

Comparative Study on Surgical Outcomes of Posterior Cortex Epilepsy - Occipital Lobe Epilepsy With Extended- Occipital Lobe Epilepsy Pathologies

Dr. LOKESH VELLORE DASARATHAN

PDF - FUNCTIONAL NEUROSURGERY

2024 - 2025



**SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND
TECHNOLOGY, TRIVANDRUM**

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**COMPARATIVE STUDY ON SURGICAL OUTCOMES
OF POSTERIOR CORTEX EPILEPSY - OCCIPITAL
LOBE EPILEPSY WITH EXTENDED-OCCIPITAL
LOBE EPILEPSY PATHOLOGIES**

A THESIS SUBMITTED BY

Dr. LOKESH VELLORE DASARATHAN

TO

SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND
TECHNOLOGY, TRIVANDRUM.

IN PARTIAL FULFILMENT OF THE REQUIREMENTS

FOR THE AWARD OF

POST DOCTORAL FELLOWSHIP

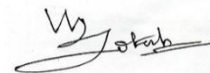
FUNCTIONAL NEUROSURGERY

DECEMBER - 2024

DECLARATION BY THE STUDENT

CERTIFICATE

I, Dr. Lokesh Vellore Dasarathan, hereby certify that I had personally carried out the work depicted in the thesis titled, “Comparative Study On Surgical Outcomes Of Posterior Cortex Epilepsy - Occipital Lobe Epilepsy With Extended-Occipital Lobe Epilepsy Pathologies”. No part of this thesis has been submitted for the award of any other degree or diploma prior to this date.



Dr. Lokesh Vellore Dasarathan

Department of Neurosurgery,

SCTIMST, Trivandrum

Date: 30/12/2024



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The thesis entitled, “**Comparative Study On Surgical Outcomes Of Posterior Cortex Epilepsy - Occipital Lobe Epilepsy With Extended-Occipital Lobe Epilepsy Pathologies**” was carried out under my direct supervision. No part of the thesis was submitted for the award of any degree or diploma prior to this date.

*Clearance was obtained from the Institutional Ethics Committee of this **institute (IEC – 2261/Sep 2024)** for carrying out the study.

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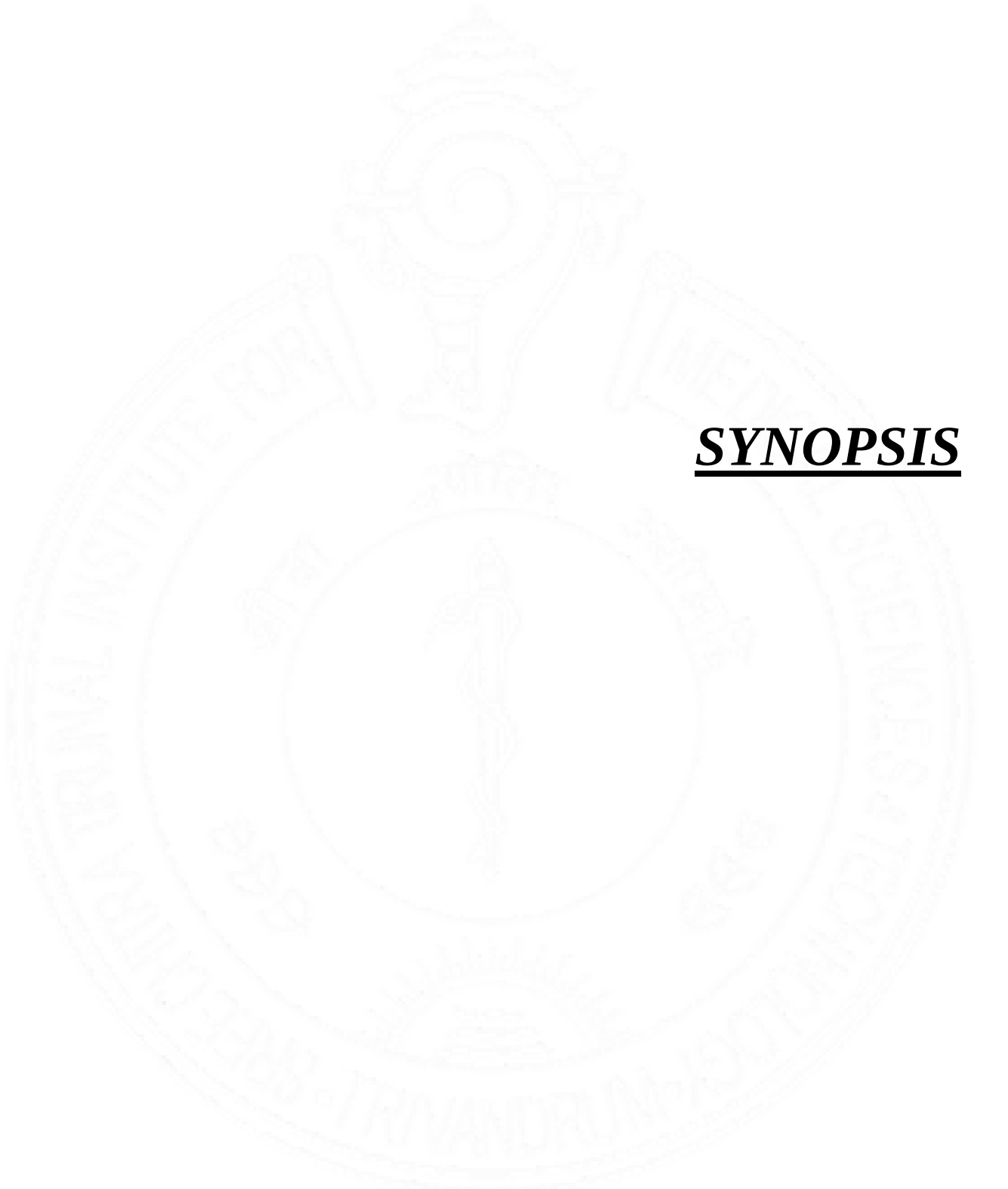
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LIST OF ABBREVIATIONS

S No	Abbreviation	Full Form
1	ECoG	Electrocorticography
2	EEG	Electroencephalography
3	MRI	Magnetic resonance imaging
4	PET	Positron emission tomography
5	SPECT	Single photon emission computer tomography
6	OL	Occipital lobe
7	EOL	Extended occipital lobe
8	DRE	Drug resistant epilepsy
9	ASM	Antiseizure medications
10	FCD	Focal cortical dysplasia



SYNOPSIS

Background:

Occipital lobe epilepsy (OLE) is a relatively uncommon etiology for epilepsy surgery compared to other regions in the cortex. As there is an imaginary boundary between occipital lobe and other adjacent lobes, there are some pathologies which extends to parietal, temporal, parahippocampal, mesial temporal structures. Depends on the extent of involvement some patients undergo partial occipital lobectomy, anatomical occipital lobectomy, with partial or complete parieto-temporal resection. The etiopathogenesis could be the same for lesions confined within occipital lobe and those with adjacent lobar extension. But the extension into adjacent lobes may have stronger underlying epilepsy network. Doing partial occipital lobectomy for pathologies involving the occipital lobe with adjacent lobe extension, in order to minimize the cortical resection, may predispose to poor surgical outcomes due to the underlying intact epileptogenic network. The seizure outcome analysis between this group of patients were not analyzed and compared exclusively in the literature.

Methods:

We retrospectively analyzed the prospectively collected data from 2005 to 2022 in our RMNC epilepsy center. We included the patients of all age groups who underwent surgery for occipital lobe pathologies with drug resistant epilepsy. We have divided the patients into two groups viz pure occipital lobe pathologies and those involving the occipital lobe with parieto-temporal extension. We evaluated the preoperative clinical, electrophysiological, Video EEG, radiological profile, surgical strategies, histopathological diagnoses, complications and post operative seizure outcomes in these both groups.

Results

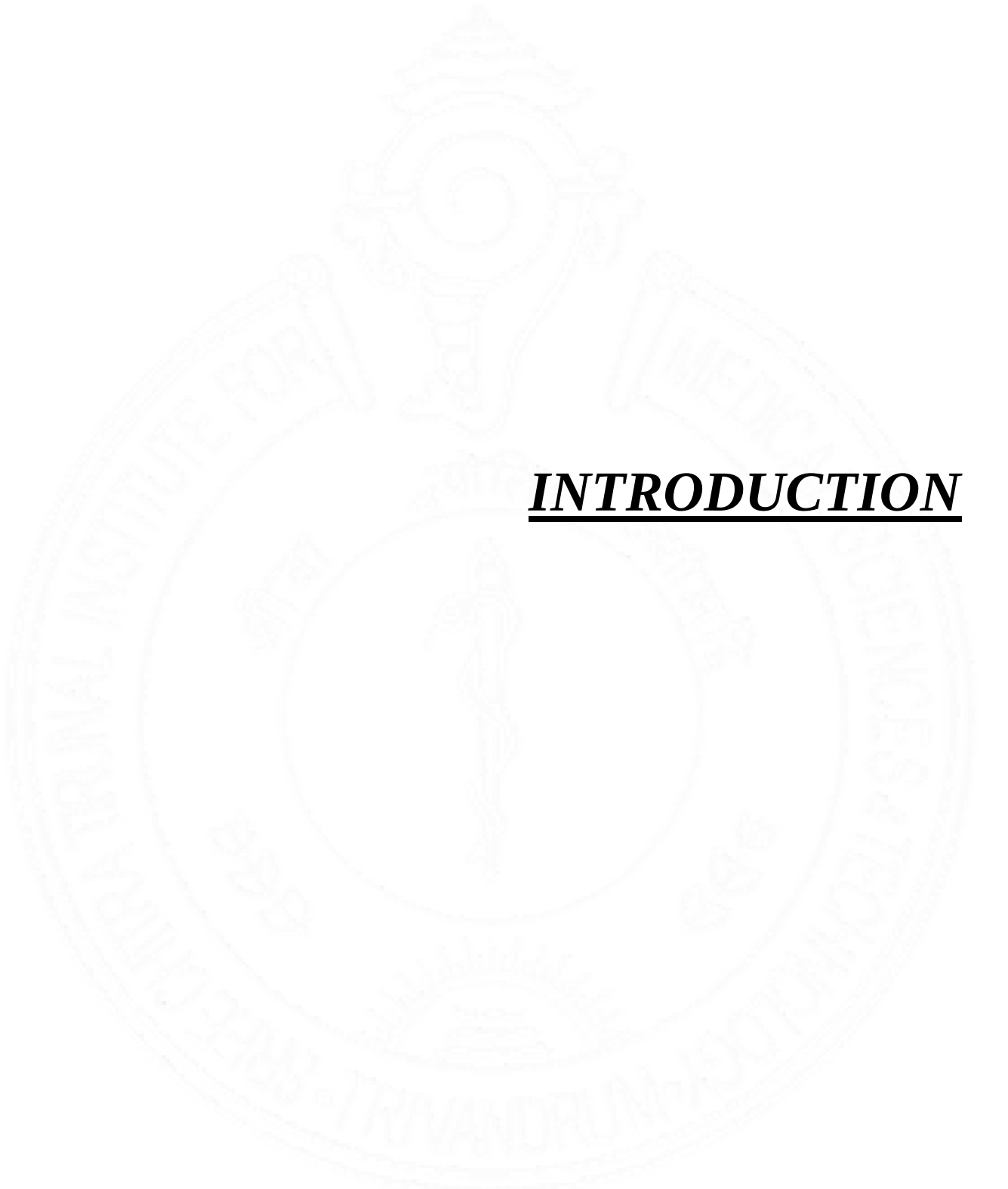
In this study, 124 patients with occipital lobe pathologies were included. Lesions involving only occipital lobe were found in 67(54 %), and the lesions involving occipital lobe(either whole or partial) with extension to adjacent lobes were found in 57 patients(46%). Antecedent events in neonatal period were identified in 60% of patients. The mean age of onset of epilepsy is 5 (2-7)

Complex partial seizures were the most common seizures identified with visual aura reported only in 80%. Invasive SEEG using strip and grid electrode was done in 26 patients with preoperative discordant data and uncertain localization. Seizure related falls($P=0.009$), Preop Motor deficits were more in EOL whereas Visual field deficits were higher in OL group before surgery($P=0.012$). Most common histopathology seen is Gliosis, followed by FCD, tumours and MCD. Within Occipital lobe, Gliosis - predominantly in Medial aspect, Tumours were seen more in lateral aspect ($P=0.001$). Intraop persistent spikes in ECOG($P=0.04$), residual lesion in MRI ($P=0.04$) seen more in EOL than OL group. Within EOL group, Large lesions extending to both Temporo-Parietal lobe has better resection status compared to lesions having limited extension to either Temporal or parietal lobe ($P=0.033$). Overall Seizure benefit - Engel outcome(class 1 and 2) is better in OL group as compared to EOL ($P=0.017$). Post op MRI complete resection correlated with good seizure benefit(Engel 1 and 2 – $P=0.001$) and reduced spikes in follow up EEG ($P=0.004$).

Post op EEG shows reduced/absent spikes more in OL group than EOL group (P=0.042).

Conclusion

Extended Occipital lobe pathologies and Occipital lobe pathologies has similar clinical and EEG characteristics. EOL group has more Pre and Post op motor deficits, OL group has more visual deficits. Intra op ECoG spikes reduction, Completeness of resection, Good Engel outcome, Post op EEG spike reduction was better in OL than EOL. EOL with parietal lobe involvement has poor outcomes than temporal lobe followed by combined parieto-temporal lobe pathologies. EOL group has poor results than OL probably because of its intricate whitematter connections to other lobes, which merits better preop planning (Stereo EEG, Higher Imaging modalities), more aggressive resection than required using Intraop ECoG guidance.

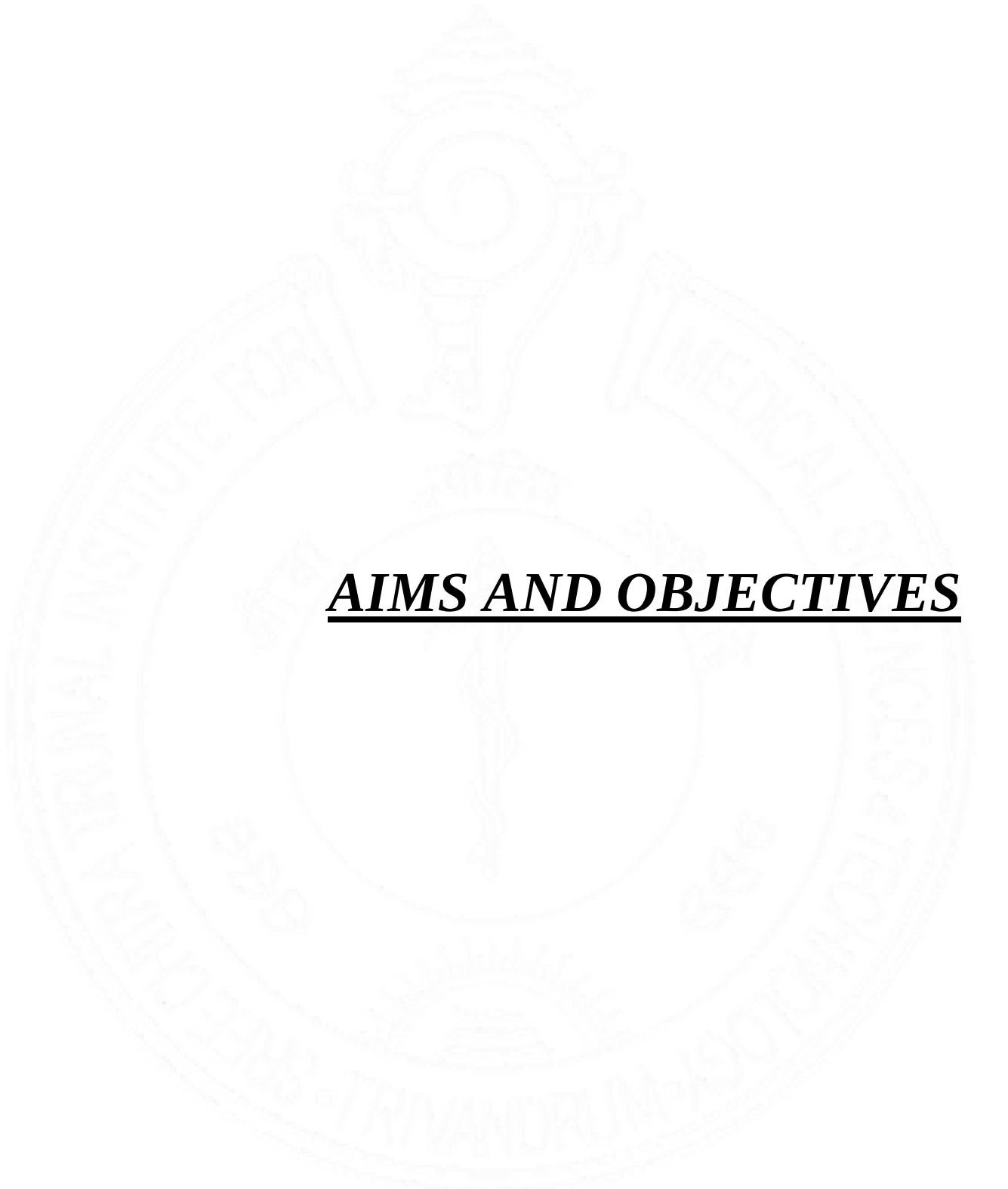


INTRODUCTION

Occipital lobe epilepsy (OLE) is relatively uncommon, accounting for 5% to 10% of focal epilepsy cases.(Harward et al,2018)

- Localisation using EEG and semiology is difficult compared to TLE as they can present with varied clinical types.
- Most of them may have Antecedent events and predispose to Occipital gliosis later in life. There are other pathologies like FCD, Tumour, MCD presents with OLE.
- Most of them confined within the Occipital lobe and it can extend to the adjacent parietal or temporal lobe, harboring an underlying wide epileptogenic network.
- But the adjacent eloquent regions limit the boundaries of resection.

