Utility of intraoperative visual evoked potential on the peri-operative visual function in patients undergoing endoscopic resection of sellar and suprasellar tumours.

Dissertation submitted for the partial fulfilment for the

Requirement of The degree

of

DM Neuroanaesthesia

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July 2021

DECLARATION

I hereby declare that this thesis titled "**Utility of Intraoperative visual evoked potential on the peri-operative visual function in patients undergoing endoscopic resection of sellar and suprasellar tumours**" has been prepared by me under the capable supervision and guidance of Dr Manikandan.S, Professor & Head, Division of Neuroaneasthesia and Neurocritical Care, Department of Anaesthesiology, Sree Chitra Tirunal Institute for Medical Sciences & Technology, Thiruvananthapuram.

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This is to certify that this thesis titled **" Utility of Intraoperative visual evoked potential on the peri-operative visual function in patients undergoing endoscopic resection of sellar and suprasellar tumours"** is a bonafide work of Dr. Aishvarya Shree, DM Neuroanesthesia Resident, and has been done under my direct guidance and supervision at Sree Chitra Tirunal Institute for Medical Sciences & Technology (SCTIMST), Thiruvananthapuram. She has shown keen interest in preparing this project.

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ACKNOWLEDGEMENT

I thank almighty for giving me the strength and courage to endure through this. Throughout the this period I have received immense support from a great deal of people without which my dissertation would not have reached the present stage. I would like to thank my esteemed institution, Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST) for giving me such a great opportunity to pursue with my thesis.

I express my sincerest gratitude to my guide, Dr. Manikandan S, Professor and Head of Division of Neuroanesthesia and Neurocritical care, Department of Anaesthesiology, SCTIMST for patiently going through several versions of my text, investing his valuable time and helping me out with his expert guidance.

I'm extremely grateful to Dr. Ajay Prasad Hrishi, Associate Professor, Neuroanesthesia division, Department of Anaesthesiology, SCTIMST, my co-guide who was always there to clear my doubts and help me with the writing.

A special word of gratitude is due to Dr. Smita V, Dr. Unnikrishnan P, Dr. Ranganatha Praveen CS, Dr. Soumya M, Faculty of the Division of Neuroanesthesia & Neurocritical Care, and Dr. Prakash Nair, Associate professor, Department of Neurosurgery for their valuable advice and generous help.

I'm indebted to all those patients who consented to take part in this study. I would like to acknowledge the help of all my fellow colleagues and a special thanks Dr Sapna and Dr Revikrishnan for their support.

Last but not the least, I’m indebted to my family who stood by me in all my decisions and helped me sail through. I’m extremely grateful to my late grandfather who took keen interest in all my academic endeavours and helped me achieve this.

ABBREVIATIONS

ACA: Anterior Cerebral Artery.

AEEGS: American Electroencephalographic Society.

ANOVA: Analysis of variance.

ASA: American Society of Anaesthesiology.

BMI: Body Mass Index

CABG: Coronary Artery Bypass Grafting

CSF: Cerebrospinal Fluid

ECG: Electrocardiogram.

EEG: Electroencephalogram

ERG: Electroretinogram.

$ETCO_2$: End tidal carbon dioxide.

fERG: Flash Electroretinogram.

fVEP: Flash Visual Evoked Potential.

HR: Heart Rate.

HVF: Humphrey visual fields

ICA: **Internal Carotid Aretry.**

LED: **Light Emitting Diode.**

MAP: **Mean Arterial Pressure.**

MCA: **Middle cerebral artery**

mfVEP: **Multi Focal Visual Evoked Potential.**

NIBP: **Non-invasive blood pressure.**

NSICU: **Neuro surgical intensive care unit.**

ON: **Optic Nerve.**

$PaCO_2$: **Partial pressure of arterial carbon dioxide.**

PaO_2: **Partial Pressure of oxygen.**

PCA: **Posterior cerebral artery.**

PICC: **Peripherally inserted central line.**

SBP: **Systolic blood pressure.**

SpO_2: **Peripheral oxygen saturation.**

SSPS: **Statistical package for the social sciences.**

SD: **Standard Deviation.**

TIVA: **Total Intravenous Anaesthesia.**

VA: **Visual Acuity.**

VEP: **Visual Evoked Potential.**

WHO: **World Health Organization.**

NFPA: **Non-Functioning Pituitary Adenoma.**

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1. ABSTRACT

Abstract

Background: Visual pathway monitoring and preserving its function is important in pituitary tumours. The anatomical proximity of the optic chiasm to these tumours is the reason for frequent presentation with visual symptoms in the form of decline in visual acuity, visual field defects and involvement of ocular movements. Our primary aim of the study was to evaluate the changes in the intraoperative flash VEPs and its utility on peri-operative visual function.

Materials and Methods: Our study included a total of 25 patients aged 18-60 years belonging to ASA grade I and II with a GCS of 15 posted for elective endoscopic trans nasal trans sphenoidal excision of sellar and supra sellar lesions based on preoperative MRI/CT. pre-operative visual acuity and perimetry were recorded as per our hospital protocol. Flash visual evoked potential were recorded during awake state, post induction, during tumour resection and at the end of surgery.

Results: We were able to obtain stable VEP recordings throughout the intraoperative period. We found significant prolongation of VEP recordings from baseline values to post-induction. The increase was 12.3% for N75 and 10.3% for P100 latencies. The amplitude change between N75-P100 was 46.6% decrease. The change in latencies and amplitude were over and above the baseline values during the resection times. The increase was 33.3% for N75, 7.8% for P100 latency and 15.1% decrease for N75-P100 amplitude. At the end of resection and just before extubation, when the anaesthetic agents were stopped, the N75 and P100 latencies and N75-P100 amplitudes returned to pre-resection levels but never touched the awake baseline. Analysis of the post-operative perimetry with the VEP recordings at the end of surgery showed that the increase in latency was more in the patients with no defects as compared with patients who had an improved perimetry. The results were not statistically significant.

Conclusion: Patients in our study had greater improvement in the postoperative vision due to better intraoperative preservation of VEPs and the return of the values to pre resection values at the end of surgery signifies that the optic nerve was intact. Our study shows greater knowledge on the pattern of the intraoperative VEPs changes on integrity of visual pathway and preservation of visual function postoperatively.

2. INTRODUCTION

Introduction

Tumours of the sellar and suprasellar region contribute to 10% of the intracranial neoplasms. (1) Tumours in this region consist of pituitary adenomas, meningiomas, craniopharyngiomas, epidermoid cysts, germinomas, chordomas etc. Surgery forms the main stay in the management of these tumours. Advances in endoscopic techniques has transformed the surgical management of these tumours from transcranial to trans nasal approach. With the advent of the angled endoscope, visualization and resection of para-sellar and suprasellar tumours became possible. (1)

Visual pathway monitoring and preserving its function in important in pituitary tumours. Along with hormonal impairment, because of the anatomical proximity of the optic chiasm tumours of these regions frequently present with visual symptoms in the form of decline in visual acuity, visual field defects and involvement of ocular movements. As compared to the transcranial approach where the optic fibres come into the operative view early, they are seen much later in trans-nasal trans-sphenoidal approach risking the visual pathway. Surgical resection of suprasellar meningiomas has been shown to worsen visual function in 14–28% of patients and surgical resection of craniopharyngiomas worsen visual function in 3–11.5% of patients. (2) Manipulation of the optic nerve and interference with the microvasculature during microsurgical dissection is thought to be responsible for the visual loss in the perioperative period. In patients with preserved visual function, postoperative visual impairment becomes a greater concern. Thus, one of the important goals is to preserve the visual function and avoid any further deterioration in the intra-operative period. (2)

Visual evoked Potentials (VEP) is an important modality to monitor the visual pathway. VEPs have been successfully used for diagnostics of demyelinating diseases like multiple sclerosis. (3) However, the role of VEPs in the intra operative period have yielded conflicting reports in the literature owing to their technical difficulties and effects of anaesthetic methods. (3) In the early 1970s, VEPs using flash stimulus showed promising results. Even though this recording became possible, large scale studies to assess the correlation between the intraoperative VEPs with the post-operative outcome are lacking. Hence, there is no consensus currently on the use of intraoperative VEP recordings for visual function monitoring. The effects of preoperative visual functions, intraoperative changes in relation to surgical manipulation and correlation of these changes in VEP with respect to postoperative visual function needs to be studied for its widespread application. There has been constant research in this area with improvements in stimulus delivery, recording parameters and anaesthetic technique.

We had planned the current study to address some of the shortcomings of the use of VEP intraoperatively with which we aimed at obtaining reliable and consistent VEP waveforms in patients undergoing trans nasal trans sphenoidal resection of sellar and supra sellar tumours and to correlate them with the post-operative visual outcome.

3.REVIEW OF LITERATURE

Review Of Literature

Tumors of the pituitary gland and sellar region constitute 10 to 15% of intracranial neoplasms.(4) Incidence of pituitary tumors increases with age with 9% of the tumors occurring in population under 20 years of age and 30% of the tumors occurring in the age group between 50 and 60 .(5, 6) In 2017, the World Health Organization (WHO) classified tumors of the pituitary gland into the following types: pituitary adenoma, pituitary carcinoma, pituitary blastoma, tumors of the posterior pituitary, Neuronal and para-neuronal tumors, craniopharyngioma, mesenchymal tumors, germ cell tumors, secondary tumors and haematological tumors.(7) Pituitary tumors are classified as functioning and non-functioning based on hormone secretion. Non-functioning pituitary adenomas (NFPAs) are benign neoplasms that originate from the adenohypophyseal cells and are not associated with clinical evidence of hormonal hypersecretion.(8) The functioning pituitary adenomas causes increased secretion of one or multiple hormones of the anterior pituitary depending on the cell type that causes the tumour. Pituitary adenoma can be classified as microadenoma, macroadenoma, and giant tumors based on size. Microadenoma is a tumour less than 10 mm, while macroadenoma describes a tumour larger than 10mm. Giant pituitary tumors are bigger than 40 mm.(9) Surgery forms the mainstay in the management of all these pituitary adenomas.

Surgical Approaches to Pituitary Tumors And Their Relevance

The first reported case of transsphenoidal excision of the pituitary is by Schloffer in 1907.(10) However, only during the 1960s did the trans sphenoidal approach gained popularity. In the past the major indications for transcranial approach were if the tumour has dominant extrasellar component and a small sellar component, large eccentric extensions into the middle, anterior and posterior cranial fossa, coexisting ICA or ACA aneurysm and relative indication like poorly pneumatized sphenoid sinus. (11) The advances in endoscopic assisted trans sphenoidal approaches has lessened the need for transcranial approach in large tumours.

