(52.6%) of 19 frontal lesions, 1(50%) of 2 parietal lesions and 8(80%) of 10 occipital lesions were seizure-free on follow-up. In the series of Silfvenius, 56% of frontal lobe, 48% of parietal lobe, 35% of sensori-motor area resections were found to be seizure free. But these resections were performed both for lesional and non-lesional epilepsy. In the paper by Arhtur Cukiert, 81% of his patients with lesional epilepsy were found to be seizure free on follow-up, though he has not given the break-up of the outcome with respect to the site of resection, maximum number of cases was in the frontal lobe. Also, Frontal lobe epilepsy (FLE) is the second largest group of localization related epilepsies occurring in 6 to 30% of all surgically treated epilepsy patients. According to Megdad M. Zaatreh only 35% of frontal lobe epilepsy patient was in Engel's class I. He also said that frontal location of intracranial neoplasm may predict a less favorable long-term epilepsy prognosis than tumoral epilepsy in general. The better outcome recorded for occipital resections can be attributed to the higher incidence of gliotic lesions, which preclude better resections than other neoplastic and developmental lesions.

Andre Olivier had a Class I Engel's outcome in 34% of frontal lobe epilepsy surgery in a mean follow-up of 5.8 years.

The presence of a lesion in an eloquent area had no relationship to the outcome. Many of the lesions in eloquent areas were operated under awake craniotomy to limit deficits with respect to the resection. This could be a cause for the tailoring of resection as and when a patient experienced a deficit and then limiting the resection.

In his review on Surgery for central, Parietal and Occipital Epilepsy, Theodore Rasmussen[14], had found that the incidence of tumour aetiology was found to be 37% in the three anatomical subgroup. Post-inflammatory brain scarring was found in 5% of cases. Out of these 56% had a complete or marked reduction in seizure tendency significantly less than that of temporal lobe resections.

An analysis done with respect to outcome of lesional temporal lobe epilepsy, done by the same author showed a good outcome in nearly 78%[13] of the 21patients versus 58% of extra-temporal lesion patients in this study. The outcome of Surgery performed for Mesial Temporal Sclerosis had a seizure free outcome of 65%, with 20% having a significant reduction of seizures.

Complications:

13(41%) patients had developed post-operative complications, with some of the patient developing more than one complication.

10 patients (32.25%) had developed major complications, which were permanent; which is high in comparison to the data (4.3%) published by Bertil Rydenhag, for epilepsy surgery in general and less than the major morbidities (45%) recorded by Gregory D Cascino[3] for extra-temporal resections.

Many of the major complications (more in number with respect to minor complications) recorded were related to the site and nature of the lesion, which required resection/decompression of lesions situated in eloquent areas. Awake craniotomy did not reduce the incidence of complications.

The major complications encountered by Gregory D Cascino[3], for Extratemporal cortical resections were 13 in 39 patients, amounting to 45% and the majority included speech disturbance 5), Motor deficits (3), Intracranial (3). However, they had used extra-operative functional mapping, and intra-operative recordings of eloquent lesions had reduced the incidence of morbidity in the later part of the series. This had significantly reduced their morbidities.

Though there was no operative mortality though, one of the patient had committed suicide due to depression and this patient was lost to follow-up.

The evaluation done with respect to the incidence of complications in patients who had and did not have surgery under intra-operative monitoring, showed that there was no significant reduction in motor, sensory deficits in those with and without monitoring.

CONCLUSIONS:

Extra-temporal cortical excisions can safely be carried out benefiting the patient with intractable focal epilepsy. Since the extra-temporal areas harbor vital cortical function, language, sensory-motor capacities and vision, it is essential in the preoperative analysis to define the surgical chances and risks.

Neuropsychological testing is necessary to evaluate pre and post-surgical capabilities.

Intra-operative studies contribute exact information about the epileptogenic lesion and guide the surgery.

Our study found that the age of onset of seizure had a bearing on the outcome of surgery for extra-temporal epilepsy in a defined subgroup, and disorders of migration and occipital lesions were having a better though not significant outcome.

The outcome with regard to seizures is less favorable than after temporal lobe excisions, because of the restrictions set by the surrounding areas of eloquent cortex. Frontal lobe excisions lead to freedom from seizures in 52.6% depending on the type and location of the lesion. Excisions in the parietal and occipital cortices lead to freedom from seizures in 50% and 80% respectively.

The postoperative mortality was nil, morbidity occur in 41% of the patients, predominantly minor complications. The most frequent major surgical complications are hemiparesis, visual-field deficits. The surgical chances and risks should be assessed against the long-range outcome of intractable extra-temporal epilepsy treated medically.

Lesional extra-temporal lobe surgery should be considered in candidates who are refractory to medical treatment in view of the fair chance of seizure control and minimum risk of morbidity.

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