As a tertiary care epilepsy center, our institution has a large series of operated patients for posterior cortex epilepsy. In this study, we were planned to analyze the patients' demographic profiles, seizure profile, type of surgery, distribution of pathological types, surgical outcomes, complications, and seizure outcomes. This will give us the opportunity to analyze the treatment outcomes in our part of the country which in turn can improve our patient care and give new insights into the current practice.



AIMS AND OBJECTIVES

1. To evaluate the clinical spectrum, electrophysiological data, histopathology and seizure outcomes of patients with occipital lobe pathologies.
2. To compare the data between groups involving only anatomical occipital lobe with extension into adjacent lobes (parietal and temporal).



REVIEW OF LITERATURE

Epilepsy surgery aims to treat seizures in patients with drug-resistant epilepsy. Drug resistant epilepsy consists of patients who did not have satisfactory reduction of seizure burden with optimized antiepileptics. The proportion of drug resistant epilepsy consists of 25% of all patients with epilepsy. The annual cumulative incidence of epilepsy was 67.77 per 100,000 persons and lifetime prevalence was 7.60 per 1,000 persons. There is a proportion of patients in whom there is a chance of an increase in frequency of seizures(4%) and new onset of seizures after surgery(3.9%). The predictors were the lower age of seizure onset, lower age at surgery, longer epilepsy duration, preoperative neurological deficit, intellectual disability, high preoperative seizure frequency, histopathological diagnosis and extratemporal procedures.(Davis et al., 2012)

On long term follow up, 69% of patients achieve adequate seizure control(Engel's class 1). Subsequent re-operations for persistent seizures decreased the probability of achieving seizure control to 42%(Yardi et al., 2020). The complications after epilepsy surgery include operative cavity bleeding, hematoma, meningitis, intraventricular hemorrhage, neurological deficits depends on the eloquent region which includes motor deficits, sensory deficits, visual field defects, speech disturbances, post operative seizures.

Remission of seizures depends on multiple factors and seizure recurrence can happen any time after surgery.

The extent of resection is determined by multiple factors based on Radiological extent, intraoperative appreciation of pathological tissue, tailoring done due to usage of intraoperative Electrocorticography, and limitation of resection due to the adjacent eloquent areas. The success of epilepsy surgery is determined by the removal of epileptogenic foci and disruption of epileptogenic network.(Kun Lee et al., 2005)

The reorganization of functional white matter tracts known to occur in long standing epilepsy which may not follow the normal anatomical and functional boundaries as in normal population. The disruption of this complex functional reorganisation may be responsible for the post operative complications. And persistent epileptogenic network is responsible for recurrence of seizures. (Binder et al., 2008)

These outcomes may differ from patient to patient based on number of factors like seizure duration, severity of seizure burden, location of pathology, ease of localization using EEG and MRI, deficits in other domains of cognition, neuroplasticity and other yet to identify factors. (Sinclair et al., 2004)

Occipital lobe epilepsy (OLE) is relatively uncommon, accounting for 5% to 10% of focal epilepsy cases. Causes are wide-ranging and include metabolic, structural, neoplastic, traumatic, infective, and idiopathic etiologies.

OLE semiology often involves visual symptoms including hallucinations, blindness, eye blinking, and nystagmus. However, OLE can also manifest with altered mental status and generalized tonic-clonic activity, suggesting electrical spread to neighboring cortical regions, and complicating accurate diagnosis and seizure localization. Overall, OLE is often a severely debilitating disorder with significant impact on patient quality of life. For OLE patients with medically refractory seizures, focal surgical resection has proven a viable therapeutic option, with many studies reporting postoperative seizure freedom in the majority of patients. Despite this reported success, OLE surgery is not without its challenges (Harward et al., 2018). While OLE can arise from an identifiable focal lesion, such as a malformation of cortical dysplasia (MCD) or tumor, identifying a seizure focus in many other cases can be challenging, as magnetic resonance imaging (MRI) and ictal electroencephalography (EEG) are not always localizing. Additionally, because of anatomic proximity to the visual cortex, OLE surgery is associated with the risk of postoperative visual decline. In previous reports of resective epilepsy surgery, seizure freedom is achieved in approximately 60% to 80% of individuals with temporal lobe epilepsy (TLE) and 40% to 60% of patients with extra-temporal lobe epilepsy (ETLE). Compared to other focal epilepsies, OLE is less common and thus relatively understudied. The case studies that are available show significant variability in their results due to their generally small sample size and patient heterogeneity. Consequently, specific rates and predictors of both seizure freedom and visual

decline following surgery are not known. Such information is critical to improve patient selection for OLE surgery

But there are not much data available in the literature comparing the seizure outcomes and surgical complications, and factors determining the same. As we have the large series of epilepsy patients in our country, we aim to study the correlation of surgical complications with seizure outcomes and factors associated with the same.(Agrawal et al., 2022; Castagno et al., 2021; Delev et al., 2019; Kutsy, 1999; Mendes Coelho et al., 2021; Ray et al., 2021)

Among patients with neocortical epilepsy, prior studies have investigated interictal EEG, ictal EEG, MRI, fluorodeoxyglucose positron emission tomography (FDG-PET), and single-photon emission computed tomography (SPECT) as surgical outcome predictors found that concordance of 2 or more diagnostic modalities increased the likelihood of seizure free outcome found that a focal MRI lesion, correct localization from hypometabolism on FDG-PET, and localized ictal rhythms on EEG predicted seizure free outcome. found that epileptic EEG activity arising from the resection site, and absence of invasive monitoring predicted seizure free outcome. Among patients with posterior quadrant epilepsy, investigators have identified a variety of outcome predictors. Postoperative epileptiform discharges predicted seizure recurrence in 2 studies and found that early age of epilepsy onset and briefer pre-operative epilepsy duration favored seizure control found that complete excision of

epileptogenic cortex, and absence of pre-operative temporal lobe epileptiform discharges favored a seizure free outcome.(Raymond et al., 1995; Saggi et al., 2024) Among patients with MRI lesions, found that seizure control was more likely when seizure semiology lateralized to the hemisphere with the MRI lesion identified briefer pre-operative epilepsy duration and normal neurological exam as favorable predictors for seizure control. Some studies have failed to show clear predictors for seizure control. A study⁶ of 26 occipital lobe epilepsy patients found that aura, seizure type, interictal EEG, ictal EEG, MRI, FDG-PET, and SPECT failed to predict seizure control. A study of 43 patients found that seizure behavior, MRI, interictal EEG, and ictal EEG failed to predict seizure control. Investigations on the significance of surgical pathology have yielded mixed results found that tumor favored far better surgical outcome than cortical dysplasia. However, found that complete excision of tumor or cortical dysplasia both favored good seizure control.(Kurwale et al., 2021)

Although neuropsychological outcome from temporal lobe epilepsy is well documented, neuropsychological outcome from posterior quadrant epilepsy is less clear. A better understanding of the effects of posterior quadrant epilepsy surgery on visual perceptual and visual spatial functions is important.

Type of surgery:

There are multiple combination of resection being done for posterior quadrant epilepsy viz occipital lobectomy, partial lobectomy / lesionectomy, modified posterior quadrant resection where part of temporal, parietal or both removed under ECoG guidance. Posterior quadrant disconnection consists of separating white matter fibers from occipital, parietal and temporal lobe with corpus callosotomy.(Ramantani et al., 2017; Tandon et al., 2009)

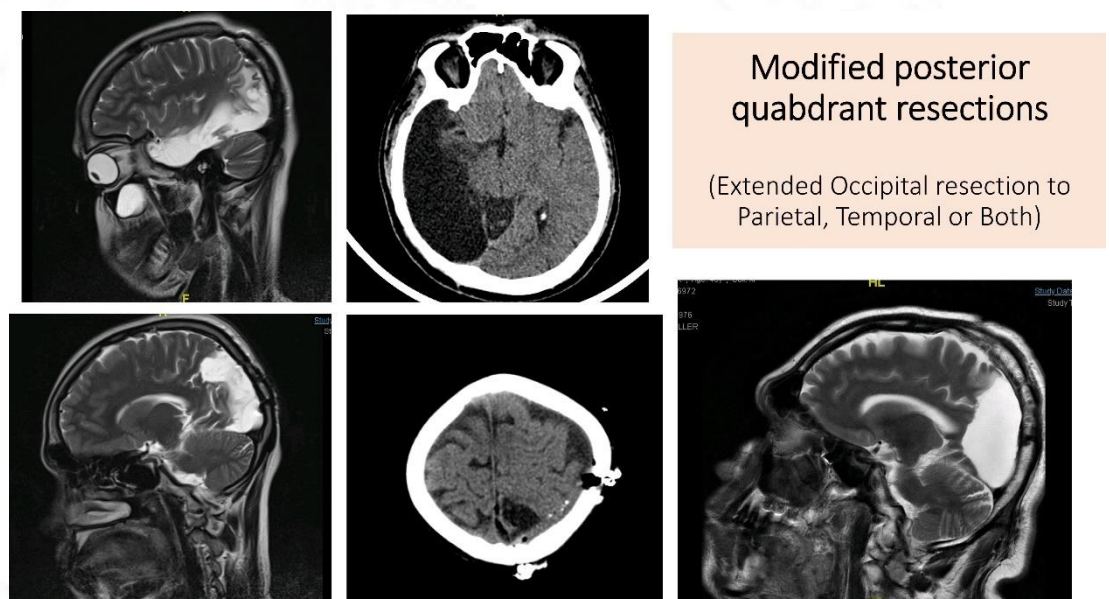


Figure 1: MRI pictures showing variations of modified posterior quadrant resection.

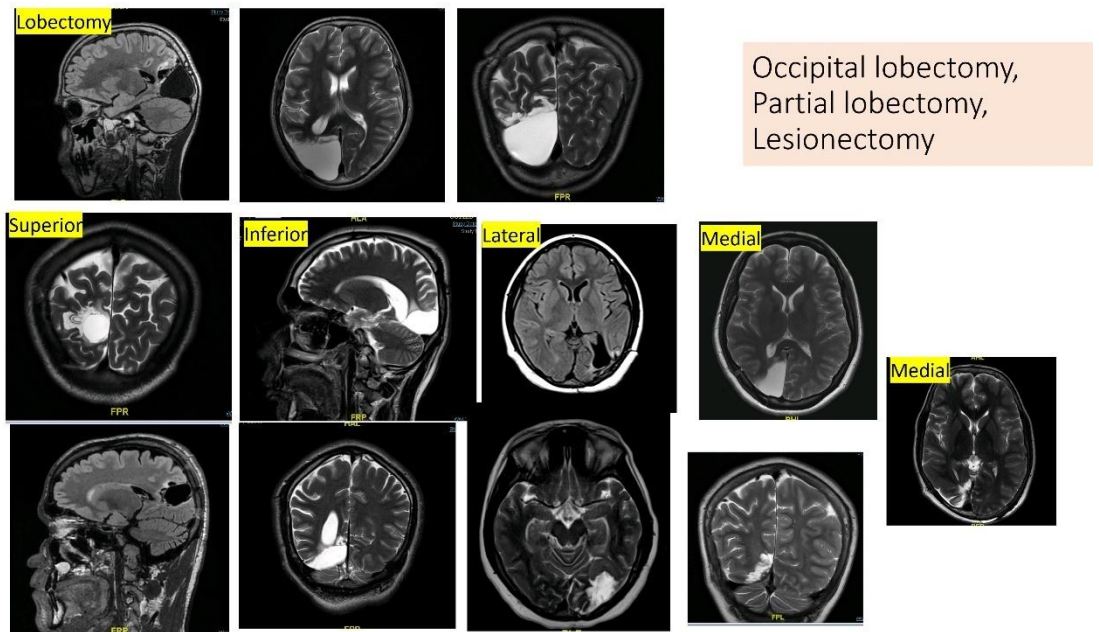
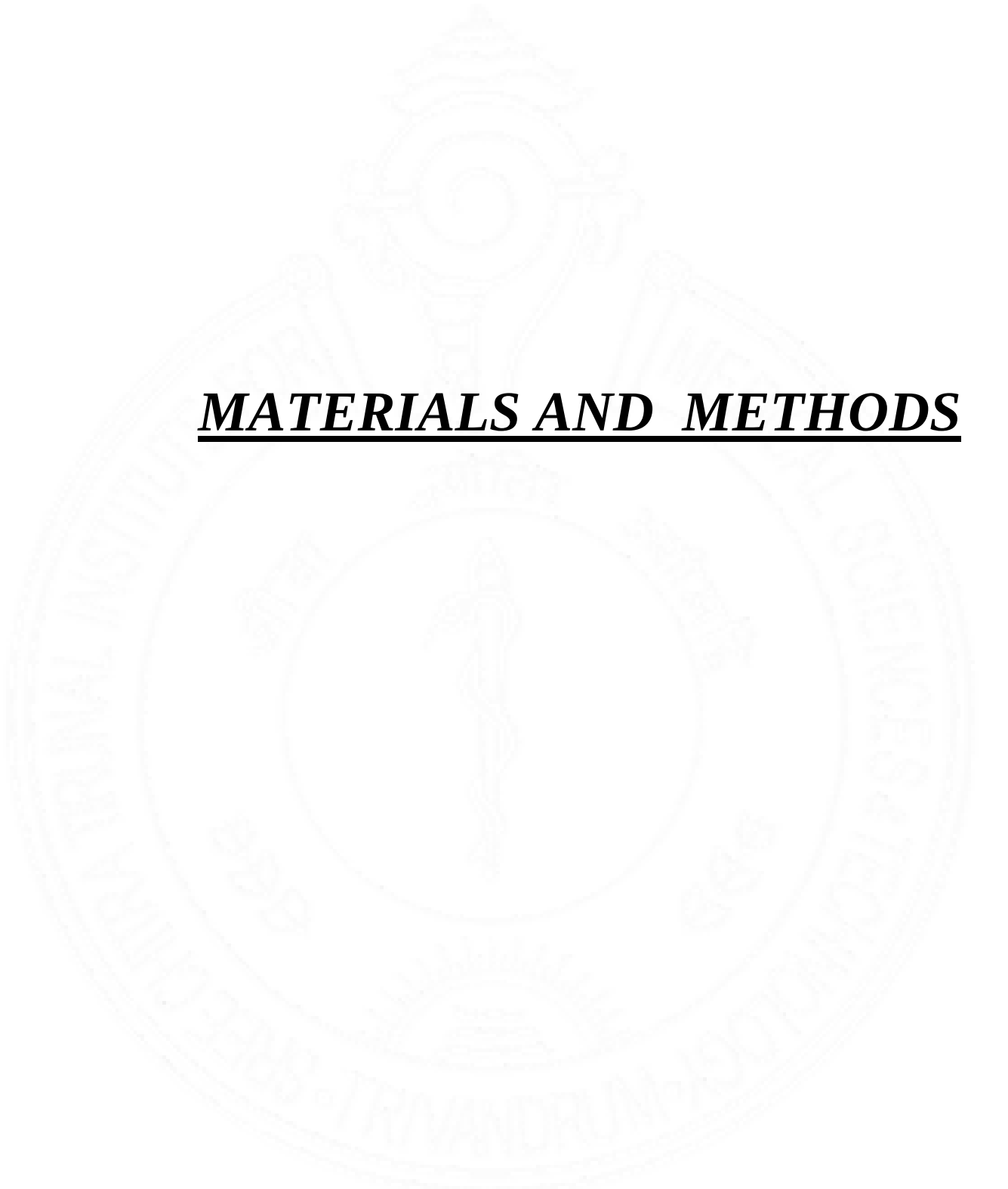


Figure 2: Variations of Occipital lobe surgeries showing complete lobectomy, partial lobectomy and lesionectomy.