Trans nasal technique involves microscope and endoscope both of which are safe and effective. In microscope assisted technique the stereoscopic view is maintained with easier control of massive bleeding from cavernous sinus and major vessels, the retraction of the sometimes oedematous nasal mucosa is less traumatic and the learning curve is not as steep as in endoscopic assisted technique.(12) The endoscopic approach is minimally invasive with wider panoramic visualization, improved mobility of instruments and the ability to look around the corners with angled lens. Lack of bimanual dissection which was a concern for the surgeon in the initial times was overcome by bi-nostril approach now a days. The ability to identify key landmarks plays a vital role in endoscopic approaches for best outcomes. These anatomical landmarks can be obscured in reoperations. In these situations an endoscopic assisted approach in which a standard microscope is used assisted by the an endoscope through a nasal speculum can be beneficial. (12) Thus becoming familiar with the pros and cons of each of these techniques is important.

Dallapiazza, et. al, showed microscopic and endoscopic techniques provided similar outcomes in the treatment of non-functioning adenomas with Knosp grades 0–2. (13) Several

meta- analysis and retrospective series show the superiority of the endoscopic approach for invasive and giant adenomas in contrast to the above study. Messerer, et. al, also noted that the endoscope was more efficient than microscope with respect to the quality of resection and the endocrinological outcome for large tumors and those with advanced Knosp grade. (13) Thus, with the advent of neuro-endoscopy combined with electrophysiological monitoring, neuro navigation, ultrasound doppler and high-speed drill the surgical quality and prognosis of the patients with pituitary adenoma greatly improved.

Visual Impairments In Sellar And Suprasellar Tumours

The pituitary gland is located in the cavity of Sella which is limited above by the optic nerve, optic chiasm and the circle of Willis, laterally by the cavernous sinus and internal carotid artery, inferiorly by the sphenoid sinus and posteriorly by the prepontine cistern with pons and basilar artery. (Fig 1a) Depending on their location, the enlarged pituitary mass can compress the optic nerve, chiasm, or tract. (Fig 1b) Thus patients with sellar and suprasellar lesions frequently present with neuro-ophthalmic features due to mass effect.(15) The incidence of decrease in visual acuity in these patients is 32% and visual field defects is 86%.(15) A comprehensive visual examination including visual acuity, field of vision, colour vision, ocular reflexes, and fundus examination is warranted. The slow growing nature of the tumour keeps the patients unaware of their field defects. Typical changes in field defects is the bitemporal hemianopsia and quadrantanopia leading to binocular vision difficulties.(16) The 3^{rd}, 4^{th} , 6^{th} and the maxillary and ophthalmic branch of the 5^{th} cranial in the cavernous sinus can get involved leading to pain around the eye, diplopia, ophthalmoplegia, and altered ocular reflexes.(17)

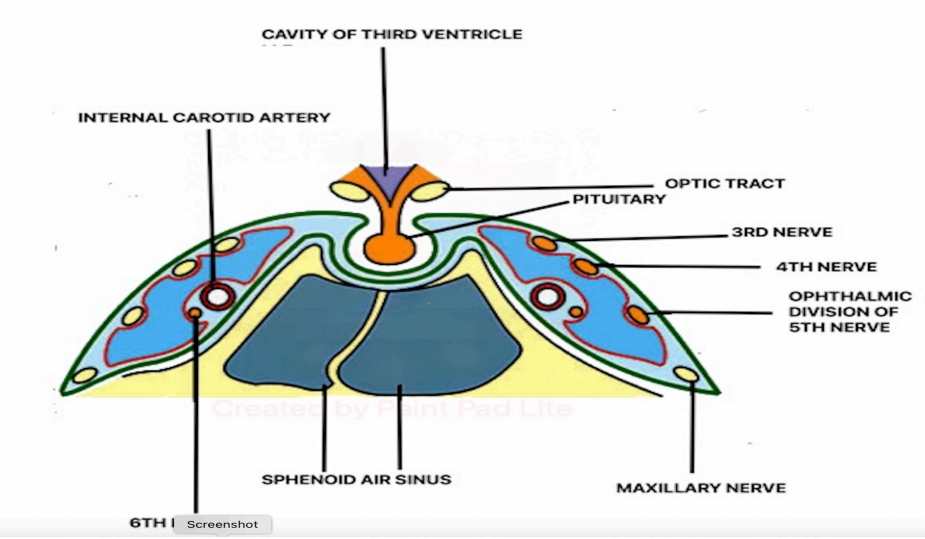


Fig 1a: shows the anatomy of the pituitary gland-coronal section and its relationship with optic pathway

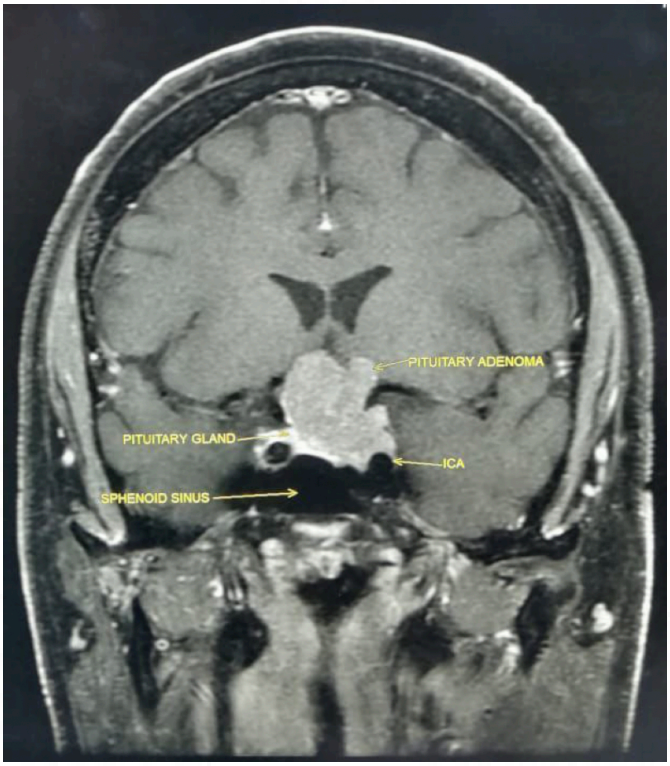


Fig 1b: shows the MRI - coronal T1 post-contrast image of our patient showing a giant pituitary adenoma

Pituitary adenomas causing visual impairment are treated surgically to improve or halt further progression of vision loss as longer duration of the symptoms is associated with worse visual outcomes after surgery.(18) In these patients the improvement in visual field is rapid following surgery with most of the recovery occurring during the first three months of post-operative period.(19) Most of the studies showed acceptable visual outcome post-surgery but they are limited by the heterogenous groups of tumours and the evaluation of visual field and visual acuity at the time of presentation that was lacking. Fahlbusch, and Schott, et. al, showed that young age and short duration of symptoms were good prognostic factors for visual outcome. (20) Zevgaridis, et. al, showed age, symptom duration, preoperative visual function, and arachnoid membrane intactness as prognostic factors. (21) Margalit, et. al, highlighted the importance of optic nerve encasement, size of the tumour and preoperative visual function in prognostication. (22)

However surgical manipulation is the most important factor that determines the postoperative visual function thereby monitoring of visual apparatus is an important priority. In studies that analysed the visual outcomes following tuberculum sellae and diaphragm sellae meningiomas, the postoperative deterioration of vision reflected the possibility of direct vascular insult to the optic apparatus during surgery rather than transient neural oedema. This is because the inferior surface of the optic nerve and optic chiasm receives its blood supply from superior hypophyseal arteries which is a branch of supra-clinoid segment of the internal carotid artery which is at risk during resection. (23)

The Effect Of Lesions At Different Levels In The Optic Tract

A variety of pathologies can cause particular type of visual field defect indicating the site of the neurological damage. (Fig 2). A lesion in the optic nerve can cause complete visual field loss in the ipsilateral eye called as monocular visual loss. Lesion in the middle portion of the optic chiasm most commonly caused by pituitary tumours affects the fibres crossing from the nasal retina of each eye, leaving the uncrossed fibres from the temporal retina intact. This results in loss of vision in the temporal visual field of each eye and is known as bitemporal hemianopia. Homonymous hemianopia is caused by a lesion in the optic radiation on the contralateral side of the anopia. Homonymous hemianopia with macular sparing is caused by a posterior cerebral artery (PCA) stroke. The macula is spared because of its dual blood supply from both the middle cerebral artery (MCA) and the posterior cerebral artery. Any lesion in the temporal lobe causes superior quadrantanopia. A lesion in the parietal lobe causes inferior quadrantanopia. Lesions of macula causes defects in the central vision leading to central scotoma.

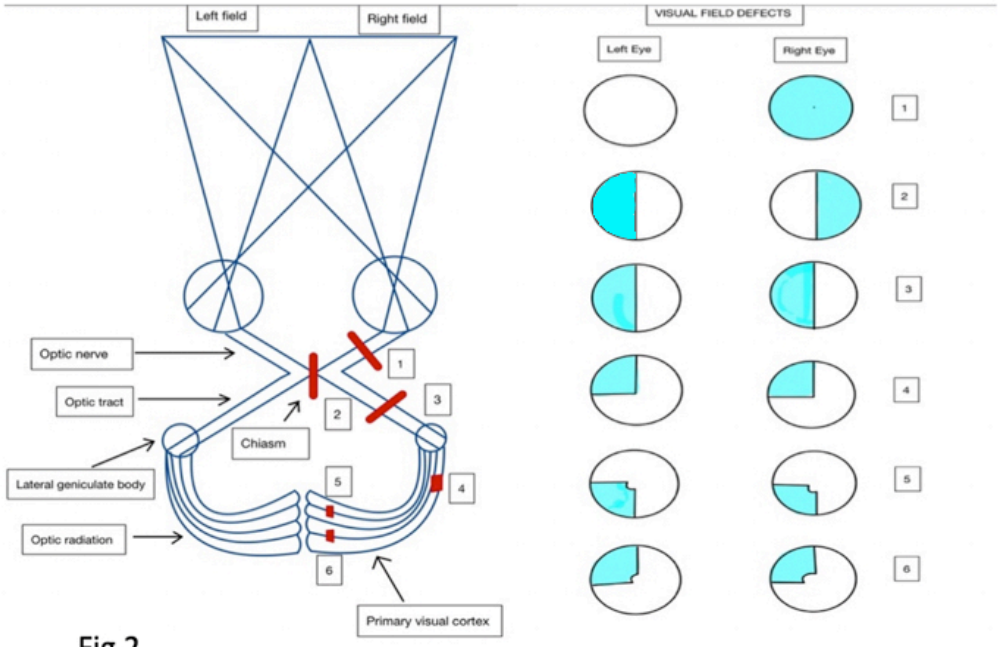


Fig 2

Fig 2: shows the description of Lesions at various levels in the visual pathway and the type of visual field defect

Perioperative Evaluation Of Vision

Patients with pituitary tumors undergo preoperative evaluation of the visual apparatus to identify and quantify the defects. Pre-operative evaluation of vision involves testing visual acuity(VA) using Snellen's chart, Colour vision using Ishihara Colour Charts, Fundus examination using ophthalmoscope, Visual field evaluation by a Humphrey field analyser, Octopus perimeter or a Goldmann perimeter.