MATERIALS AND METHODS

Methodology:

We retrospectively analyzed the prospectively collected data from 2005 to 2022 in our RMNC epilepsy center. We included the patients of all age groups who underwent surgery for occipital lobe pathologies with drug resistant epilepsy. We have divided the patients into two groups viz pure occipital lobe pathologies and those involving the occipital lobe with parieto-temporal extension. We evaluated the preoperative clinical, electrophysiological, Video EEG, radiological profile, surgical strategies, histopathological diagnoses, complications and post operative seizure outcomes in these both groups.

Sample size: 124 patients operated for posterior cortex epilepsy.

Definition of cases:

All patients operated for posterior cortex epilepsy after through pre-surgical workup.

Study Population:

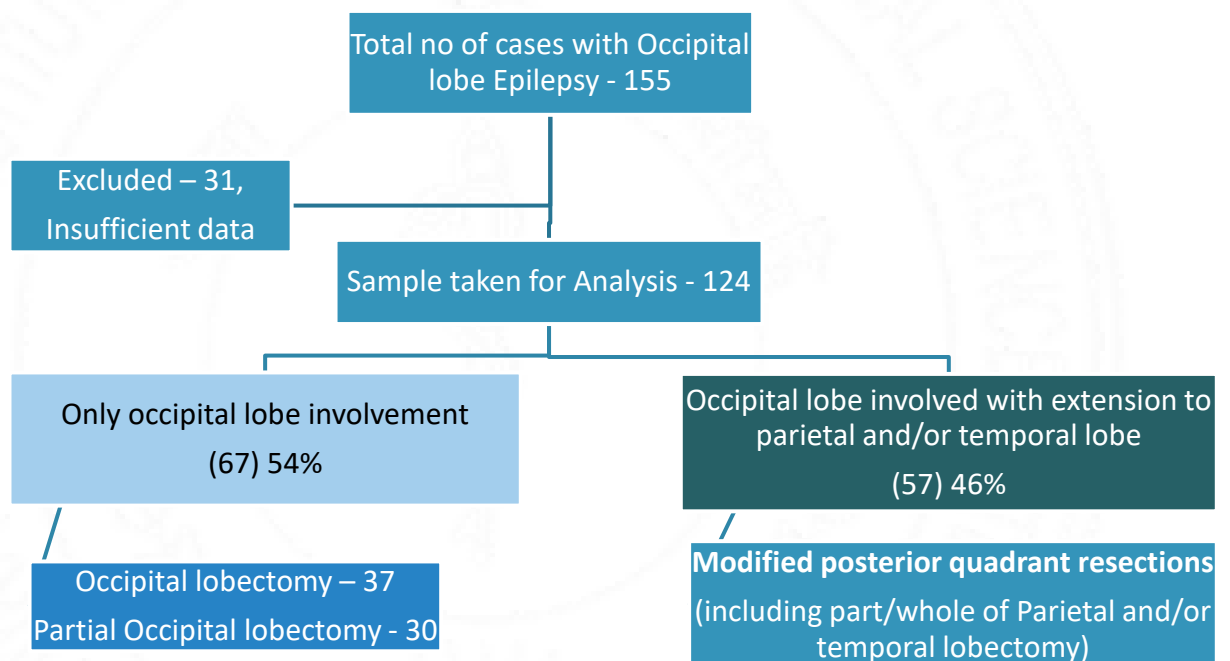
Study population included patients of all age groups who underwent surgery for posterior cortex epilepsy including occipital, parietal and temporal lobe.

Inclusion criteria:

- Patients in any age group evaluated and operated for Occipital lobe epilepsy pathology(OLE) with or without extension into the adjacent lobe (Parietal and/or Temporal)

Exclusion criteria:

- Isolated pathologies in other lobes without involving the Occipital lobe.
- Clinico-Electrical-Imaging not concordant with OLE
- Dual pathologies

SAMPLE COLLECTION PROTOCOL :**Figure 3:** Schema of study flow – sample collection**Data collection:**

The demographic data, clinical presentation details were collected from the computer records and database. Surgical details were collected from the operation

records. Post op complications, seizure outcomes were collected from the OPD, Admission and Medical records.

Histopathological Slide review:

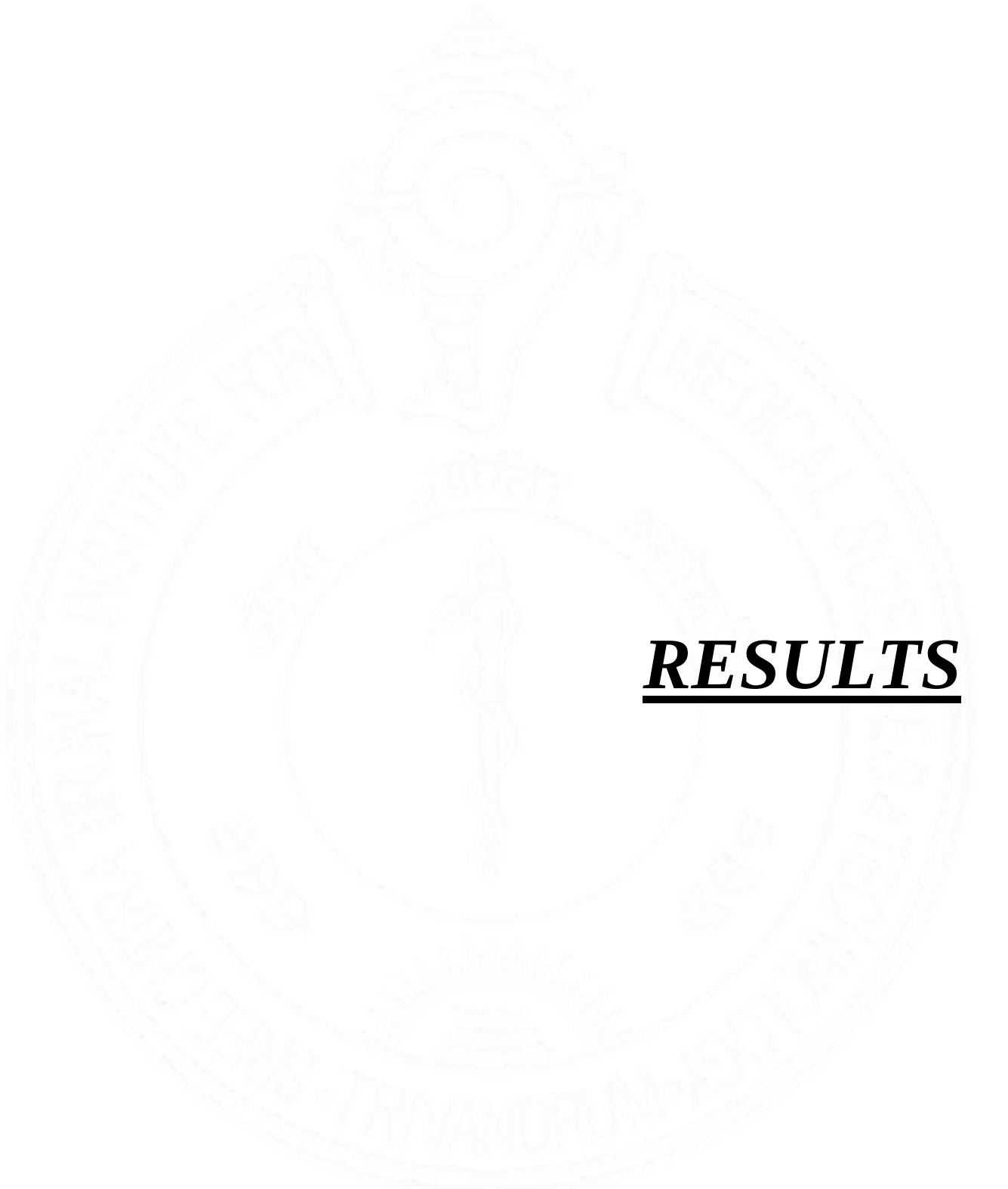
The Histopathological slides of proven Medulloblastoma patients were retrieved from the archives of Pathology Department in the time duration from 2005 to 2020. Two experienced Pathologists reviewed the slides independently and confirmed the diagnosis of Medulloblastoma. Any doubtful cases or features suggestive of other tumours were excluded from the study group.

Statistical analysis

- Data was entered using Microsoft Excel (Password protected computer)
- Statistical analysis was done using WHO Epi info / SPSS software
- Descriptive variables were analysed with Mean, Standard deviation and Proportions.
- Qualitative variables were compared using Fisher exact test and quantitative variables using ANOVA. Multiple logistic regression analysis was performed wherever needed.

Ethics Committee Approval:

This study was approved by the Institutional Ethics Committee of Sree Chitra Tirunal Institute for Medical Sciences and Technology, Trivandrum(IEC No:2261, Year- 2024)



RESULTS

Demography

In this study, the Occipital lobe pathologies were 67 in number, Extended occipital lobe pathologies were 57 in number.

Table 1: Demographics and clinical history

		Lobar involvement					
		EOL –Extended Occipital lobe		OL - Occipital lobe		Total	P value
		N=57	%	N=67	%	124	
Seizure onset Age		5.04 ± 4.83		6.61 ± 4.06			0.23
Age at surgery		16.63 ± 8.76		16.69 ± 6.16			0.125
Gender	Male	39	44.32%	49	55.68%	88	0.196
	Female	18	50%	18	50%	36	
Development	Normal	39	72.22%	48	81.36%	87 (77%)	0.184
	Mild delay	10	18.52%	10	16.95%	20 (18%)	
	Global DD	5	9.26%	1	1.69%	6 (5%)	
Psychomotor regression		4		1		5(4%)	-
Antecedents		26	45.6%	37	55.2%	63 (51%)	0.331
Side of Pathology	Right	28	22.76%	34	27.64%	62(50.4%)	0.791
	Left	29	23.58%	32	26.02%	61(49.6%)	

The average age of seizure onset is 5.04 years in EOL group, whereas in OL group it is 6.6 years. Males were dominant 88, compared to females 36. Development delay was more in EOL group(9.2%) compared to OL group(1.6%, P-0.184). Side of pathology was equally distributed.

Table 2: Preoperative semiology comparison between EOL and OL group.

		EOL (Extended Occipital lobe) (N=57)		OL (Occipital lobe) (N=67)		Total	P value
		n	%	n	%	n	
Tonic		5	8.77%	5	7.46%	10	
Clonic		2	3.51%	2	2.99%	4	
Tonic Clonic		7	12.28%	5	7.46%	12	
Myoclonic		3	5.26%	1	1.49%	4	
SPS		7	12.28%	6	8.96%	13	
CPS		53	92.98%	61	91.04%	114	
GTCS		10	17.54%	15	22.39%	25	
Atonic		2	3.51%	2	2.99%	4	
Infantile Spasm		2	3.51%	0	0%	2	
Hemiclonic		1	1.75%	0	0%	1	
AURA		33	57.89%	44	65.67%	77	0.647
No. of Semiology types			1.8 ± 0.82		1.89 ± 0.75		0.441
	Present	36	37.5%	28	29.17%	64	0.009
	Absent	9	9.38%	23	23.96%	32	

Complex partial seizures were the most common form of semiology in both the groups(91%)

Seizure frequency and burden as per AAN category:

Table 3: Seizure burden between both the groups

		EOL - 57		OL - 67		Total	
Frequency /burden	Innumerable to >10/day	6	10.71%	6	8.96%	12	Mean – 3.12 Median - 3
	Multiple/day, 4 days in week, >2 seizures	21	37.5%	22	32.84%	43	
	Daily, >= 4/week	7	12.5%	10	14.93%	17	
	Weekly but not daily (1-3/week)	14	25%	20	29.85%	34	
	Monthly but not weekly (1-3/month)	5	8.93%	5	7.46%	10	
	At least once per year, but not every month (<10 in year)	3	5.36%	4	5.97%	7	
Total		56	100%	67	100%	123	

Seizure burden is equally same in both the groups, predominant pattern seen are multiple events in a day, 4 days per week.

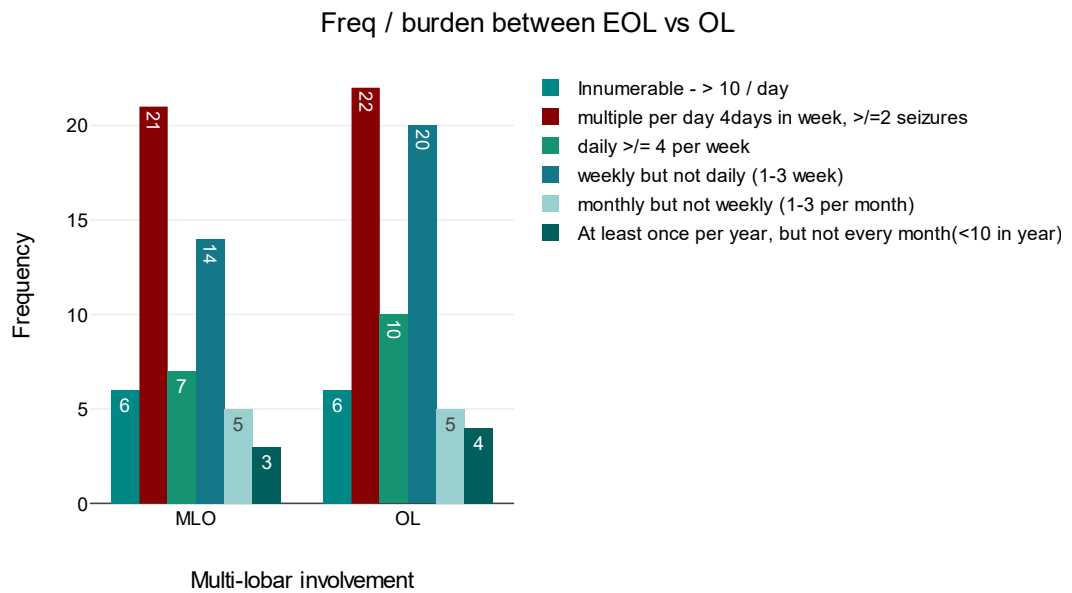


Figure 4: Bar graph showing seizure burden in frequency between EOL and OL group

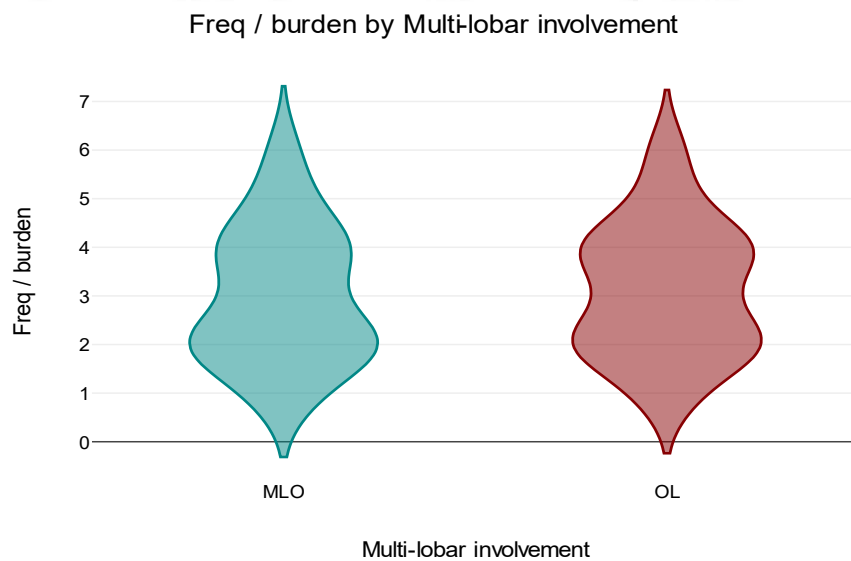


Figure 5: Violin plot showing seizure burden in frequency between EOL and OL group