Perimetry

Perimetry is the systematic measurement of visual field function using different types and intensities of stimuli. It is of two types: *the static type* which has a stationery target to map the sensitivity of the visual field and *the kinetic type* which has a moving target to map the boundaries of the visual filed. Since, visual field defect is a common mode of presentation in these tumours, evaluation of visual field abnormality becomes important. Furthermore, it is important to detect subtle visual field defects, particularly those that arise in the peripheral visual field, which is typically the area of visual field first compromised by pituitary compression. Thus, kinetic field perimetry is favoured over static perimetry in neuro-ophthalmological evaluation of sellar and supra sellar tumours.(24)

Visual Evoked Potentials (VEP)

-One of the main goals of surgeries involving the visual pathways is the preservation and thereby preventing any inadvertent damage. Efforts to evaluate intraoperative monitoring of visual pathways started in the 1970s. the first report on monitoring of visual pathway was published by Wright et al in 1973.(25) Flashes of light were utilized in their study to stimulate the retina during orbital surgery. Several researchers evaluated the usefulness of visual evoked potentials in different clinical scenario. They tried to obtain a consistent intraoperative VEP recordings, correlation of VEP with visual acuity and visual field, characteristic changes in intraoperative VEP that indicate injury and its association with post-operative visual outcome. Some studies have shown favourable outcome but most studies have dismissed their use stating technical issues in delivery of stimuli and recording, their high sensitivity to anaesthetic agents and their poor correlation with the post-operative outcomes. The incidences of visual

complications in the intraoperative period is related to the optic nerve (ON) or chiasmal manipulation or devascularization and the effect of these harmful manoeuvres may go unnoticed without real time monitoring. The sensitivity of perioperative VEP monitoring was 66% with a specificity of 94%. (35) All these concerns has encourages several researchers to further refine their techniques for intraoperative monitoring of visual pathways.

Methods Of Stimulation

There are two kinds of visual stimuli to generate VEPs. (11)

1) Unpatterned Flashing Lights- consists of brief flashes of light without any perceptible pattern

2) Patterned Stimuli- This can be presented in three ways

a) Flash VEP- It is generated by flashing luminance using a screen or a stroboscopic light. The resultant VEP waveform consists of a series of positive and negative waves. (Fig 3) The flash VEP is a triphasic response. The first wave that can be seen is at 30ms called as N_1.The actual triphasic response is considered from a small positive deflection at 40 to 50ms(P_1), a second negative deflection at 70 to 89ms (N75/N_2) followed by a positive deflection at 100ms(P100/P_2) that are generated by the lateral geniculate, striatum, and areas 17, 18, and 19 of the visual cortex respectively. (27) From there on peaks are consequently labelled in a numerical order as negative and positive (N_3 and P_3) and this nomenclature differentiates flash VEP from the pattern reversal type. Flash stimuli do not require patient fixation and cooperation and can be delivered through closed eyelids This type of stimuli is used in un co-operative patients and in patients who have opacities in the media. This is the method of stimuli that is used in the perioperative period.(28)

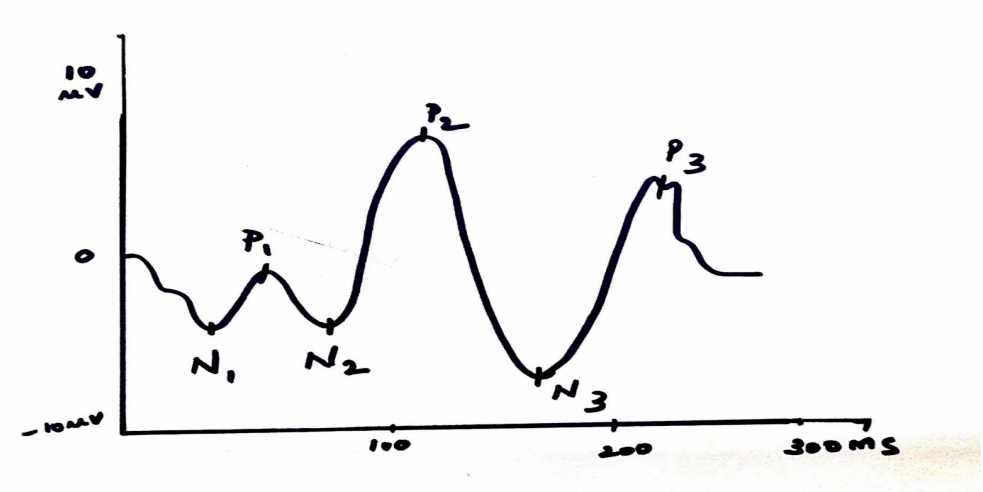


Fig 3: shows the Flash VEP waveform

b) Pattern onset/offset VEP- It has patterns in the form of small and large checks. The resultant VEP waveform has three prominent peaks: a positive C1 wave at about 75ms, a negative C2 wave at about 125ms, and lastly a positive C3 wave at around 150 ms. (Fig 4) Thereafter, the negative and positive peaks are measured consequently as C_4, C_5 and C_6. This type of pattern is best to identify malingering and in patients with nystagmus.

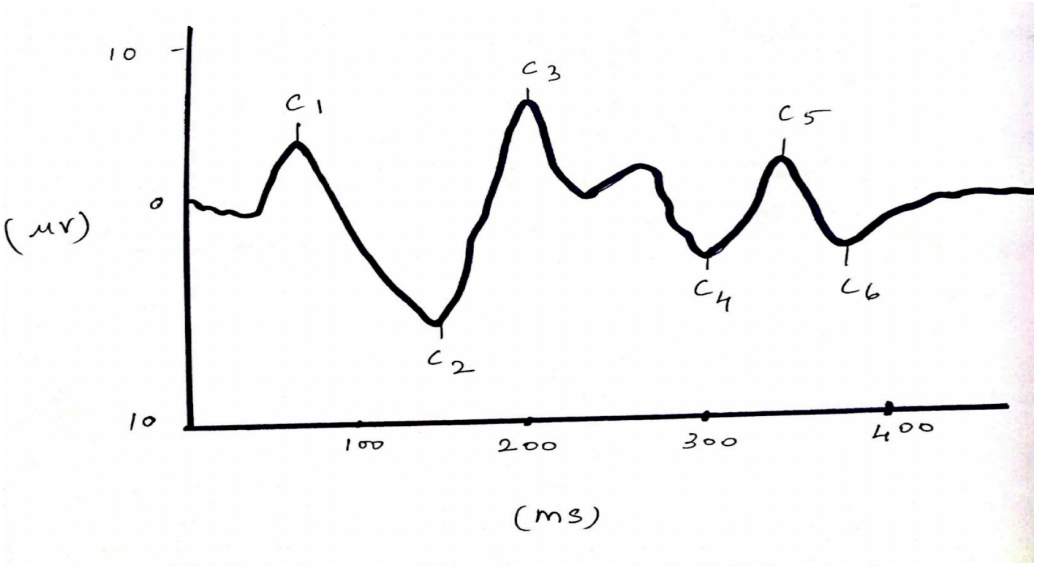
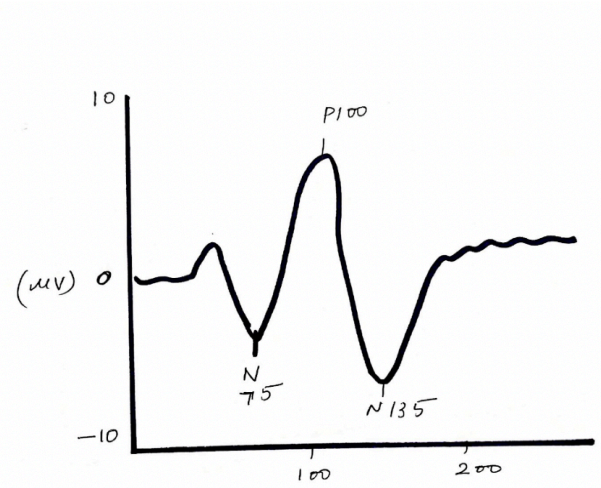


Fig 4: Shows the Pattern onset/offset VEP waveform

c) Pattern reversal VEP- A good stimulus for exciting the visual pathways is a pattern reversal stimulus It is generated by checkerboard pattern with alternation of these checks from black/white to white/black without change in the overall luminance of the screen at a specific reversal rate.(Fig 5b) This kind of pattern reversing checkerboard pattern needs patient cooperation. The resultant waveforms consists of N70, P100, and N155 peaks.(Fig 5a) P100 wave is the most robust peak with minimal interindividual variability and negligible variation with high repeatability.



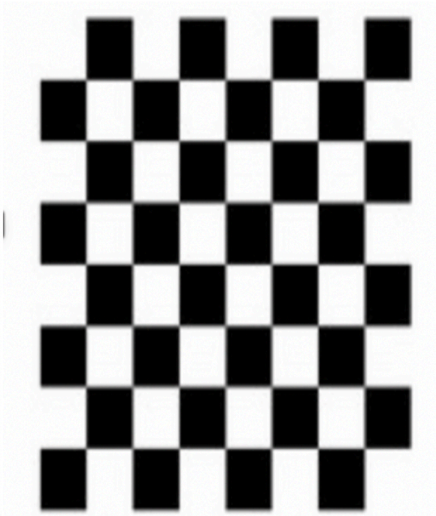


Fig 5a: shows the Pattern reversal VEP waveform

Fig 5b: shows the Checkerboard pattern

Once the stimulus is given, the neural information passes through the optic chiasm, via the optic tracts to the lateral geniculate body in the thalamus, which then projects into the visual cortex. Since the optic pathway cross at the chiasm monocular or binocular flash stimuli will produce activation of bilateral visual pathways behind the chiasm unless a hemifield visual stimulation is done as in awake subjects. To ensure consistent retinal stimulation, a flash electroretinogram(F-ERG) can be used. Feinsod, et. al, used combined electroretinogram (ERG) with averaged VEPs in the pre and post-operative period in two patients with tuberculum sella meningioma. (29) They showed improvement in the AVEP in the post-operative period that was associated with an improved visual outcome.

Stimulation Devices

Effective activation of the visual pathway relies on adequate stimulation. In the 1970s, flash stimuli was provided by fibreoptic haptic lens and scleral contact lens connected to photo stimulators. (30) The invasive nature of the contact lens posed a potential risk of corneal abrasion and ulceration. Furthermore, the American Electroencephalographic Society (AEEGS) Guidelines recommend that hard lens stimulators cannot be kept in the eyes more than 45 min.(31) The above limitations led to the development of LED mounted in eye patched or goggles. Goggles are bulky device which require a headband to fix. This will interfere in transcranial surgeries. (32) Flash stimuli can be given via white stroboscopic light or red LEDs. A stimulus rate of 1-2.5Hz is used for transient response and 8-30Hz for steady state response. A study conducted in 2004 compared the stimulus rate and concluded that there was no significant difference between the two rates. (3)

Recording Parameters

The scalp electrodes used for recording can be a surface electrode or a subdural needle electrode. Ota et al. in his study favoured subdural electrodes because they reflect cortical activity since they have greater spatial resolution and amplitude when compared to potentials acquired from surface EEG electrodes placed on the scalp.(33) The electrode placement follows international 10-20 system. An analysis period of 250-500ms is needed for F-VEPs. A total of 50-200 responses are averaged for a single response. (31) Digital smoothing and filtering can be done to reduce artefact. The filter settings should remain constant throughout the monitoring period. Houlden et al. recommended using 15–20 Hz as a low pass filter setting for F-VEP responses. (34) There is lack of clear guidelines for warning criteria to be used in the perioperative period to

preserve the visual pathway. Kodama, et.al, and Sasaki, et. al, have used a F-VEP amplitude decrease >50 % from baseline control levels as a limit for the cessation of the surgical procedure until recovery of the F-VEP occurred. (35,28)

Correlation Of VEP With Perimetry

Amany, et. al, compared the responses of flash FVEP and pattern VEP in amblyopic eyes with the eyes of healthy children to find out whether the flash VEP can help in the diagnosis of amblyopia. (36) Flash VEP P100 latency showed no significant difference between the two studied groups. Pattern VEP P100 latency in amblyopic group was significantly longer than that of control group. They concluded by stating that pattern VEP were able to diagnose amblyopia, but fVEP changes were not reliable. The use of mfVEP offers the advantage to register localized disturbances of the optic nerve and ganglion cells. Several studies tried to determine the relationship between multifocal visual evoked potentials (mfVEP) and Humphrey visual fields (HVFs). They concluded by stating that a linear relationship exists between the amplitude of the mfVEP response and linear HVF loss in cases of primary open angle glaucoma.(37) In the initial stages of visual dysfunction in pituitary adenomas, electrophysiological tests can be abnormal even before any clinical evidence of the visual impairment is seen in the ophthalmological examination and perimetry or optical coherence tomography.(38)

Factors Affecting Flash VEP:

F-VEPs are very sensitive to the effects of anaesthetics and physiologic factors because they represent polysynaptic cortical activity.

1) Pre-operative visual function- In patients with blindness or severe visual field defects where the optic nerve cannot be stimulated sufficiently by flash stimulation, VEP waveforms have low reproducibility and difficulty in recording.
2) Temperature- Hypothermia affects synaptic transmission of impulses. For every 1°C decrease in temperature, the peripheral conduction is reduced by 5% and central conduction by 15%. (39) In general anaesthesia where hypothermia is prone to occur, polysynaptic pathway like the optic pathway is affected by hypothermia. Hypothermia causes decrease in amplitude and increase in latency of VEP and waveforms completely disappear at 25–27°C.(5) Russ, et. al, the effect of hypothermia on VEP on 43 patients who underwent coronary artery bypass grafting (CABG). (40) The N75 and P100 latencies increased with decreasing temperatures and each of the hypothermic trace were significantly different from the control trace. During rewarming an immediate return of latencies were demonstrated in their study. The amplitude was not analysed because of the interindividual variation.

3) Partial pressure of carbon dioxide- Although there are no studies till date evaluating the effects of partial pressure of carbon dioxide on VEP, acceleration of the conduction velocity is seen in somatosensory evoked potential. (41) Hence any major fluctuations in partial pressure of CO_2 is avoided.
4) Hypoxia- A PaO2 of 20 mmHg resulted in a transient increase followed by a decrease in feline VEP amplitude.
5) Hypotension- A decrease in mean arterial pressure (MAP) to levels below the autoregulatory threshold decreased the amplitude without changing latency of the

sensory evoked potentials. These changes can become irreversible in case of permanent tissue injury.

6) Haemodilution- A haematocrit below 15% increases the latency and reduces the amplitude of the VEP. The changes in VEPs recovered by returning the haematocrit to 22% .(42)

7) <u>Effects Of Anaesthesia On fVEP</u>

Volatile anaesthetics prolong VEP latency and decrease F-VEP amplitudes in a dose-dependent fashion. However the evidence is conflicting with the use of low dose sevoflurane with few studies reporting decrease in amplitude while the others reporting no such change.(33) Nitrous oxide (N_2O) alone considerably reduces VEP amplitude. Its use in addition to volatile anaesthetics can make VEP responses unrecordable. Administration of bolus doses of opioids have been shown to significantly reduce the amplitude.(43) Chi, et. al, studied the effects of incremental doses of fentanyl for patients undergoing coronary artery bypass graft procedures and found that fentanyl administration did not affect the latency but decreased the amplitude. They suggested that the decreases may be due to changes to retinal luminance related to pupillary-induced constriction associated with fentanyl bolus administration. (44) Therefore bolus administration of fentanyl should be taken into account while monitoring VEP. Wiedemayer, et.al, studied the effects of total intravenous anaesthesia (TIVA) on VEP and its reproducibility in the perioperative period. (3) The study included procedures involving the spine with 32 participants. All the patients had no visual symptoms. VEPs were recorded in the awake and anaesthetized state. A total of 1436 intraoperative traces were analysed. In the awake patients, VEPs showed high interindividual variability of the P100 latency and the P100-N145 amplitude. They found that compared to the awake state the mean latency of the P100 peak was slightly longer in the anesthetized state. The

amplitude of the P100-N145 peak was also showing significant decrease. A total of 1436 intraoperative traces were analysed. In 55% of the traces, the investigators were unable to identify the main VEP peaks P100-N145 and to confirm a reproducible VEP. With TIVA, the P100 latency was prolonged by approximately 8% and a loss of the P100-N145 amplitude of approximately 60% occurred compared to the recordings in the awake patients. They concluded by saying that both anaesthetic and technical factors were responsible for the poor reproducibility of the VEPs warranting further research. While neuromuscular blocking drugs do not affect F-VEP responses. Their use may contribute to an improved signal- to-noise ratio by eliminating electromyographic artefact. The use of opioid and ketamine or propofol-based anaesthetic techniques (TIVA), along with low-dose volatile anaesthetics without nitrous oxide, seems to facilitate intraoperative recording of VEPs.

Effects of surgery on Intraoperative fVEP

Cedzich, et. al, in their study explaining the limiting factors for intraoperative fVEP monitoring found a high variability of the recordings. They excluded the use of ultrasonic aspirator or bipolar coagulation as the cause as monitoring was stopped momentarily during their usage. The higher incidence of flat tracings in their study were attributed to trepanation. In patients with optic chiasmal compression the variability was greater and the incidence of potential losses were also higher during the stage of tumour dissection. (65) Feinsod, et. al, in their study in of VEP in 2 patients with tuberculum sella meningioma showed the reduction of VEP recordings during optic nerve dissection. (29) Kodama, et. al, in their study stating the limitations of VEP monitoring in the intraoperative period showed that in one of their patients VEP loss was attributed to ischaemia

injury to the optic pathway caused by transient occlusion of the superior hypophyseal artery which supplies these parts of the visual apparatus. (35)

4. HYPOTHESIS

Hypothesis

We hypothesize that Flash visual evoked potential monitoring is useful in the intraoperative monitoring of visual function during trans nasal transsphenoidal resection of sellar suprasellar lesions and thereby improves the postoperative visual outcome.

5. AIMS AND OBJECTIVES

Aims And Objectives

Aim

Our primary aim of the study will be to evaluate the hypothesis that the changes in the intraoperative flash VEPs correlate with the post-operative visual outcome as measured by static automated perimetry.

Objectives

Our secondary objectives of the study are,

1. To find the correlation between the preoperative static automated perimetry with the baseline flash VEPs.
2. To detect the degree and pattern of changes in intraoperative VEP monitoring due to anaesthesia and surgical resection during trans nasal transsphenoidal resection of sellar suprasellar lesions.
3. To find the correlation between the postoperative static automated perimetry with the intraoperative flash VEPs changes.
4. To find the correlation between the preoperative static automated perimetry with the postoperative visual function in patients undergoing trans nasal transsphenoidal resection of sellar suprasellar lesions.

6. MATERIALS AND METHODS

Materials And Methods

This is a prospective observational study that was designed to test the hypothesis that Flash visual evoked potential monitoring is useful in the intraoperative monitoring of visual function during trans nasal transsphenoidal resection of sellar suprasellar lesions and thereby improves postoperative visual outcome.

Setting: In the neurosurgical operation theatre (NSOT) at Sree Chitra Tirunal Institute of Medical Sciences and Technology (SCTIMST), Trivandrum, which is a specialized tertiary referral centre.

Institutional Ethics Committee Approval: This study was approved by our Technical Advisory Committee (SCT-/S/2019/931) (Annexure No 1) and Institutional Ethics Committee (SCT/IEC/1400/JULY-2019)). (Annexure No 2) We obtained permission from the clinical trials registry of India(CTRI) with reference number CTRI/2020/08/027095.

Study Period: The data for the study was collected from August 12 ,2019 to February 28, 2021.

Study Design: Prospective observational case study. Total number of patients recruited in the study were twenty-five.

Patient enrolment: The patients for the study were randomly selected from the elective neurosurgical operation theatre list who were scheduled to undergo trans nasal transsphenoidal excision of seller and suprasellar lesions and were recruited after fulfilling the following inclusion

and the exclusion criteria. Patients were enrolled into the study after obtaining informed written consent.