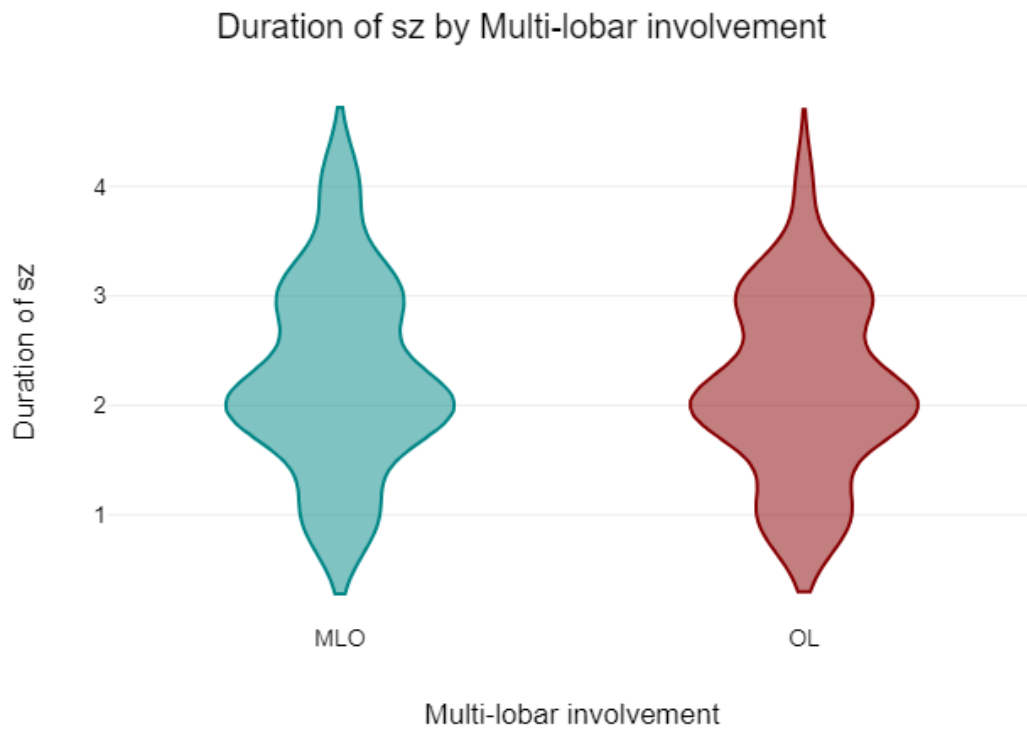


Figure 6: Violin plot showing duration of seizures between EOL and OL group

In both the groups, mean duration of seizure duration was 2 min.

Table 4: Probability test for duration of seizures

		n	Mean	Median	Standard deviation
Duration of sz	OL	56	2.16	2	0.78
	EOL	49	2.27	2	0.84

Mann-Whitney U-Test

Seizure free period – After starting AED

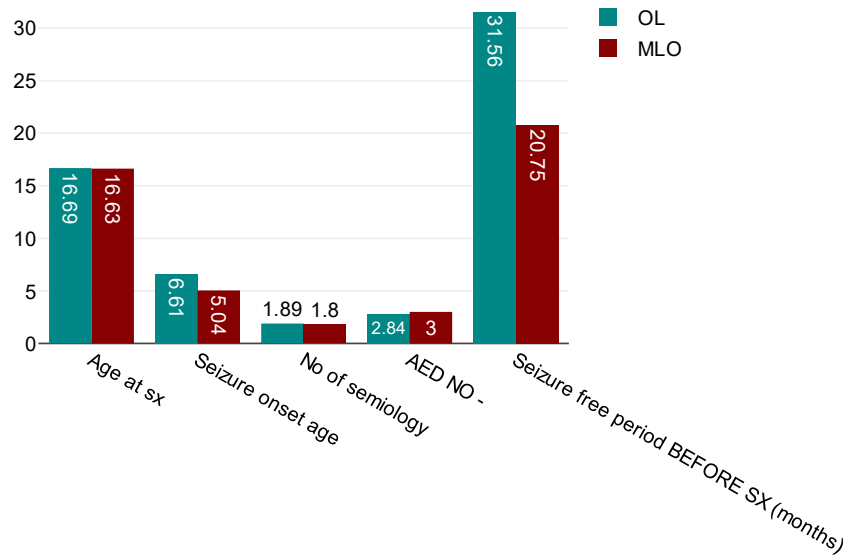


Figure 7: Bar chart showing seizure related details in EOL vs OL group.

Preop Neurological deficits

Table 5: Comparing preoperative neurological deficits between EOL vs OL

		EOL – 57		OL - 67		Total		P
		n	%	n	%	n	%	
PREOP MOTOR DEFICIT		11	91.67%	1	8.33%	12		
PREOP VISUAL DEFICITS	QUADRANTONOPIA	6	14.29%	12	28.57%	18	42.86%	0.773
	HEMIANOPIA	7	16.67%	17	40.48%	24	57.14%	
	TOTAL	13	30.95%	29	69.05%	42	100%	0.012

Chi-Square Test

	Chi ²	df	p
Multi-lobar involvement - VISUAL DEFICIT - OVERALL	6.28	1	.012

Motor deficits were more in EOL group(91%) and visual deficits were more in OL group (69%).

Preop Neuropsychology Analysis

Table 6: Comparing preop Neuropsychology analysis between EOL and OL group

		EOL - 57		OL - 67		Total		P
		n	%	n	%	n	%	
NEUROPSYCHOLOGY ASSESSMENT - PREOP	NORMAL	6	10%	11	18.33%	17	28.33%	0.429
	ABNORMAL	20	33.33%	23	38.33%	43	71.67%	
	Total	26	43.33%	34	56.67%	60	100%	
LANGUAGE DOMAIN		11	42.31%	15	57.69%	26	100%	
IQ DOMAIN		10	71.43%	4	28.57%	14	100%	
LEARNING DIFFICULTY		8	61.54%	5	38.46%	13	100%	
VERBAL MEMORY		8	44.44%	10	55.56%	18	100%	
VISUAL MEMORY		4	44.44%	5	55.56%	9	100%	
BEHAVIOUR ISSUES		14	60.87%	9	39.13%	23	100%	
SCHOLASTIC PERFORMANCE	GOOD	1	1.89%	5	9.43%	6	11.32%	0.477
	AVERAGE	8	15.09%	10	18.87%	18	33.96%	
	POOR	11	20.75%	18	33.96%	29	54.72%	
ADL - PREOP	DEPENDENT	10	71.43%	1	9.09%	11		0.002
	INDEPENDENT	4	28.57%	10	90.91%	14		

Preoperative neuropsychology shows EOL group has more learning disabilities(61% vs 38%) and less IQ compared to OL group(71% vs 28%).

Preop EEG Analysis

Table 7: Comparing EEG details between EOL vs OL group.

		EOL - 57		OL - 67		Total	P
		n	%	n	%	n	
ICTAL ONSET	FRONTAL	3	75%	1	25%	4	
	TEMPORAL	9	45%	11	55%	20	
	PARIETAL	5	71.43%	2	28.57%	7	
	OCCIPITAL	7	35%	13	65%	20	
	PHR	24	38.1%	39	61.9%	63	
INTER ICTAL DATA	CENTRAL	1	33.33%	2	66.67%	3	0.038
	DIFFUSE	19	59.38%	13	40.63%	32	
	BILATERAL	4	44.44%	5	55.56%	9	
	FRONTAL	11	64.71%	6	35.29%	17	
	TEMPORAL	14	43.75%	18	56.25%	32	
	PARIETAL	6	85.71%	1	14.29%	7	
	OCCIPITAL	4	33.33%	8	66.67%	12	
	GENERALIZED	7	53.85%	6	46.15%	13	
	CENTRAL	6	60%	4	40%	10	
	MULTIFOCAL	11	61.11%	7	38.89%	18	
	PHR	20	35.71%	36	64.29%	56	
	BILATERAL	18	42.86%	24	57.14%	42	0.619

In EOL group, parietal group has more of parietal ictal onset(71%) and parietal ictal onset is 65% in OL group, 35% in EOL group.

Role of WADA

Table 8: Comparing handedness and WADA test in both the groups

		EOL		OL		Total		P
		n	%	n	%	n	%	
HANDEDNESS	RIGHT	33	36.67%	44	48.89%	77	85.56%	0.003
	LEFT	9	10%	0	0%	9	10%	
	AMBIDEXTROUS	1	1.11%	3	3.33%	4	4.44%	
	Total	43	47.78%	47	52.22%	90	100%	

		LANGUAGE LATERALISATION		Total
		SAME SIDE OF SX	OPPOSITE SIDE TO SX	
WADA	RIGHT	0	1	1
	LEFT	6	0	6
	Total	6	1	7

WADA was lateralized to left side in 6 patients out of 7 patients.

Other imaging modalities were done to facilitate the diagnosis in case of discordant findings.

SPECT – 3, PET – 4 - done for localization, MRI inconclusive and for supporting hypothesis.

Type of surgical resections

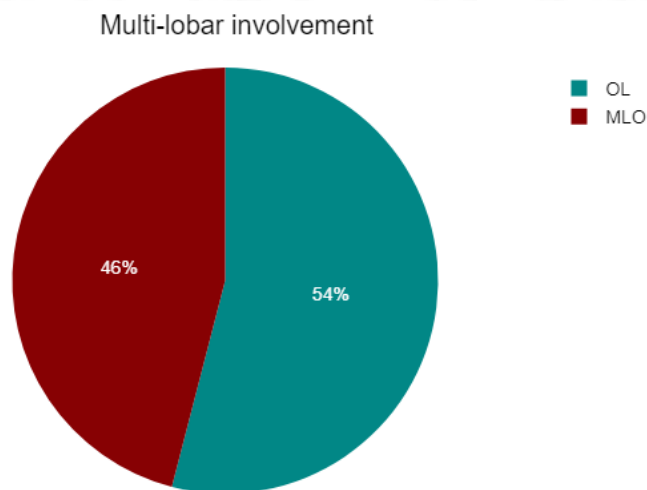


Figure 8: Pie chart showing distribution of resections(OL – occipital lobe resections, MLO – multilobar/Extended occipital lobe resections)

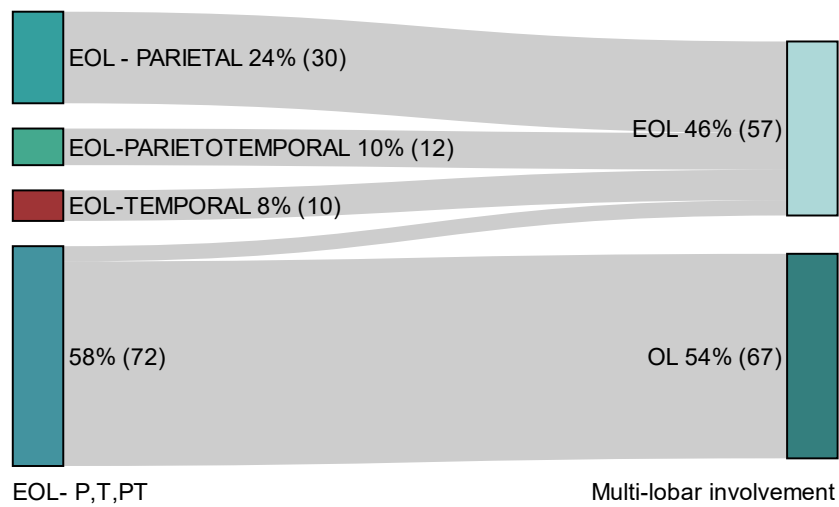


Figure 9: Graph showing distribution of resections(OL – occipital lobe resections, MLO – multilobar/Extended occipital lobe resections)

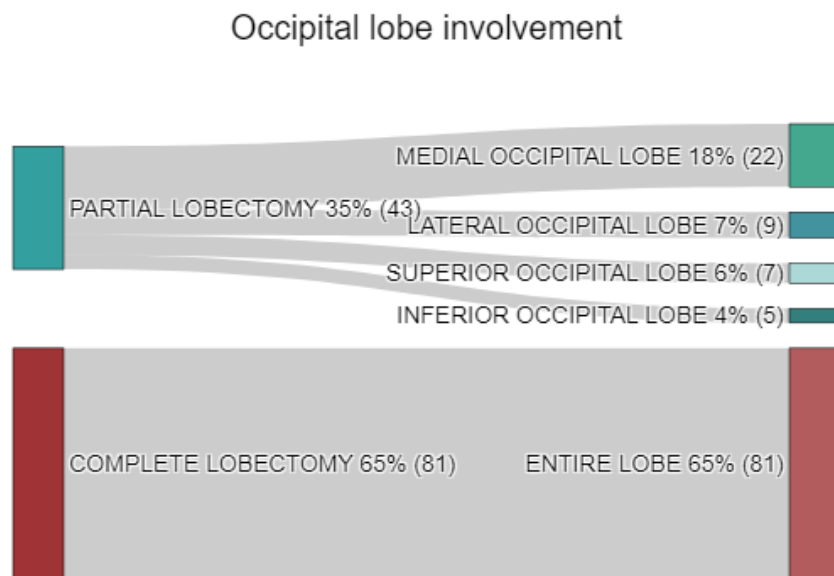


Figure 10: Graph showing distribution of resections with in occipital lobe

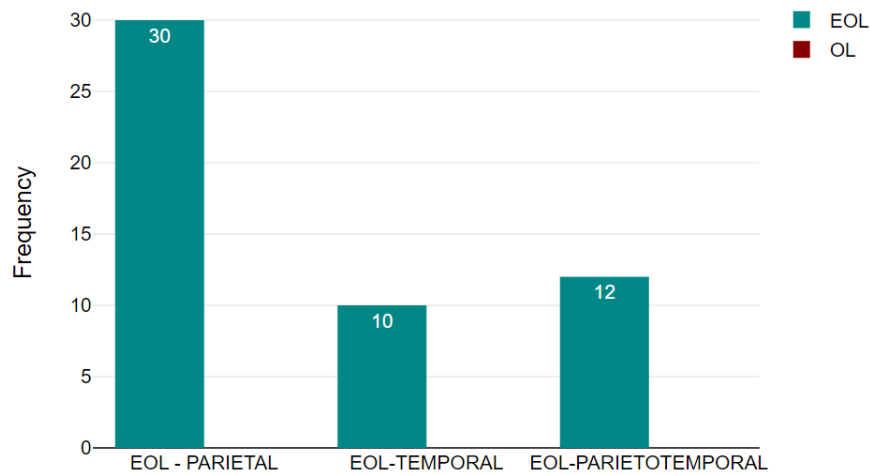


Figure 11: Bar diagram showing distribution of resections with in multilobar/extended occipital lobe resections in parietal and temporal lobe.