Inclusion criteria

- Patients posted for elective endoscopic trans nasal trans sphenoidal excision of sellar and supra sellar lesions based on preoperative MRI/CT.
- Age 18-60 years.
- ASA grade I and II.
- GCS 15.

Exclusion criteria

- Patient refusal for study.
- Age less than 18 years and more than 60 years.
- ASA grade III and IV.
- Emergency surgeries.
- GCS<14.
- Proptosis.
- H/o eye injury.
- H/o anaphylaxis.
- Pregnant and lactating mothers.
- Presence of significant comorbidities like coronary artery disease, chronic obstructive pulmonary disease, systemic hypertension, chronic renal disease, etc.

Study protocol

Preoperative clinical visual field testing by finger confrontation method and static automated perimetry was performed for all recruited patients as per our hospital protocol. Fig 6 shows the pre-operative perimetry of one of our patients showing bitemporal defect and Fig 7a and 7b shows the same patient's post-operative perimetry. The data on preoperative visual function based on the clinical presentation, clinical examination, static perimetry and fundus examination, radiological data of the tumour regarding location, size and extent based on preoperative Magnetic resonance imaging and CT scan of the brain were collected in the proforma.

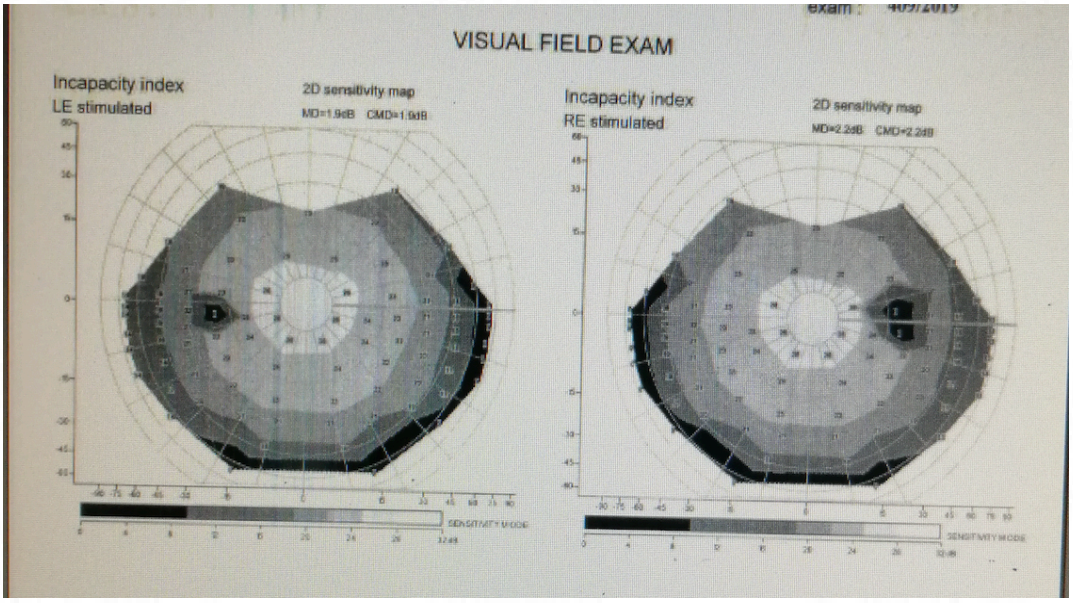


Fig 6: shows the Pre-operative perimetry of one of our patient showing bitemporal field defects.

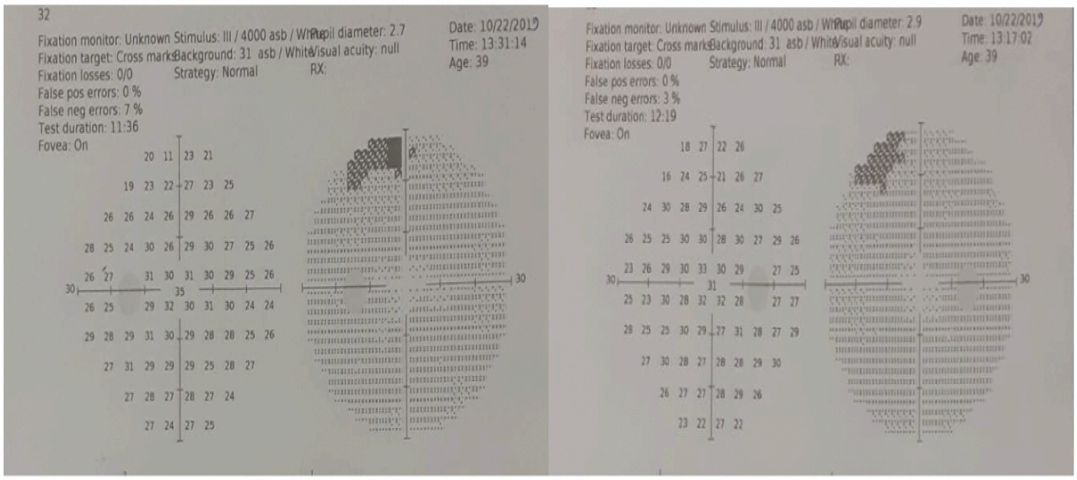


Fig 7a: Shows the Post-operative perimetry- left. Fig 7b: post-operative perimetry right

The recruited patients were kept nil per oral for 8 hours for solids and 2 hours for clear fluids on the day of surgery. Premedication consisted of Tab Pantoprazole and Inj Glycopyrrolate 0.2 mg IM 45 minutes prior to shifting to Operation theatre (OT). No sedative premedication were administered. After shifting to operation theatre, World Health Organization (WHO) Safety check list assessment was done. Monitoring lines were attached to the patient which included 5 lead electrocardiogram(ECG), non-invasive blood pressure cuff, pulse oximetry probe (Philips IntelliVue MX700) and bispectral index(BIS)(BIS ASPECT). Baseline heart rate (HR), non-invasive blood pressure (NIBP), oxygen saturation (SpO2) were recorded. Intravenous access was obtained using a wide bore 18G cannula inserted in a peripheral vein under local anaesthesia.

Technique for fVEP recording

VEP monitoring was initiated in awake state for recording of baseline values. We used standard subdural needle electrodes(Natus- disposable subdermal needle electrodes, Indonesia) on the scalp for recording. We followed the 10-20 international system for electrode placement and the electrodes were placed in the following order. A midline occipital electrode which is 5cm above inion (OZ), 5cm from OZ on the right and left occipital areas is O1 and O2 respectively and FZ is placed in midline frontal region as a reference electrode and ground electrode were placed. (Fig 8) Three montages i.e., OZ-FZ, O1-FZ and O2-FZ were used for recording. VEP stimulation is done using soft goggles with a head band (Natus Xltek Protektor 32 IOM machine).(Fig 9a) The google is secured over to the closed eyelid with tapes. This will ensure snug fit of the goggles.(Fig 9b) After checking the impedance, binocular flash stimulation was given by red LED lights at a rate of 2Hz. Averaging was done with 500 samples. Digital smoothing and filter settings were employed to reduce artefact and it remained constant throughout the monitoring period. Electrode impedance was kept below 5 kOhms.

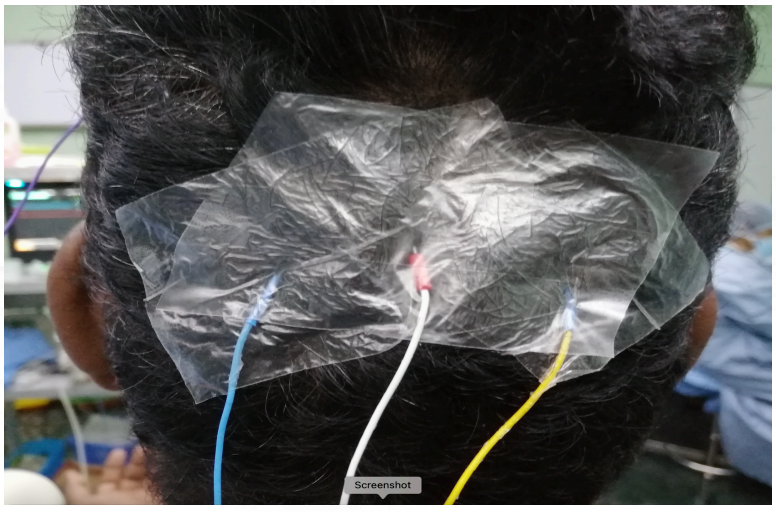


Fig 8: shows the placement of O1,O2 and OZ electrodes in our patient.

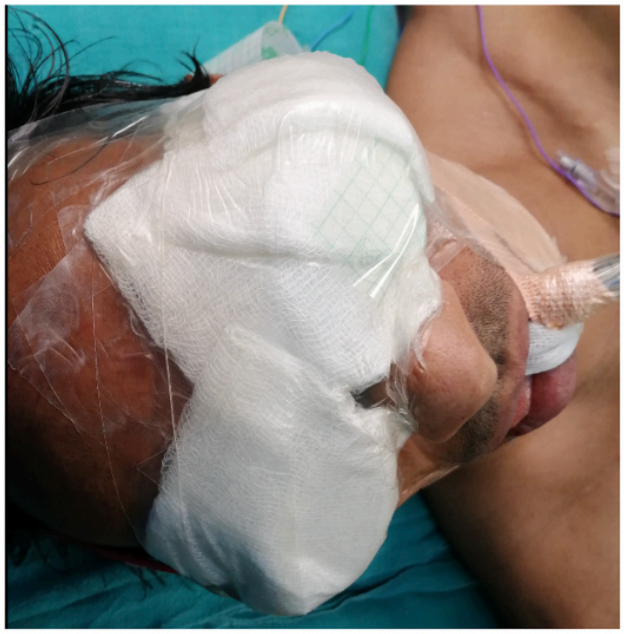


Fig 9a: shows the goggles placement. Fig 9b: shows the goggles firmly secured

Baseline recording of the VEP waves in all the three montages were obtained and the N75 and P100 peaks were identified based on the latency.(Fig 10) Latency was noted from the end of stimulus to the peak of the wave and the amplitude was defined as the difference in amplitude between the apex of the largest positive and negative peaks at 75 and 100milliseconds. The appropriate cursors were used to measure the amplitude and latency. Rightward shift of the peak was defined as an increase in latency and an increase above 20% was considered significant. (45 and 46).