COMBINATION OF RESECTIONS

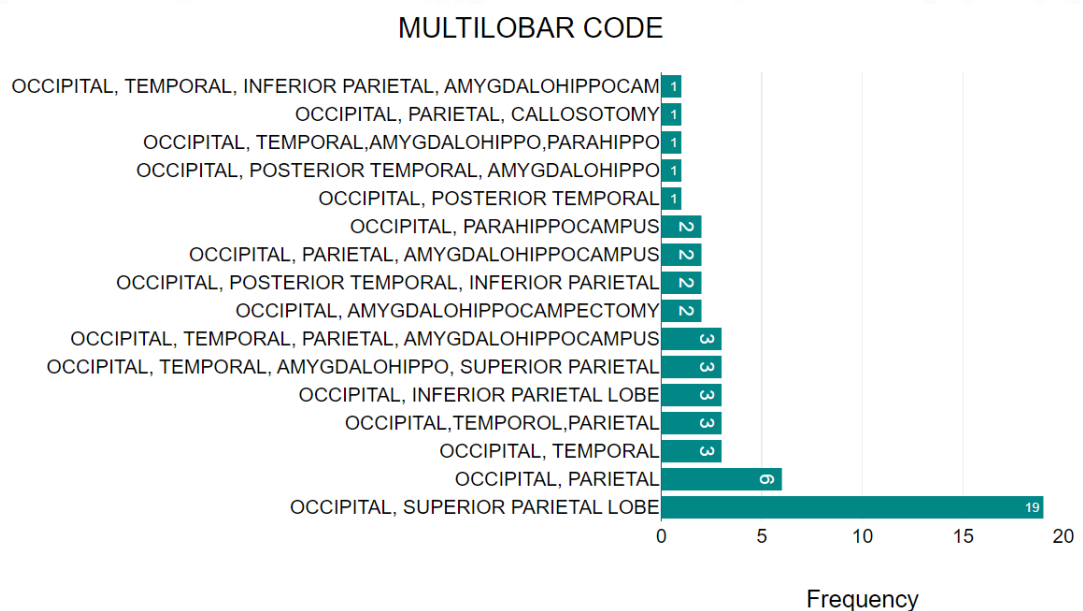


Figure 12: Bar chart showing different combination of resections done

Distribution of Histopathology:

The most common histopathology seen in entire cohort is gliosis, followed by FCD and tumours.

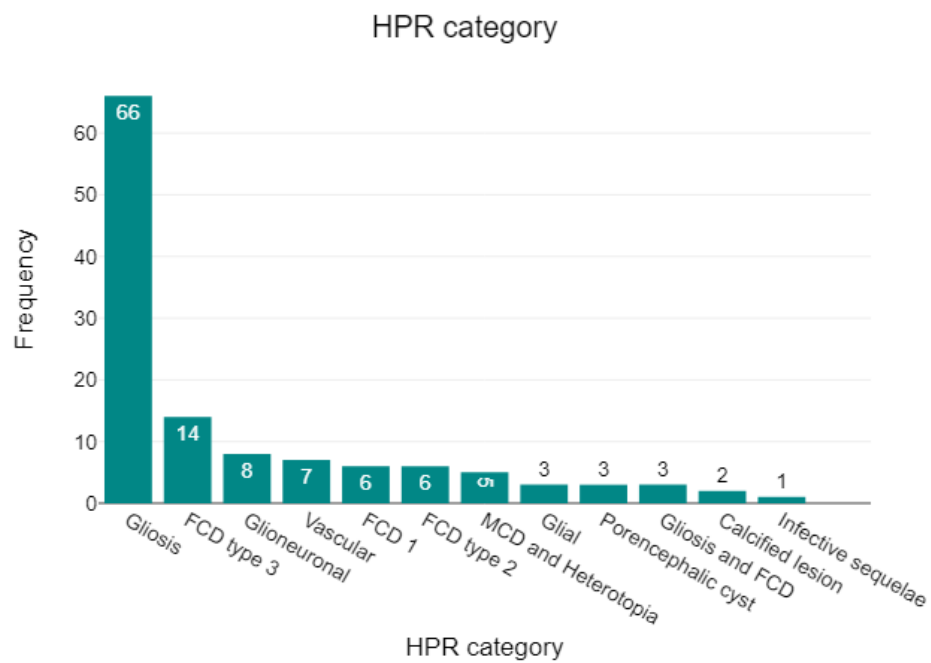


Figure 13: Distribution of histopathology in overall cohort

Table 9: Comparing histopathology between EOL and OL group

	EOL		OL		Total	
HPR	n	%	n	%	n	%
Gliosis	24	19.35%	42	33.87%	66	53.23%
Glioneuronal	3	2.42%	5	4.03%	8	6.45%
Glial	2	1.61%	1	0.81%	3	2.42%
Porencephalic cyst	3	2.42%	0	0%	3	2.42%
Vascular	4	3.23%	3	2.42%	7	5.65%
FCD 1	3	2.42%	3	2.42%	6	4.84%
FCD type 2	4	3.23%	2	1.61%	6	4.84%
FCD type 3	6	4.84%	8	6.45%	14	11.29%
Calcified lesion	1	0.81%	1	0.81%	2	1.61%
Infective sequelae	0	0%	1	0.81%	1	0.81%
MCD and Heterotopia	4	3.23%	1	0.81%	5	4.03%
Gliosis and FCD	3	2.42%	0	0%	3	2.42%
Total	57	45.97%	67	54.03%	124	100%

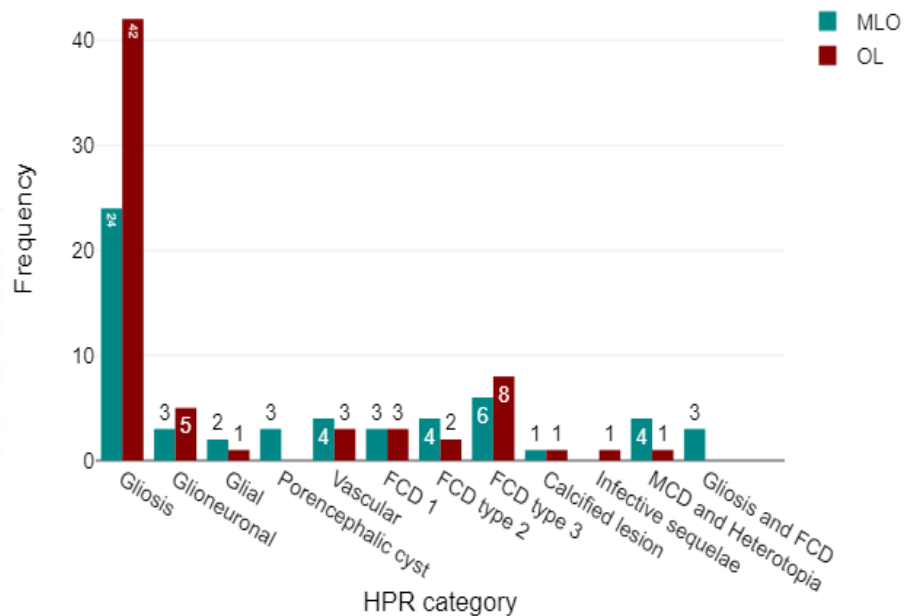


Figure 14: Bar chart showing distribution of pathologies between EOL and OL group

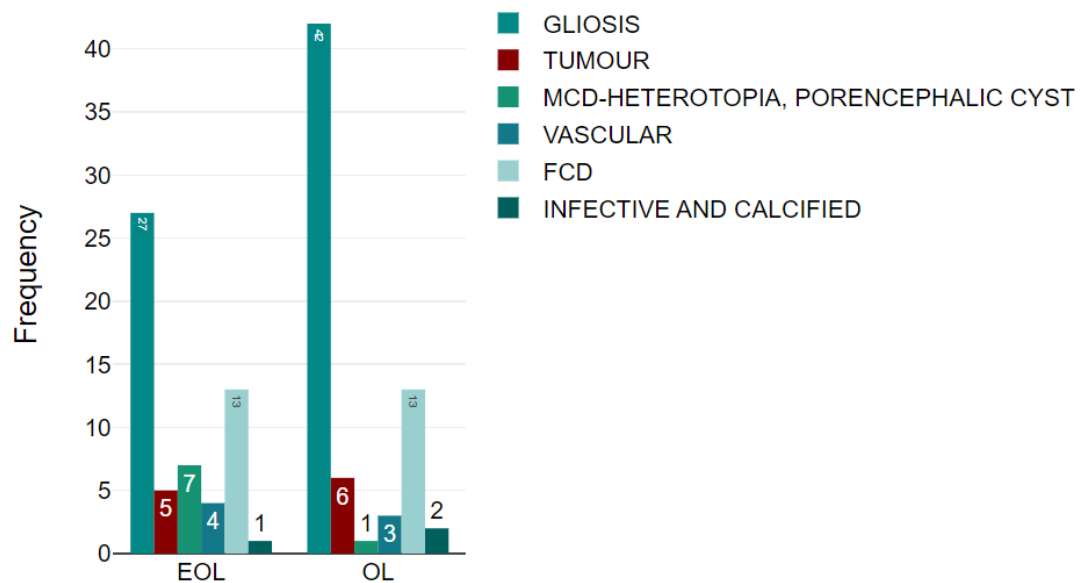


Figure 15: Bar chart showing distribution of grouped pathologies between EOL and OL group.

In OL group, gliosis is predominant than EOL group, malformation of cortical development were seen more in EOL group, FCD were equally distributed in both the groups.

Table 10: Distribution of pathologies with in Occipital lobe (Focal vs Diffuse involvement)

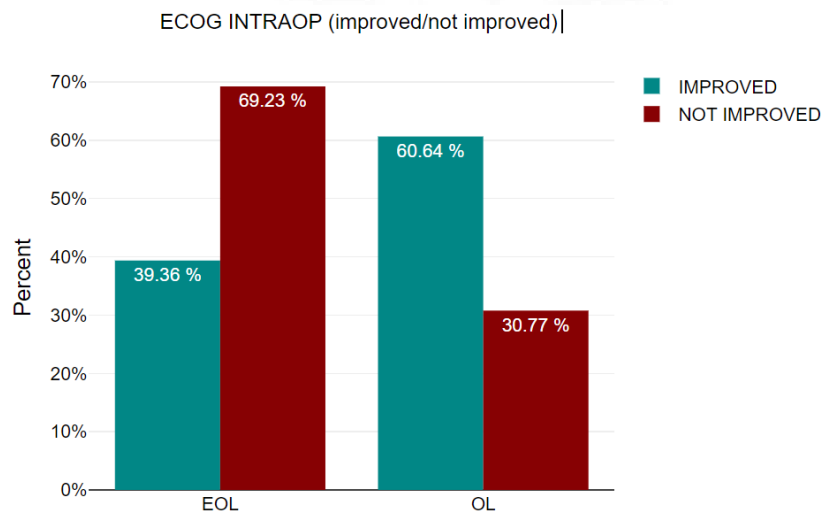
		HPR CATEGORIES BROAD						Total
		GLIOSIS	TUMOUR	MCD-HETEROTOPIA, PORENCEPHALIC CYST	VASCULAR	FCD	INFECTIVE AND CALCIFIED	
FOCAL OCCIPITAL LOBE PATHOLOGY UNDERWENT LESIONECTOMY	MEDIAL OCCIPITAL LOBE	14	2	1	0	3	2	22
	LATERAL OCCIPITAL LOBE	2	5	0	1	1	0	9
	SUPERIOR OCCIPITAL LOBE	2	2	0	1	2	0	7
	INFERIOR OCCIPITAL LOBE	1	1	0	2	1	0	5
	ENTIRE LOBE	50	1	7	3	19	1	81
	Total	69	11	8	7	26	3	124

	Chi ²	df	p
Partial occipital lobe involvement - HPR CATEGORIES	58.02	20	<.001

Within the occipital lobe, gliosis is more commonly seen in medial aspect, whereas tumours were seen more in the lateral aspect. Pathologies like FCD and MCD were diffuse and involving the entire occipital lobe.

Intraop ECOG analysis

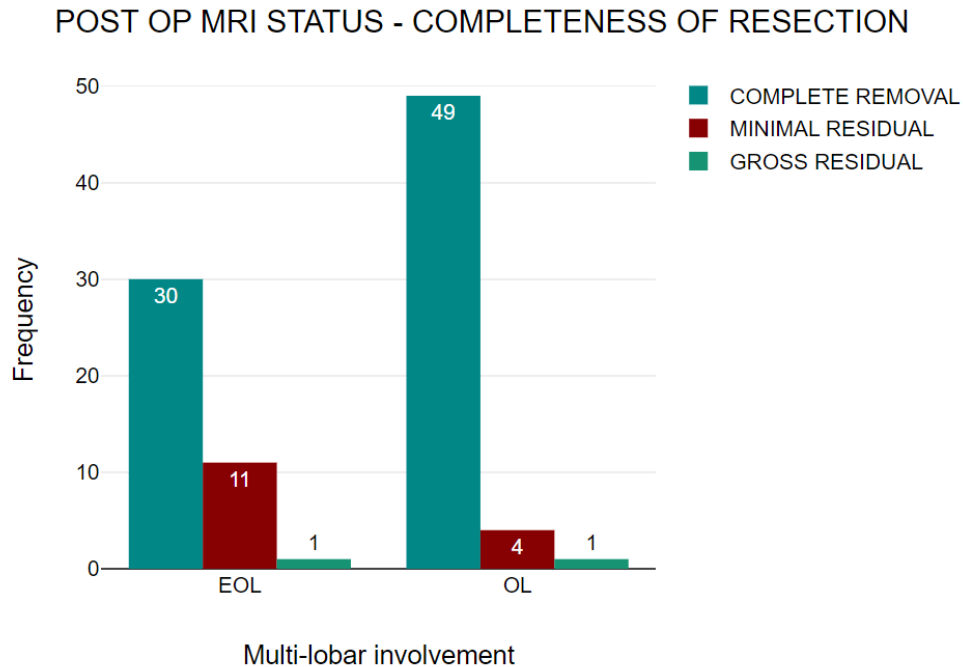
Figure 16: Intraoperative Electrocorticography comparison between both groups



		EOL	OL	Total
ECOG INTRAOP (improved/not improved)	IMPROVED	37	57	94
	NOT IMPROVED	9	4	13
	Total	46	61	107

	Chi ²	df	p
ECOG INTRAOP (improved/not improved)	4.16	1	.041

Figure 17: Comparing post op MRI for completeness of resection.



	Chi ²	df	p
Multi-lobar involvement - Post sx MRI	6.44	2	.04

The chance of leaving residual lesion was seen more in EOL group(P-0.04).

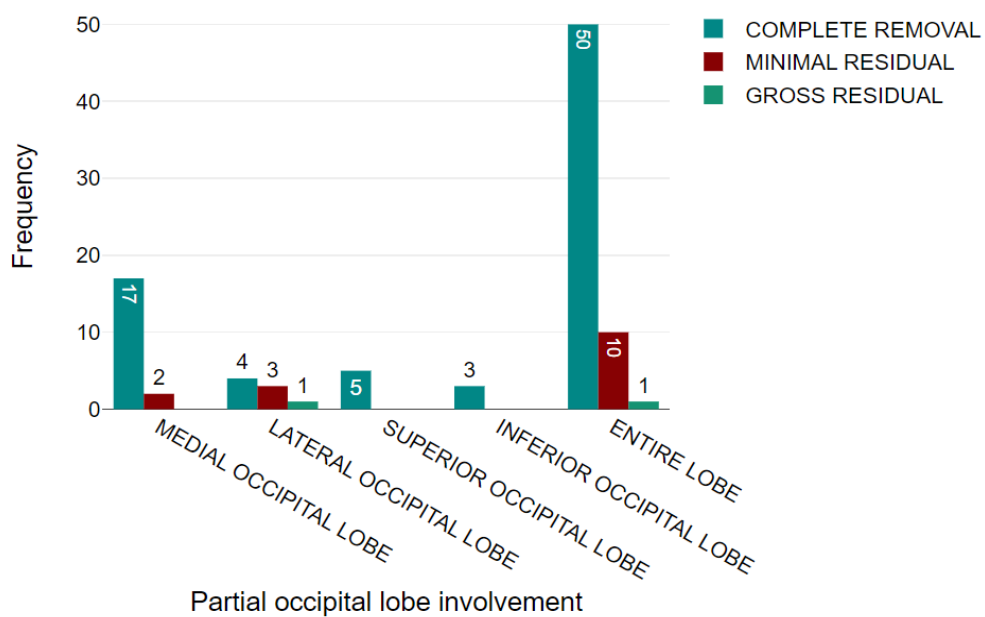
Table 11 : Post op MRI – Assessment of completeness of resection within EOL group

		EOL - PARIETAL	EOL-TEMPORAL	EOL-PARIETOTEMPORAL	Total
Post sx MRI	COMPLETE REMOVAL	13	4	10	27
	MINIMAL RESIDUAL	9	2	0	11
	GROSS RESIDUAL	0	1	0	1
	Total	22	7	10	39

In EOL group, the chances of leaving residual lesion is seen more in parietal lobe extensions than temporal lobe or combined.