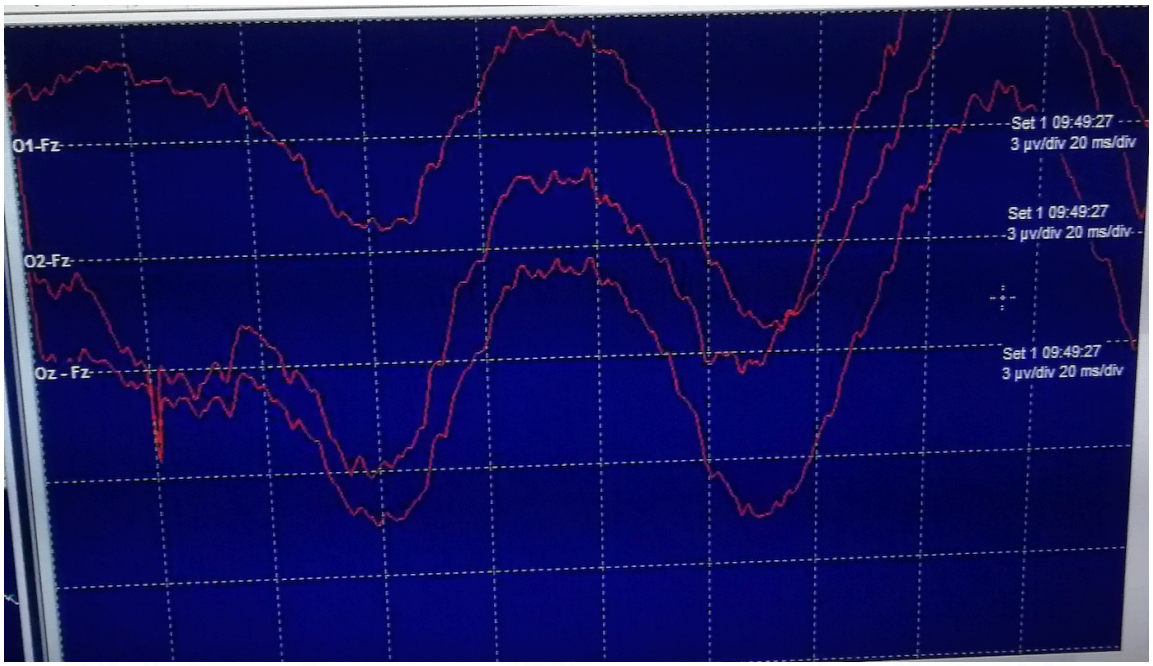


Fig 10: shows the Baseline VEP recording in our patient.

After baseline recording of the parameters, the goggles were removed. After preoxygenation for 3-5 minutes anaesthesia was induced with fentanyl (2µg/kg) and propofol (titrated to loss of consciousness). After adequacy of mask ventilation was ensured, vecuronium (0.1 mg/kg) was given. After 3 minutes, patients were intubated orally with appropriate size flexometallic endotracheal tube via direct laryngoscopy/ video laryngoscopy/ fibreoptic bronchoscopy based on patient's physiological or pathological considerations. After intubation and confirming the tube position, all the patients were ventilated in volume control mode with tidal volume of 8 ml/kg with air: Oxygen mixture (50:50). The respiratory rate was adjusted to maintain an end tidal carbon-di-oxide levels($etco_{2)}$ of 32-35 mmHg. Invasive arterial line in the radial artery using a 20G cannula and central venous line via Peripherally inserted central catheter (PICC)were inserted. Anaesthesia was maintained during the procedure with TIVA consisting of Inj propofol and Inj fentanyl based infusion(propofol at an effect site concentration of 2 to 2.5 µg and fentanyl at 1 µg/kg infusion).

BIS value was maintained between 50-60, $ETCO_2$ of 32-35mm Hg, airway pressure was maintained below 15-22 cm H_2O. Heart rate(HR) and Systolic blood pressure (SBP) were maintained within 20% of baseline throughout the procedure with vasopressors.

Following ten minutes of stable anaesthesia and haemodynamics, the VEP goggles were reapplied and VEP recording was done which was represented as 'anaesthesia'. (Fig 11)

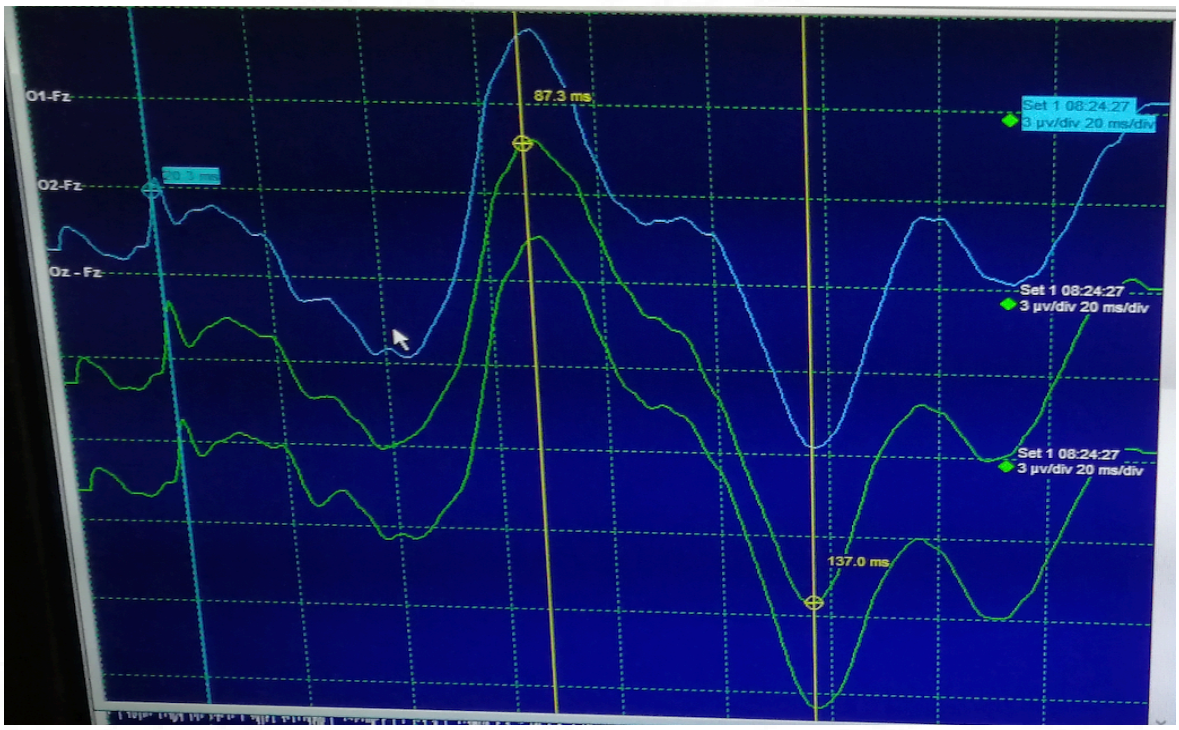


Fig 11: shows the Post-induction VEP recording

The next recording was obtained just before the Dural opening, every 5mins till the tumour resection is done and the final recording before reversal and extubating the patient. (Fig 12 ,13)

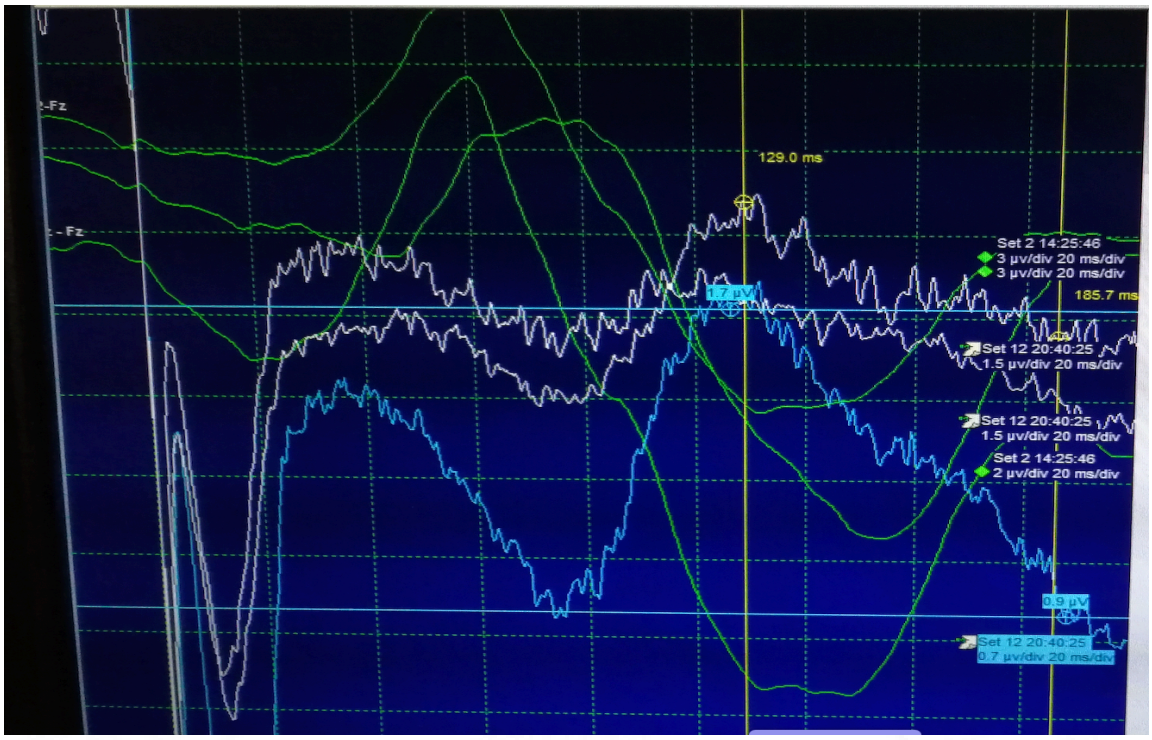


Fig 12: shows the VEP recordings during resection – the green coloured waveforms indicate baseline and the white and blue waveforms indicate VEP during resection.