Figure 18 : Post op MRI – Assessment of completeness of resection in Occipital lobe

(Lesionectomy/Partial occipital lobectomy)



Within Occipital lobe, the chances of leaving residual lesion were more in Medial occipital lobe.

Table 12: Post op MRI – Assessment of completeness of resection in Occipital lobe

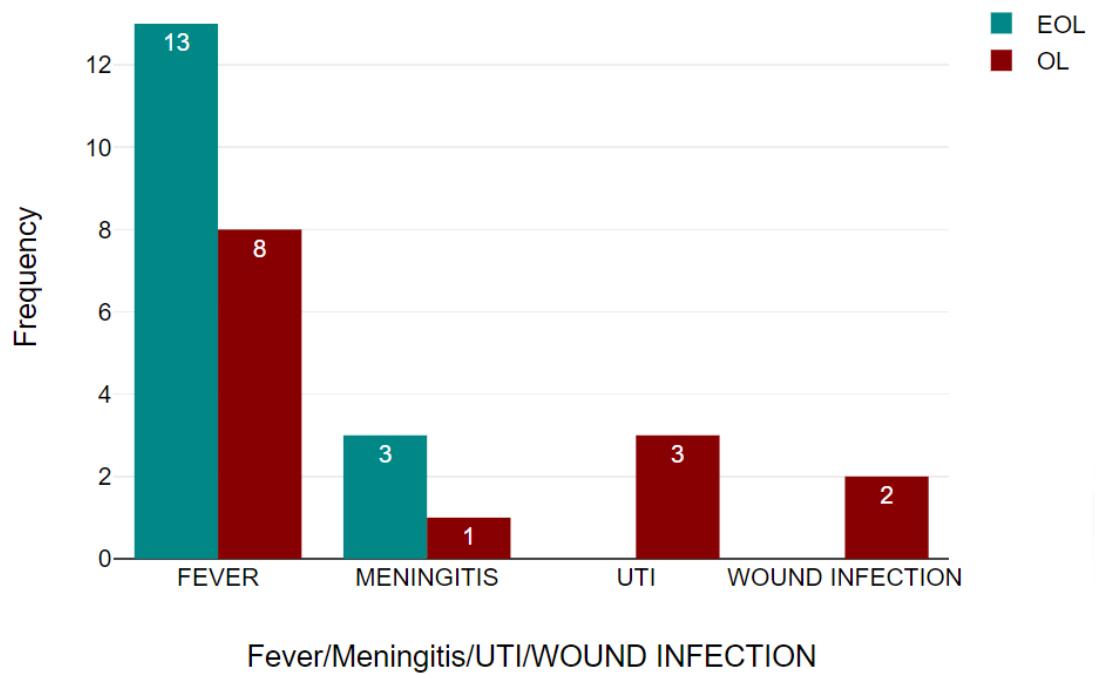
(Lesionectomy/Partial occipital lobectomy)

	COMPLETE REMOVAL		MINIMAL RESIDUAL		GROSS RESIDUAL		Total	
	n	%	n	%	n	%	n	%
MEDIAL OCCIPITAL LOBE	17	17.71 %	2	2.08%	0	0%	19	19.79%
LATERAL OCCIPITAL LOBE	4	4.17%	3	3.13%	1	1.04%	8	8.33%
SUPERIOR OCCIPITAL LOBE	5	5.21%	0	0%	0	0%	5	5.21%
INFERIOR OCCIPITAL LOBE	3	3.13%	0	0%	0	0%	3	3.13%
ENTIRE LOBE	50	52.08 %	10	10.42 %	1	1.04%	61	63.54%
Total	79	82.29 %	15	15.63 %	2	2.08%	96	100%

	Chi ²	df	p
Partial occipital lobe involvement - Post sx MRI	10.26	8	.247

Post op Complications: OL vs EOL

Figure 19: Bar graph showing complications in both groups



	Chi ²	df	p
Fever/Meningitis/UTI/WOUND INFECTION	7.5	4	.112

EOL group has more aseptic fever and risk of meningitis, though statistically not significant.

Table 13: Comparing post op Neurological complications between EOL and OL group

		EOL		OL		Total
		n	%	n	%	n
POST OP SEIZURES < 3MON		10	47.62%	11	52.38%	21
POST OP MOTOR DEFICITS		5	83.33%	1	16.67%	6
POST OP VISUAL DEFICITS	HEMIANOPIA	15	34.09%	25	56.82%	40
	QUADRANTANOPIA	1	2.27%	2	4.55%	3
	NORMAL	1	2.27%	0	0%	1

The motor deficits were more in EOL group than OL group, with visual field deficits seen more in the OL group.

The following table 14 shows the rare complications encountered in this study.

Table 14: Rare complications in this study

THROMBOCYTOPNIA	1
POST OP VARICELLA	1
HYPONATREMIA	2
PSEUDOMENINGOCELE	1
CSF LEAK	2
OPERATIVE CAVITY HAEMATOMA	1
ALEXIA, SPLENIUM INFARCT	1
PNES (Psychogenic Non Epileptic Sz)	1

Post op Visual deficits

Figure 20: Post op visual deficits in EOL and OL group

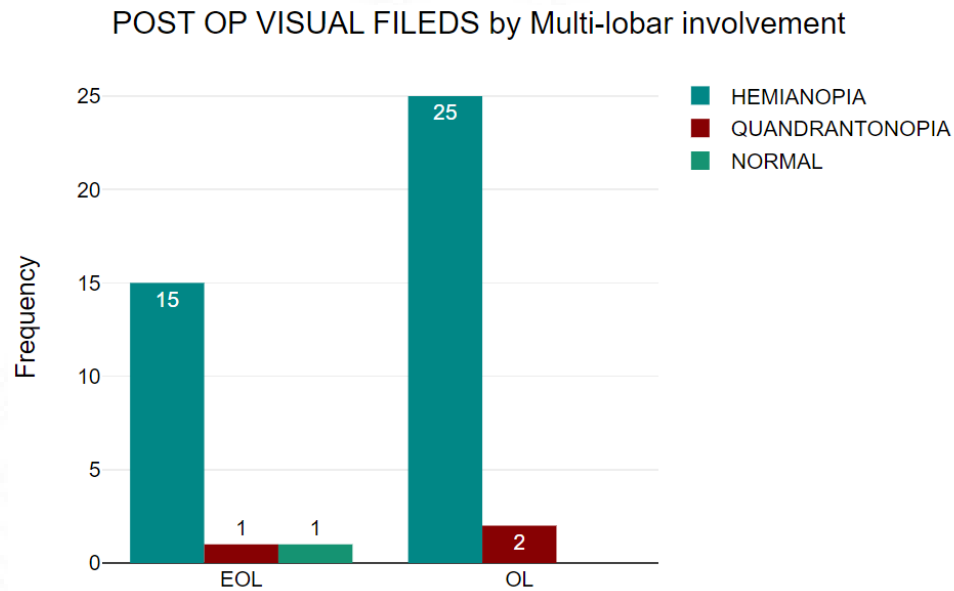
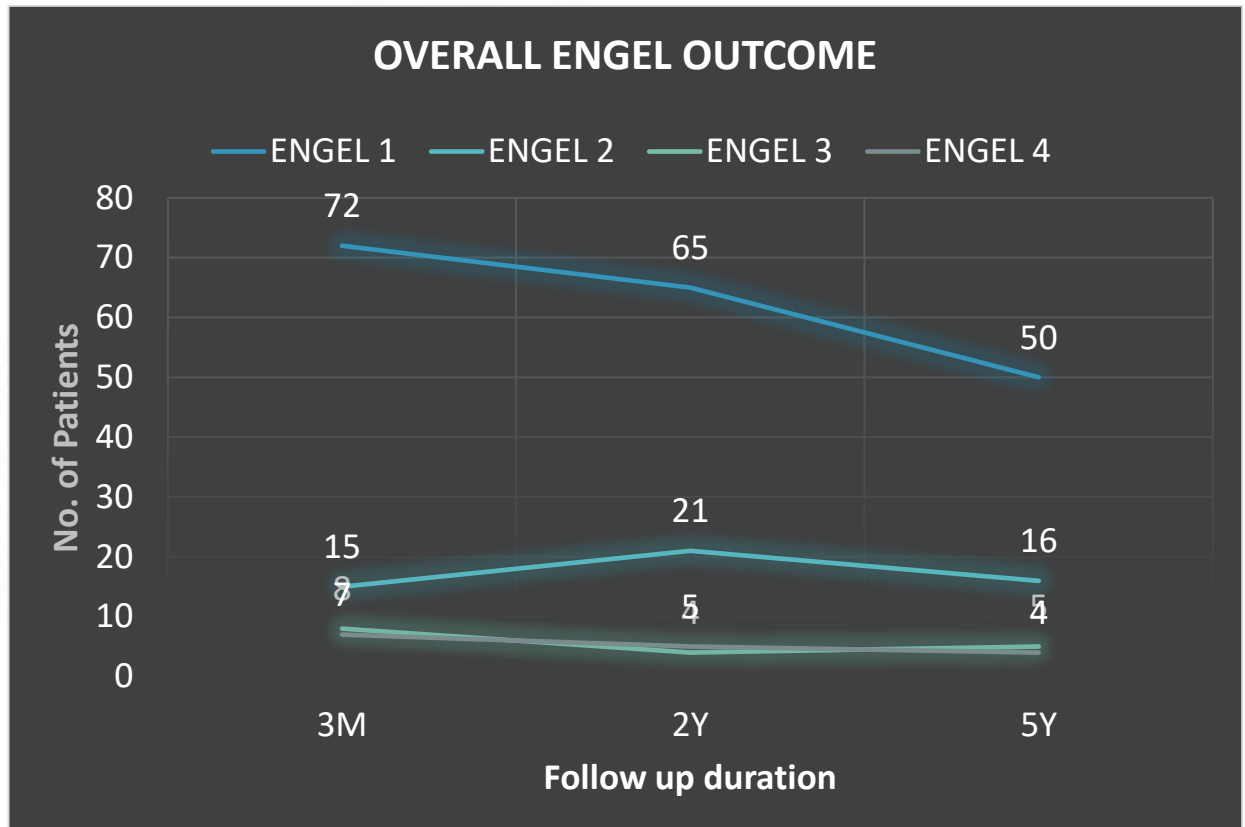


Table 15: Post op visual deficits in EOL and OL group

		EOL		OL		Total	
		n	%	n	%	n	%
POST OP VISUAL FILEDS	HEMIANOPIA	15	34.09%	25	56.82%	40	90.91%
	QUANDRANT ONOPIA	1	2.27%	2	4.55%	3	6.82%
	NORMAL	1	2.27%	0	0%	1	2.27%
Total		17	38.64%	27	61.36%	44	100%

Seizure outcomes:

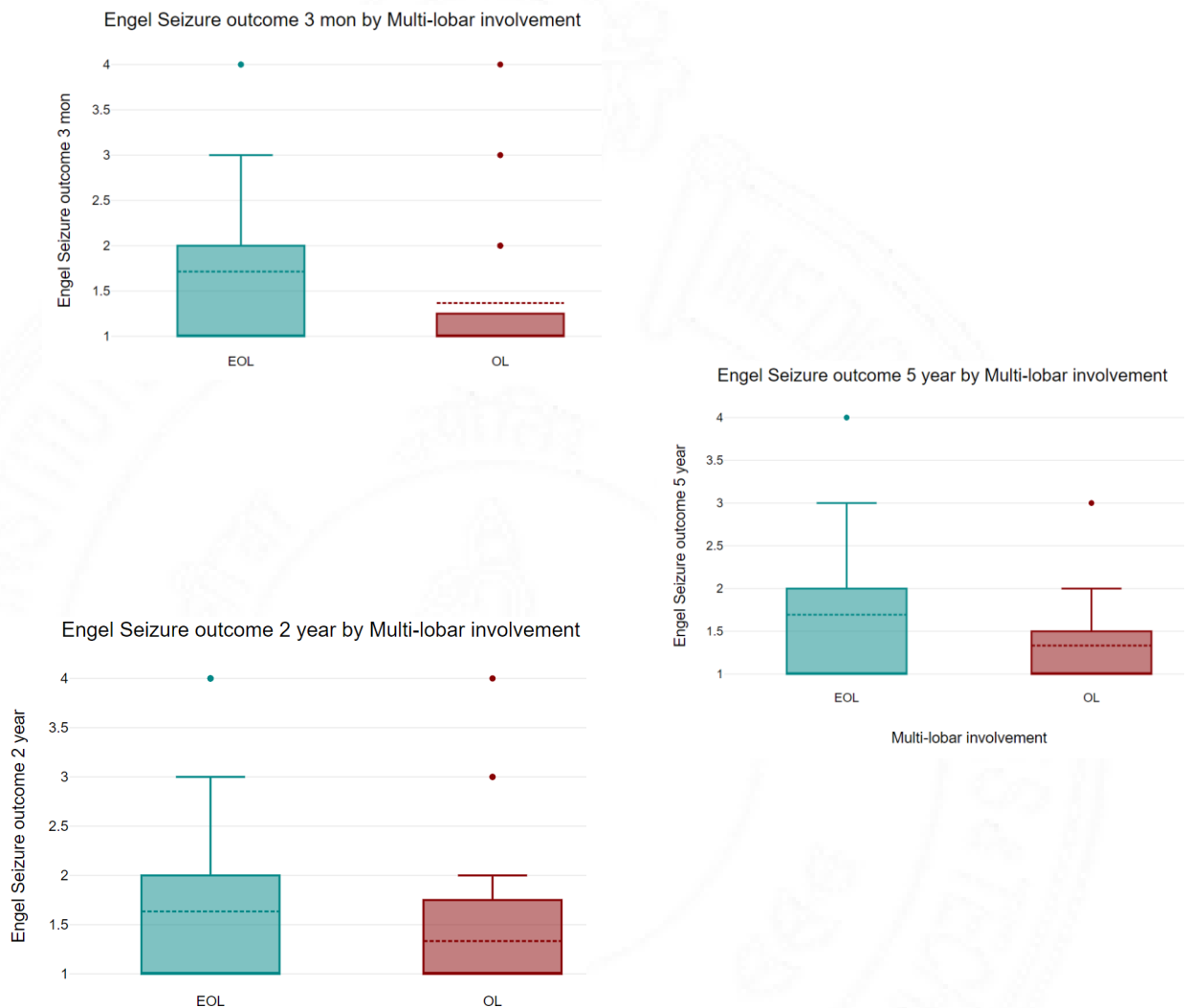
Figure 21 : Overall Engel outcome of the study group was shown in timeline



Engel Seizure outcome	3 months		2 year		5 year	
1	72	70.59%	65	68.42%	50	66.67%
2	15	14.71%	21	22.11%	16	21.33%
3	8	7.84%	4	4.21%	5	6.67%
4	7	6.86%	5	5.26%	4	5.33%
Total	102	100%	95	76.61%	75	100%