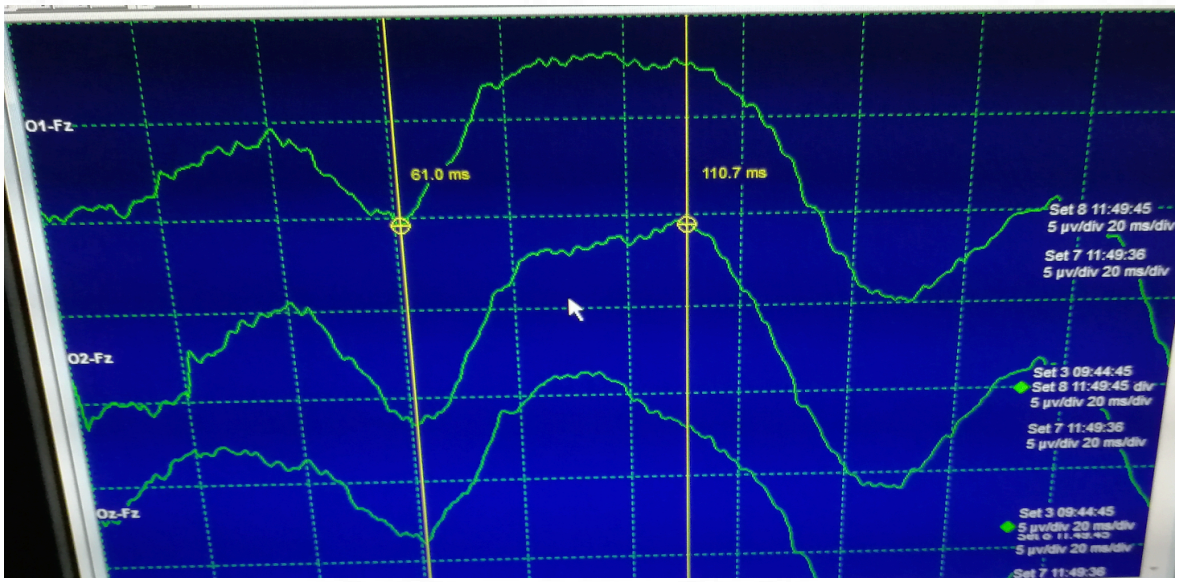


Fig 13: shows the VEP recordings before extubation

All the recordings were stored automatically in the IONM system. Patients were extubated and monitored in the neurosurgical intensive care unit. For postoperative visual function, Static automated perimetry and clinical field testing were performed after one month.

Data collected include patient demographics, clinical presentation, tumour characteristics, visual function based on visual field testing by confrontation method and static perimetry. Intraoperative VEP recordings of N75 and P100 (latency and amplitude). All these data were entered manually into the study proforma.

Statistical Analysis

A) Sample size calculation

The sample size was arrived with nMaster software Version 2.0 by applying the formula,

$n = (Z_{1-ß} + Z_{1-æ/2})^2 / (r^2 / 1-r^2)$

where,

r is correlation coefficient, $Z_{1-œ/2}$ is the desired confidence level, 1-ß is the power of the study.

With a Correlation coefficient of -0.601, a Power of 95% and an Alpha error of 5%, the calculated sample size was found to be twenty-five (n=25) subjects. Hence, we recruited 25 patients. This was based on a study conducted by Nidan et al., in which they assessed the visual pathways in patients presenting with pituitary adenomas using multifocal visual evoked potential, static automated perimetry and optical coherence tomography findings. (61)

B) Statistical Analysis of Data

The collected data were analysed with IBM SPSS Statistics for Windows, Version 23.0.(Armonk, NY: IBM Corp).To describe about the data descriptive statistics frequency analysis, percentage analysis were used for categorical variables and the mean ± S.D(standard deviation) were used for continuous variables. For the multivariate analysis for repeated measures the Repeated measures of analysis of variance (ANOVA) was used with Bonferroni correction to control the type I error on multiple comparison. In both the above statistical tools the probability value $p<0.05$ was considered significant.

7. RESULTS & OBSERVATIONS

Results And Observations

Based on the calculated sample size, 25 patients fulfilling the study criteria scheduled to undergo elective trans nasal trans sphenoidal resection of sellar and suprasellar tumours at our institute were recruited. Preoperative data collection and intraoperative VEP recordings were successfully done in all the recruited patients. However in 8 patients the post-operative perimetry details could not be obtained due to the ongoing pandemic situation. In Seventeen patients the postoperative data were obtained.

The following are the results of the study.

1) Demographic Details

Table 1: shows the demographic details of the 25 patients like age, weight, Body mass index (BMI), gender and ASA physical status.

Sl.No	Variable	Mean ± SD	Range	Minimum	Maximum
1	Age (years) Mean±SD	38±13.16	42.0	18.0	60.0
2	Weight (Kg) Mean±SD	60±9.56	36	44.0	80.0
3	BMI (kg/m^2) Mean±SD	23.8 ±2.6	8.5	18.8	27.3
4	Gender (Male: Female) Number (%)	11 : 14 (44:56)	-	-	-
5	ASA Physical status (I:II) Number (%)	16:9 (64:36)	-	-	-

The mean age was 38 years among our patients with a minimum age being 18years and maximum age of 60 years. Among our patients,14 (56%) were female while 11 (44%) male indicating most of them were female. The mean BMI was 23.8 kg/m^2 with a minimum of 18.8 kg/m^2 and maximum of 27.3kg/m^2. Majority (64%) of our patients belonged to ASA grade I and the rest (36%) to ASA grade II.

2)Tumour Characteristics

A) Preoperative Diagnosis (Based on MRI report)

Table 2.1: shows the Tumour Characteristics of the Patients

Pre-Operative Diagnosis	**Number(%)**
Pituitary macroadenoma	20 (80)
Pituitary microadenoma	3(12)
craniopharyngioma	1(4)
Sellar and suprasellar meningioma	1(4)

Most common tumour was pituitary macroadenoma with 20 (80%) patients and then pituitary microadenoma with 3 (12%), craniopharyngioma and sellar and suprasellar meningioma with 1 patient (4%) each. Among the 20 patients with pituitary macroadenoma, 2 patients had prolactinoma. Among the 3 patients with pituitary microadenoma, one had acromegaly, one had thyroid stimulating hormone secreting tumour and one had Cushing's disease.

B) sellar/suprasellar extension

Table 2.2: shows the extent of tumor location based on the MRI report.

Tumour Extension	Number(%)
Sellar tumor	12(48)
Sellar with suprasellar extension	13(52)

Almost 13 (52%) of our patients had tumour extending into the suprasellar region and 12 (48%) of our patients had tumour confined to the sella only.

C) Size of the tumour

Table 2.3 shows the size of the tumour based on the MRI report.

Tumour Size	Number(%)
<1 cm	3(12)
1-4 cm	20(80)
>4 cm	2(8)

Majority of our patients i.e. 20(80%) had pituitary macroadenoma (size >1 cm) while 3(12%) had microadenoma and two of them had giant pituitary tumours.

3) Clinical Data

A) Pre-Operative Complaints

Table 3.1 shows the details of the presenting complaints of the patients.

Presenting complaints	Number (%)
Headache	3 (12)
Headache and unilateral visual disturbance	3 (12)
Headache and bilateral visual disturbance	13 (52)
Headache, visual disturbance and endocrine symptoms	6 (24)

The most common complaint was headache ache with bilateral visual disturbance which was seen in 13 (52%) of our patients. While 3 (12%) of the patients had headache as the only symptom and 12 (3%) had headache with unilateral visual disturbance. Remaining 6 (24%) of our patients had endocrine symptoms like oligomenorrhoea, decrease in libido, lactorrhea, change in facial contour and increase in thickness of hands and fingers.

B) Pre-Operative Visual Acuity (VA)

Table 3.2: shows the Pre-operative visual acuity

VISUAL ACUITY	Number (%)
6/6	18 (72)
6/9	2 (8)
6/18	0
6/24	0
6/36	2 (8)
5/60	1 (4)
Finger counting at 1 feet	2 (8)

We grouped the pre and operative visual acuity according to the WHO International Classification of diseases grading system as mild-6/12 to 6/18, moderate- 6/18 to 6/60, severe-6/60 to 3/60 and blindness as VA worse than 3/60. Majority of our patients (n=20) belonged to the normal VA category, two patients had moderate impairment and three had blindness. The visual acuity was normal (6/6) in 18 (72%) of our patients, two of our patients had 6/9, two had 6/36, two of them were able to count fingers at 1foot and one of our patient had an acuity of 5/60.

C) Pre-Operative Visual Field Defects

Table 3.3 show the results of the pre-operative perimetry of the patient group

Pre-op perimetry	Number (%)
Normal	7 (28)
Bitemporal hemianopia	5 (20)
Bilateral superior quadrantanopia	3 (12)
Left temporal hemianopia and right early junctional scotoma	1 (4)
Right temporal hemianopia and left visual loss	1(4)
Unilateral hemianopia	5(20)
Unilateral superior quadrantanopia	1(4)
Peripheral field of vision constriction	2(8)

Of the total 25 patients, 18 patients had specific visual field defects (72%). Perimetric findings of Bitemporal hemianopia were diagnosed in 5(20%) patients and unilateral hemianopia in 5 (20%) patients. 3(12%) of our patients had bilateral superior quadrantanopia and one had unilateral superior quadrantanopia. Remaining 7 (28%) of our patients had normal preoperative perimetry. The most common presentations in patients with normal perimetry were headache and endocrine abnormalities.

D) Fundus

Fundus examination was found to be normal in 23 (92%) of patients and papilloedema was noted in two patients (8%)

4. **Perioperative Changes**

Hemodynamic Parameters

A) Changes In Heart Rate (HR)

Table 4.1: shows the changes in the mean heart rate in the intraoperative period (bpm= beats per minute)

Time points	Mean± SD (bpm)	% change from baseline	P-value
Baseline	78.6 ± 9.1		
Post-induction	69.2 ± 9.8	-11.9%	0.0005
During resection	67.0± 8.4	-14.7%	0.0005
Before extubation	77.3 ± 7.8	-1.6%	1.000

The mean baseline HR was 78.6±9.1per minute which decreased to 69.24±9.8per minute after induction of anaesthesia ,decreased further to 67.080±8.4per minute during tumour resection and a slight decrease compared with the baseline at the end of the surgery. (Fig 14)The changes in heart rate were statistically significant from baseline to post induction and during resection but the overall changes were less than 15 %. The change was not significant from baseline to the end of surgery.