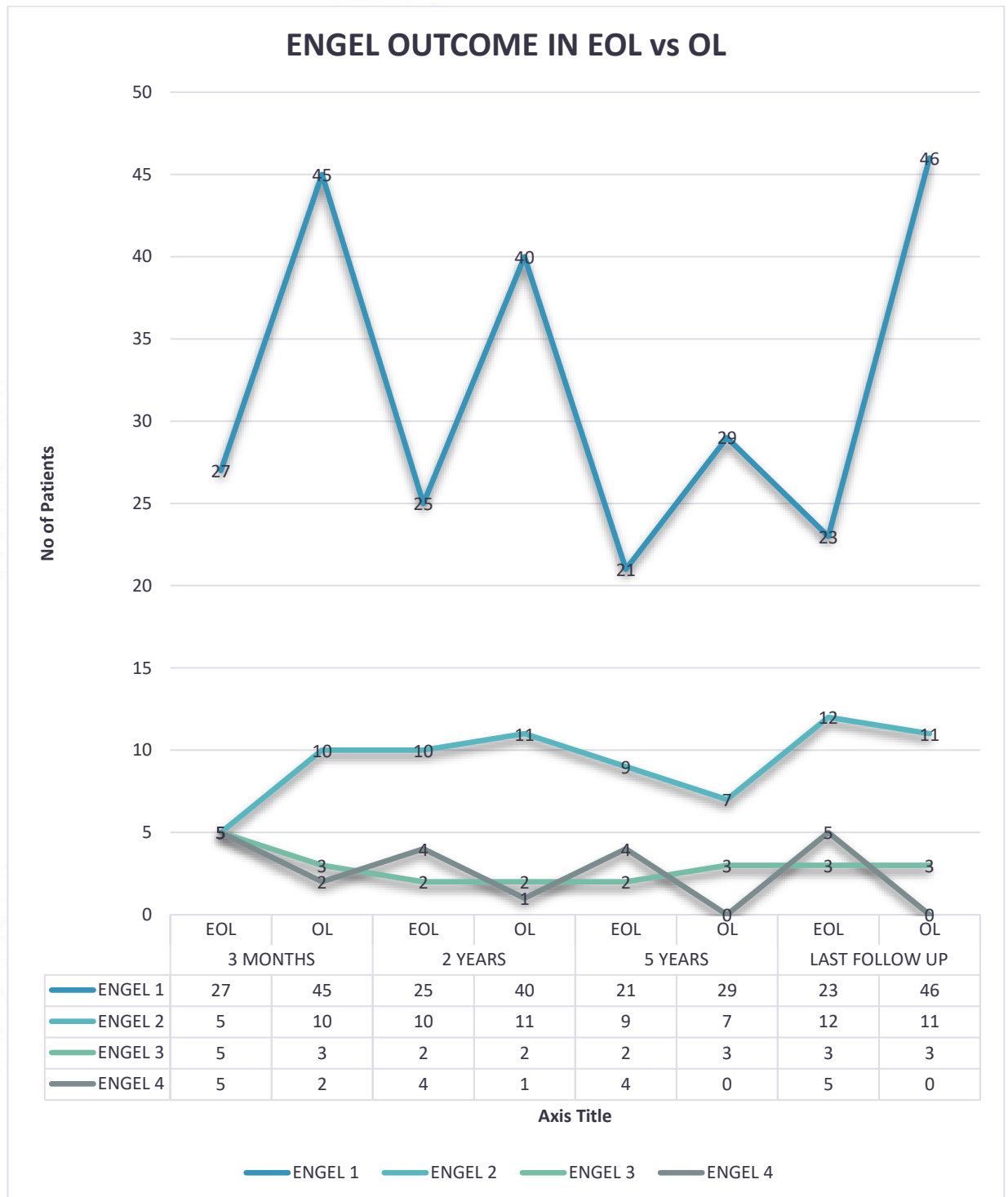
Figure 22: Box plot showing Engel outcome measure in EOL vs OL group in three time periods.

Engel outcome between EOL vs OL



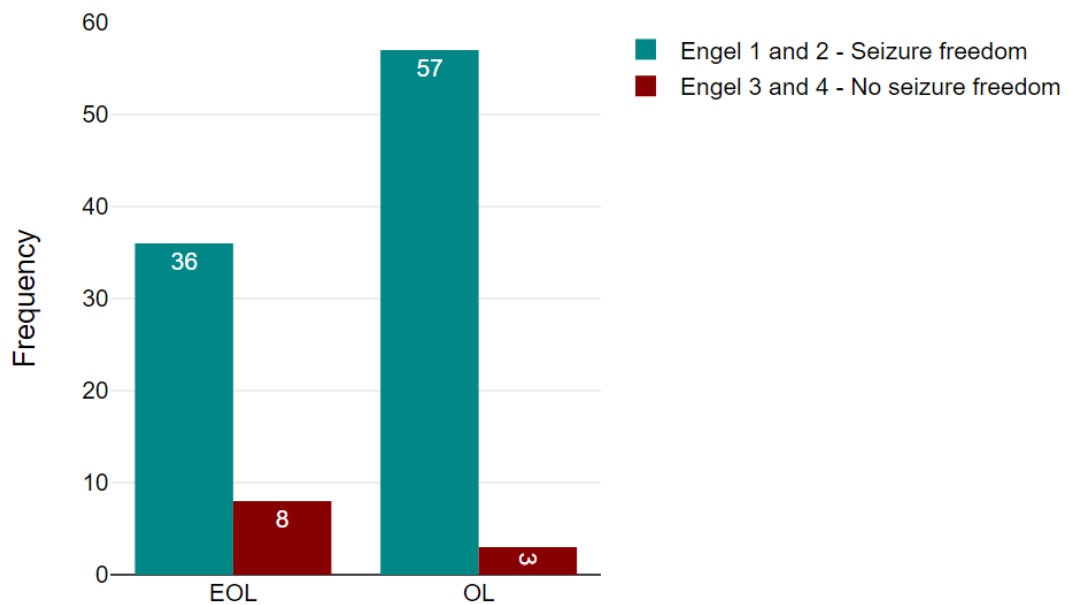
OL group has better seizure outcome at all time intervals than EOL group.

Figure 23: COMPARING ENGEL BETWEEN EOL VS OL



When Engel outcome is compared in between EOL and OL group, at all time period of follow up, OL group has better outcome and it fades as the time

Figure 24: Engel outcome Regrouped – OL vs EOL



P=0.031

When regrouped the Engel outcome into seizure freedom(class 1 and 2) vs no seizure freedom(class 3 and 4). There is statistically significant difference with P value of 0.03.

Table 16: Engel regrouped and compared between EOL and OL group

		Engel outcome overall - benefit/no benefit		
		Engel 1 and 2 - Seizure freedom	Engel 3 and 4 - No seizure freedom	Total
Multi-lobar involvement	EOL	36	8	44
	OL	57	3	60
Total		93	11	104

Chi² df p

Multi-lobar involvement - Engel outcome overall - benefit/no benefit **4.66 1 .031**

Engels outcome within EOL – Parietal vs Temporal vs Parieto-Temporal

Table 17: Engel outcome comparison within EOL group

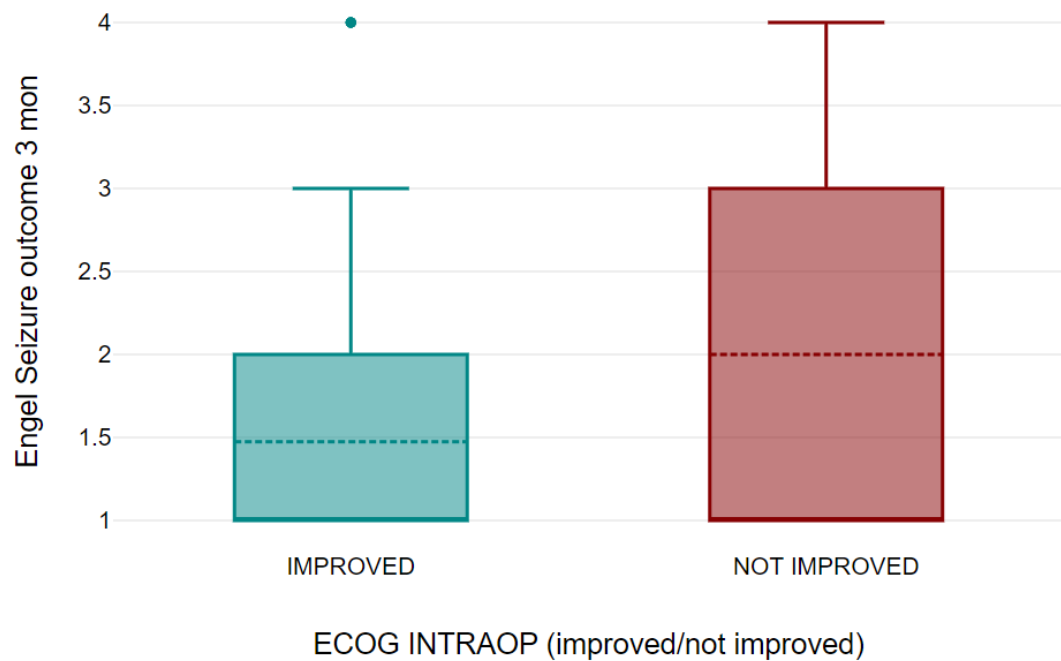
		MLR - p,t,pt			
		EOL - PARIETAL	EOL-TEMPORAL	EOL- PARIETOTEMPORAL	Total
engel last follow up	1	11	4	6	21
	2	8	1	2	11
	3	2	1	0	3
	4	3	2	0	5
	Total	24	8	8	40

	Chi ²	df	p
engel last follow up - MLR - p,t,pt	4.84	6	.564

Engel outcome score is better in the pathologies extending to the parieto-temporal group followed by temporal group, then parietal extension group though P value not significant.

INTRA OP ECOG WITH ENGEL SCORE

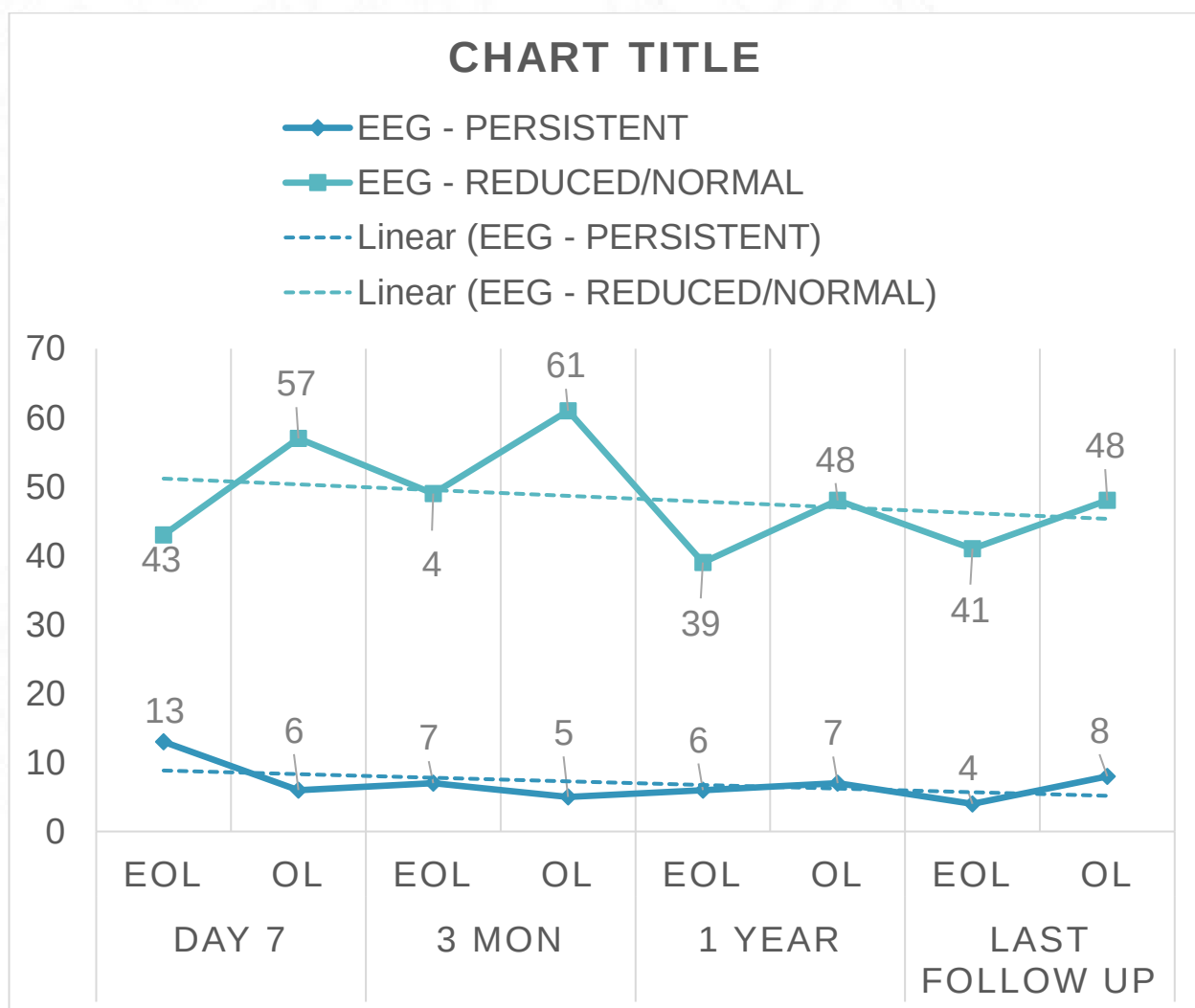
Figure 25: Box plot comparing Intraop ECoG status with post op Engel outcome



Intraoperative Electrocorticography correlated well with the post op follow up Engel outcome. Those who show intraoperative reduction in spikes has better engel outcome.

POST OP EEG TREND IN EOL VS OL

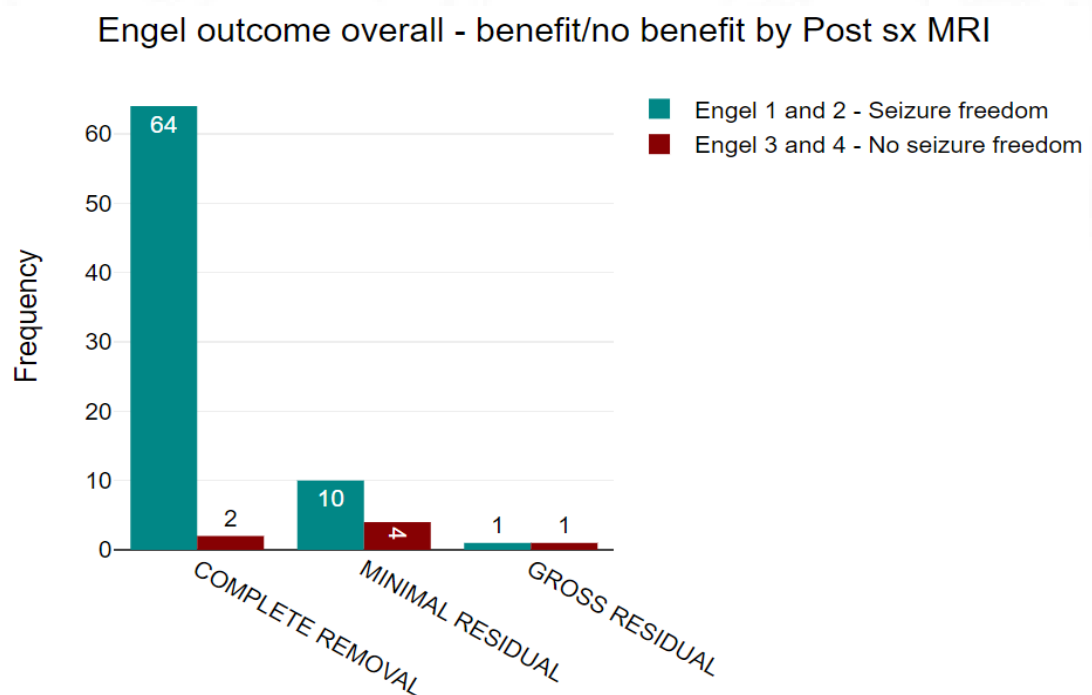
Figure 26 : Correlating post op EEG status with the Engel outcome



Post operative follow up EEG at different time intervals showed good reduction of abnormal spikes in OL group than EOL group.

Status of resection vs Seizure benefit

Figure 27: Comparing Engel outcome with the status of resection in the post op MRI



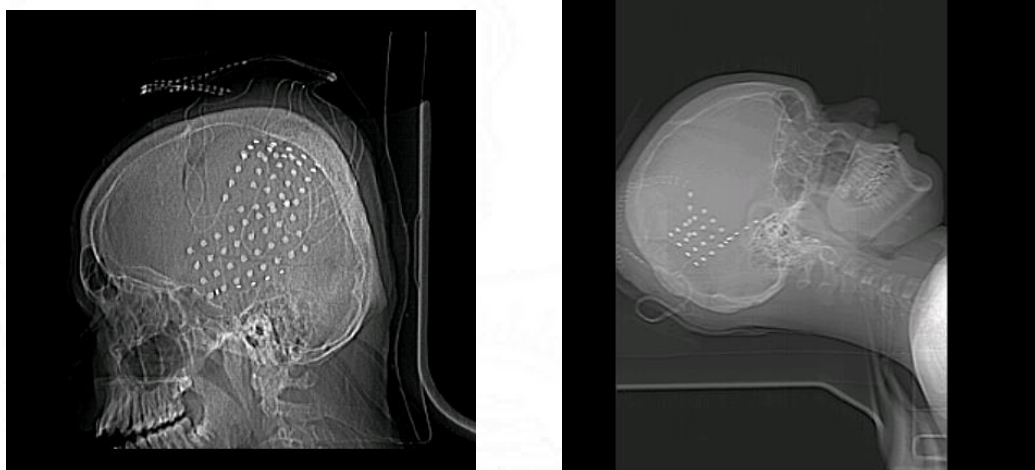
The group with no seizure freedom benefit is seen more in the patients who has minimal residual lesion.

Invasive EEG – Strip, Grid and Depth

Table 18: Invasive EEG status in EOL vs OL group

	MLO		OL		Total
	N	%	n	%	n
INVASIVE EEG - STRIP, GRID, DEPTH	12	54.55%	10	45.45%	22
DEPTH	2	50%	2	50%	4

Figure 28 : Invasive EEH with subdural electrode placement – Skull xray images

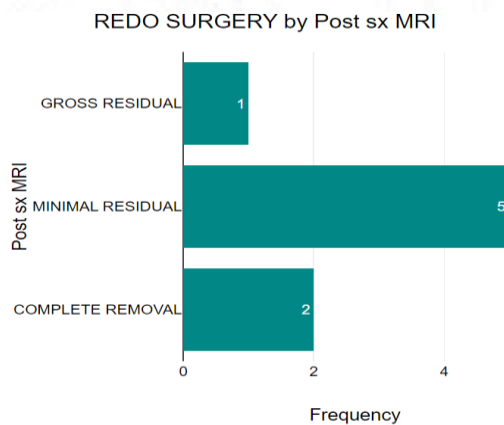


Invasive EEG is distributed fairly in equal number in both the groups.

Failed surgery - Redo Preop work and Surgery

In this study, redo surgery was done for 9 patients, invasive EEG done in 5 patients. After redo surgery, ECoG improved in 8 patients, persistent in 1 patient. Seizure benefit as follows : Engel 1 in 3 patients, Engel 2 in 2 patients, Engel 3 in 1 patient.

Figure 29 : First surgery MRI status in patients who underwent Redo surgery



Among the patients who underwent redo surgery, 5 patients had minimal residual lesion in post op MRI, 1 patient had gross residue, 2 patients did not have any obvious lesion.



DISCUSSION

In this study, on comparing EOL and OL group - basic demographics, preop clinical characteristics, seizure semiology and EEG features were comparable in both groups.

- Seizure related falls were observed more in EOL group ($P=0.009$)
- Seizure free period after starting ASM were better with OL vs EOL (31 months vs 20 months)
- Preop Motor deficits were more in EOL whereas Visual field deficits were higher in OL group before surgery($P=0.012$) (Literature – 64% Harward et al,2018)
- EOL patients were more dependent for activities of daily living(ADL) than OL ($P=0.002$)

In EEG, IED in PHR region usually seen in OL group, but not seen in EOL ($P = 0.038$). Major histopathology noted in this study was Gliosis, f/b FCD, tumours, MCD. Porencephalic cyst were seen only in EOL group. With in Occipital lobe, Gliosis was seen predominantly in Medial aspect, tumours were noted more in the lateral aspect ($P=0.001$)

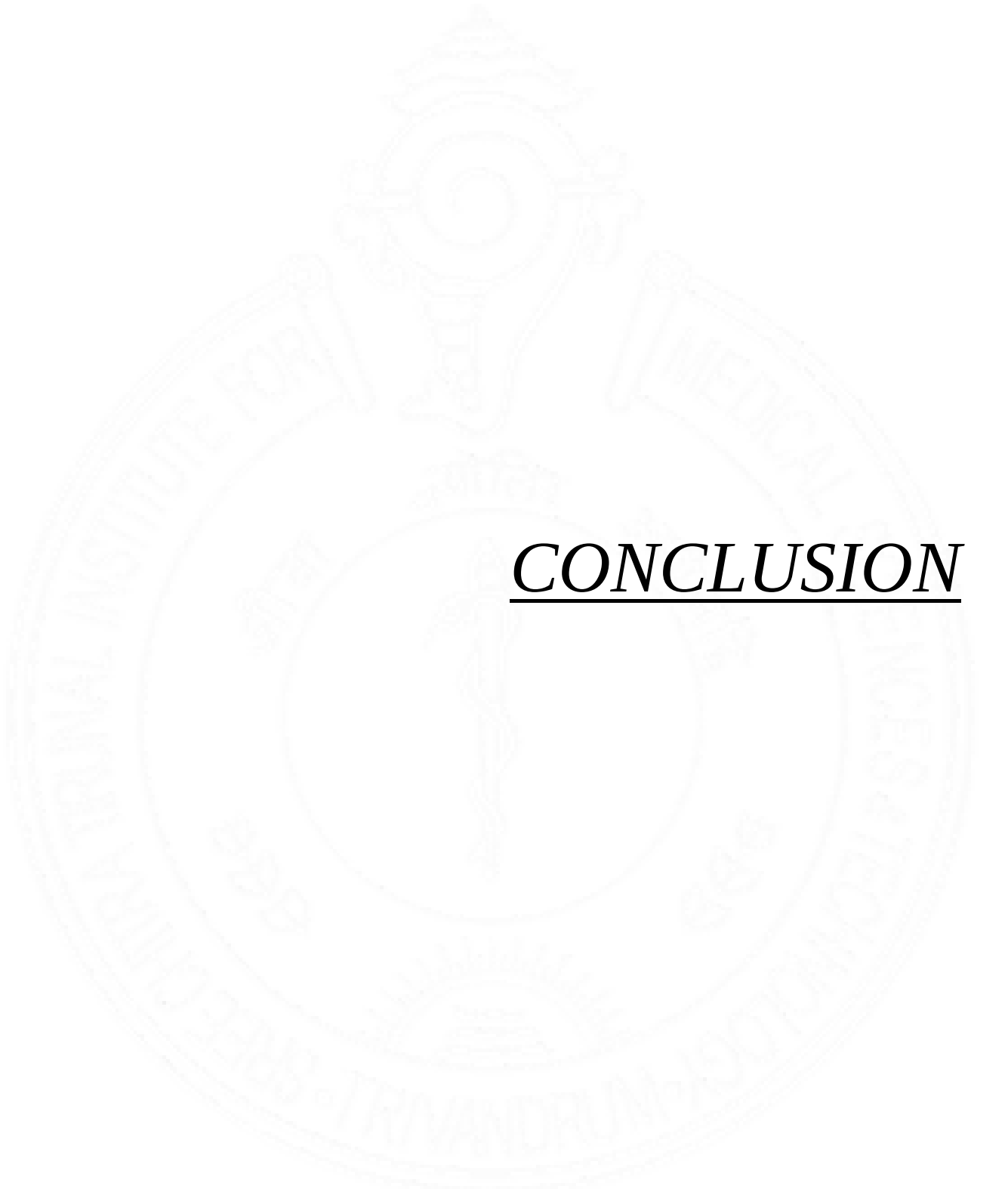
- Intraoperative ECOG showed good reduction of spikes noted in OL than EOL group with statistically significant p value($P=0.041$).
- Chances of Residual lesion in Post op MRI is more in EOL group than OL ($P=0.04$)

With in the EOL group, large extension to Temporo-parietal lobe has good resection status in the MRI compared to the group with the limited extension to either Temporal or parietal lobe ($P=0.033$). By Ramantani et al, Parietal involvement has poor seizure outcome than other lobe involvement. In our study also, engel outcome is poor for parietal extension group.(Heo et al., 2017; Liava et al., 2014; Yang et al., 2015)

Engel outcome

- Overall Engel class 1 and 2 were 70.6% and 15% respectively at 3 months, which decreases to 66.7% and 7% at 5 years.
- Overall Seizure benefit - Engel outcome(class 1 and 2) is better in OL group as compared to EOL ($P=0.017$) which is statistically significant.
- Intraoperative ECoG reduction in abnormal spikes has better correlation with the Engel score but not statistically significant ($P=0.25$)
- Post op MRI – complete resection is correlated with good seizure benefit(Engel 1 and 2 – $P=0.001$) and reduced spikes in follow up EEG ($P=0.004$). This reinforces that achieving the gross total resection of MRI abnormality in the seizure foci is paramount in achieving seizure freedom.(Kun Lee et al., 2005)

- Post op EEG shows reduced/absent spikes in OL group than EOL group which is probably due to extensive seizure network($P=0.042$)
- In the Literature, Ramantani et al, 2017 reported Engel class 1 (60%) in the posterior cortex epilepsy. In a study by Harward et al, meta-analysis of the occipital lobe epilepsy surgery showed Engel class 1 outcome as 65% whereas in our cohort we had reached more than 70%. In that analysis, more than 50% of patients underwent Invasive EEG for exact localization. Whereas in this study, only 26 patients (20%) underwent invasive EEG.(Aznarez et al., 2020; Doddamani et al., 2020; Kuzniecky et al., 1997; Yang et al., 2014)



CONCLUSION

Extended Occipital lobe pathologies and Occipital lobe pathologies has similar clinical and EEG characteristics. EOL group has more Pre and Post op motor deficits, OL group has more visual deficits. Intra op ECoG spikes reduction, Completeness of resection, Good Engel outcome, Post op EEG spike reduction was better in OL than EOL. EOL with parietal lobe involvement has poor outcomes than temporal lobe followed by combined parieto-temporal lobe pathologies. EOL group has poor results than OL probably because of its intricate whitematter connections to other lobes, which merits better preop planning (Stereo EEG, Higher Imaging modalities), more aggressive resection than required using Intraop ECoG guidance.

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ANNEXURES

List of publications from Thesis: Not yet published

Appendices

APPENDIX A – ETHICS COMMITTEE APPROVAL



श्री चित्रा तिरुनाल आयुर्विज्ञान और प्रौद्योगिकी संस्थान, त्रिवेन्द्रम
तिरुवनन्तपुरम - ६९५०११, केरल, इंडिया

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Institutional Ethics Committee

CDSO Registration No: ECR/189/Inst/KL/2013/RR-24
DHR Registration No: EC/NEW/INST/2022/2775

SCT/IEC/2261/JULY/2024

26.09.2024

Dr. Lokesh VD
Post Doctoral Fellow
Department of Neurosurgery
SCTIMST, Thiruvananthapuram

Dear Dr. Lokesh,

The Institutional Ethics Committee held on 20th July, 2024, reviewed and discussed your application to conduct the study titled "PREDICATORS OF SEIZURE OUTCOMES AND SURGICAL COMPLICATIONS AFTER EPILEPSY SURGERY FOR DRUG-RESISTANT EPILEPSY (IEC /2261)".

Principal Investigator	Dr Lokesh V D, Post Doctoral Fellow In Functional Neurosurgery, SCTIMST
Co-Principal Investigator(s)	Dr. George C Vilaniam, Professor, Department of Neurosurgery, SCTIMST Dr Krishna Kumar K, Professor and HOD, Department of Neurosurgery, SCTIMST Dr Ashalatha Radhakrishnan, Professor, R. Madhavan Nair Centre for Epilepsy, Department of Neurology, SCTIMST Dr Ramshekar Menon, Professor, R. Madhavan Nair Centre for Epilepsy, Department of Neurology, SCTIMST Dr. Deepthi AN, Additional Professor, Department of Pathology, SCTIMST Dr Kesavadas Chandrasekharan, Professor and HOD Department of Radiology, SCTIMST Dr Bijoy Thomas, Professor, Department of Radiology, SCTIMST
Duration of the study	6 months

The following members of the Ethics Committee were present at the meeting held on 20th July, 2024

SL. No.	Member Name	Highest Degree	Gender	Scientific /Non Scientific	Affiliation with Institution(s)
1.	Dr. Kusuma Kumary P	M D in Paediatrics	Female	Clinician (Chairperson)	No
2.	Dr. Pradeep S	MBBS, MD	Male	Basic Medical Scientist	No
3.	Dr. Annapurna.Y	MD	Female	Basic Medical Scientist	No
4.	Dr. Indu PV	MBBS, DPM, MPhil, PhD	Female	Clinician	No
5.	Dr. Rejnish Kumar	MBBS, MD, DNB	Male	Clinician	No
6.	Smt. Rekha Radhakrishnan	M.A (Eng.); B.Ed	Female	Lay person	No
7.	Dr. Manoj Murhekar	MD (Preventive & Social Medicine)	Male	Social Scientist	No
8.	Adv. Priya Kaimal	LLM, MBL	Female	Legal Expert	No
9.	Dr. Biju Soman	MBBS, MD, DPH, MSc, DLSHTM	Male	Basic Medical Scientist	Yes
10.	Dr. Syam K	MBBS, MD, DM	Male	Clinician	Yes
11.	Dr. Srinivas G	PhD	Male	Basic Medical Scientist (Member Secretary)	Yes

The following documents were reviewed:Original submission

1. Research Proposal
2. IEC Application Form
3. Declaration Form
4. Covering letter addressed to the Chairman, IEC, SCTIMST
5. Covering letter addressed to the Chairman, IEC, SCTIMST dated 22.04.2024
6. Forwarding letter from HOD
7. Proforma
8. CV of Principal Investigator and Co-PIs
9. Checklist Form
10. Responses /amendments made based on the Reviewer's comments
11. SRC Recommendation Letter

Revised submission

1. Research Proposal
2. IEC Application Form
3. Declaration Form
4. Covering letter addressed to the Chairperson, IEC, SCTIMST dated 22.04.2024
5. Covering letter addressed to the Chairperson, IEC, SCTIMST
6. Forwarding letter from HOD
7. Proforma
8. CV of Principal Investigator and Co-PIs
9. Checklist Form
10. Covering letter addressed to the Member Secretary, IEC, SCTIMST dated 21.09.2024
11. Responses /amendments made based on the Reviewer's comments

IEC Decision

The IEC approved the conduct of the study in the present form.

Remarks:

The Institutional Ethics Committee expects to be informed about the progress of the study, any SAE occurring in the course of the study, any changes in the protocol and patient information/informed consent and asks to be provided a copy of the final report.

There was no member of the study team who participated in voting / decision making process. The ethics committee is organized and operated according to the requirements of Good Clinical Practice and the requirements of the Indian Council of Medical Research (ICMR).

Sincerely


Dr. G. Srinivas
Member Secretary, IEC

MEMBER SECRETARY
INSTITUTIONAL ETHICS COMMITTEE (IEC)
SCTIMST, THIRUVANANTHAPURAM



APPENDIX B – SUPPLEMENTARY TABLES - Nil

APPENDIX C - PUBLICATIONS – Not yet published

APPENDIX D – PLAGIARISM CHECK REPORT



PLAGIARISM SCAN REPORT

Date Dec 31, 2024

Exclude URL: NO



Unique Content **91%**

Plagiarized Content **9%**

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