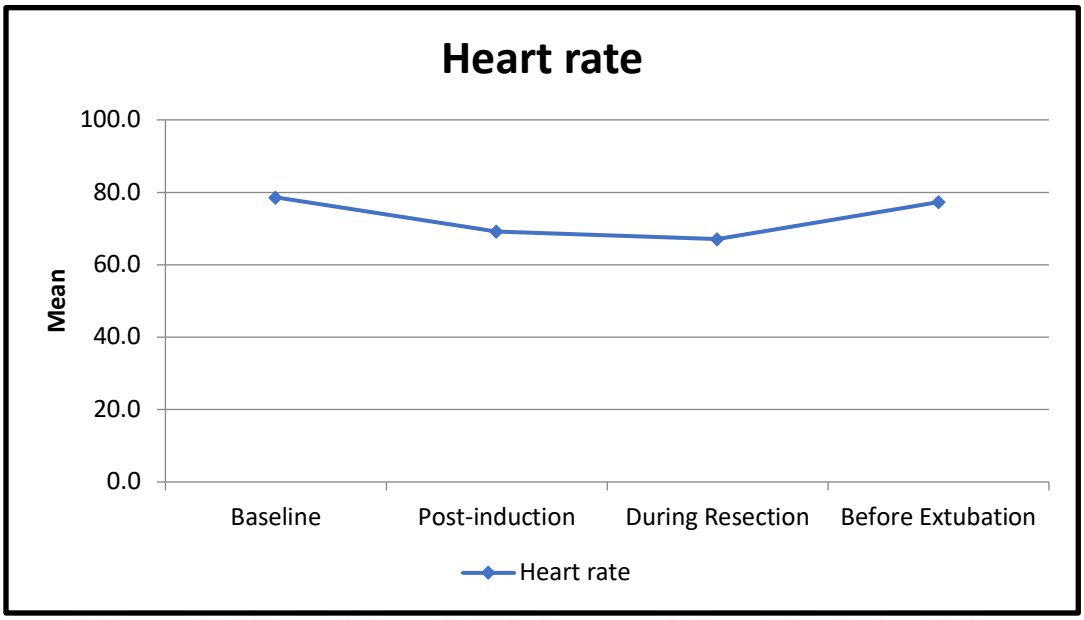


Fig 14: shows the Mean HR changes at different time points

B) Changes In Mean Arterial Pressure (MAP)

Table 4.2: shows the changes in the mean arterial pressure in the intraoperative period

Time points	Mean±SD (In mm of hg)	% Change from baseline	P-value
Baseline	94.08 ± 7.6		
Post-induction	89.00 ± 6.0	-5.4	0.0005
During resection	87.12 ± 5.71	-7.4	0.0005
Before extubation	93.32 ± 6.44	-0.8	1.000

The mean baseline MAP was 94.080±7.6mm of hg which decreased to 89.000±6.0mm of hg after induction of anaesthesia. It decreased further to 87.120±5.71mm of hg during tumour resection

and a slight decrease with a mean of 93.320±6.44mm of hg compared with the baseline at the end of the surgery. (Fig 15) The changes in MAP were statistically significant from baseline to post induction and during resection but the overall changes were less than 10 %. The change was not significant from baseline to the end of surgery.

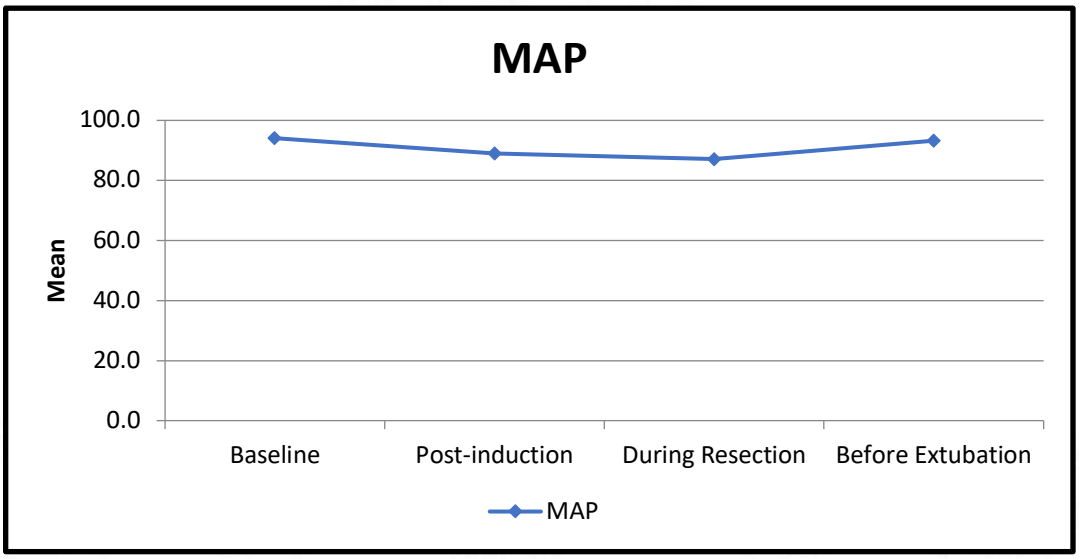


Fig 15: shows the Mean MAP changes at different time points

Peri-Operative Visual Evoked Potential (VEP):

The intraoperative VEP could be obtained successfully in all the patients. We measured the latency of the N75 and P100 waveforms and amplitude of N75-P100 before induction of anaesthesia (baseline), post induction, during tumour resection and before extubation.

C) Analysis Of N75 Latency

Table 4.3: shows the changes in mean N75 latency in the patient group

Montage		Baseline	Post-induction	During resection	Before extubation
O1-FZ	MEAN±SD (in ms)	88.5±14.2	99.6±18.6	109.8±16.8	98.9±16.7
	% Change from baseline		+12%	+24.1%	+11.7%
	P-value		0.0005	0.0005	0.011
O2-FZ	MEAN±SD (in ms)	87.3±13.9	98.1±17.7	136±15.2	98.9±17.3
	% Change from baseline		+12.4%	+55.9%	+13.4%
	P-value		0.0005	0.0005	0.003
OZ-FZ	MEAN±SD (in ms)	87.3±13.9	98.1±17.7	136±15.2	98.9±17.3
	% Change from baseline		+12.4%	+55.9%	+13.4%
	P-value		0.0005	0.0005	0.003

Repeated measures of ANOVA was used for the analysis.

We compared the latency of the left side VEP montage (O1-FZ) of the N75 waveform. The baseline N75 was 88.5±14.2ms, post induction it increased to 99.6±18.6ms, during resection times it went up to a maximum of 109.8±16.8 and at the end of surgery it became 98.9±16.7.There was a 12.6% increase in latency from baseline to post induction which was significant and the maximum increase was during the resection times which was 24.1%. There was a 11.7% increase in latency from baseline towards the end of the surgery.

We compared the latency of the OZ-FZ VEP montage of the N75 waveform. The baseline N75 was 87.3±13.9ms, post induction it increased to 98.1±17.7ms, during resection times it went up to a maximum of 136.0±15.2ms and at the end of surgery it became 98.9±17.3ms.There was a 12.4% increase in latency from baseline to post induction which was significant and the maximum increase was during the resection times which was 55.9% and a13.4% increase in latency from baseline towards the end of the surgery.

We compared the latency of the right sided VEP montage of the N75 waveform. The baseline N75 was 87.1±12.9ms, post induction it increased to 98.3±17.2ms, during resection times it went up to a maximum of 108.7±15.8ms and at the end of surgery it became 98.8±17.3ms.(Fig 16) There was 12.9% increase in latency from baseline to post induction which was significant and the maximum increase was during the resection times which was 24.9% and an increase of 13.5% in latency from baseline towards the end of the surgery

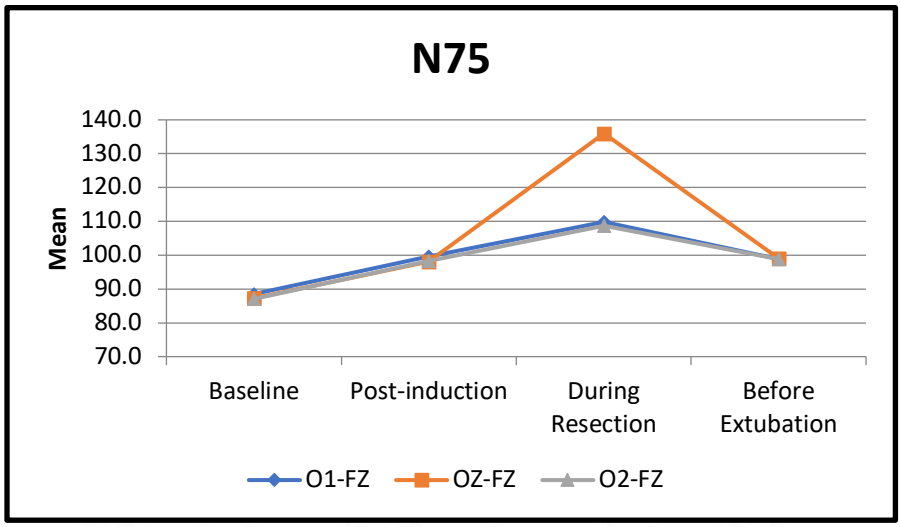


Fig 16: shows the N75 latency changes at different time points

D) Analysis Of The P100 Latency

Table 4.4: shows the changes in mean P100 latency

Montage		Baseline	Post-induction	During resection	Before extubation
O1-FZ	MEAN±SD (in ms)	118.9±19.7	131.4±15.6	140.5±17.3	126.5±18.8
	%Change from baseline		+10.5%	+18.2%	+6.4%
	P-value		0.0005	0.0005	0.288
OZ-FZ	MEAN±SD (in ms)	117.3±17.9	130.6±14.3	139.7±17.2	125.2±18.5
	%Change from baseline		+11.4%	+19.1%	+6.7%
	P-VALUE		0.0005	0.0005	0.190
O2-FZ	MEAN±SD (in ms)	117.9±18.3	130.4±15.4	138.2±19.0	125.7±19.2
	%Change from baseline		+10.6%	+17.2%	+6.6%
	P-value		0.0005	0.0005	0.190

Repeated measures of ANOVA was used for the analysis

The latency of the P100 waveform on the left side was analysed. We found that the baseline was 118.9±19.7ms, post induction there was 10.5% increase with a mean of 131.4±15.6ms, during resection there was 18.2% increase with a mean of 140.5±17.3ms and during the end of the surgery there was minimal change of 6.4% from baseline with the mean of 126.5±18.8ms.

The latency of the P100 waveform of the OZ-FZ was analysed. We found that the baseline was 117.3±17.9ms, post induction there was 11.4% increase with a mean of 130.6±14.3ms, during resection there was 19.1% increase with a mean of 139.7±17.2ms and during the end of the surgery there was minimal change of 6.7% from baseline with the mean of 125.2±18.5ms.

The latency of the P100 waveform of the right side was analysed. We found that the baseline was 117.3±17.9ms, post induction there was 11.4% increase with a mean of 130.6±14.3ms, during resection there was a 19.1% increase with a mean of 139.7±17.2ms and during the end of the surgery there was minimal change of 6.7% from baseline with the mean of 125.2±18.5ms. (Fig 17)

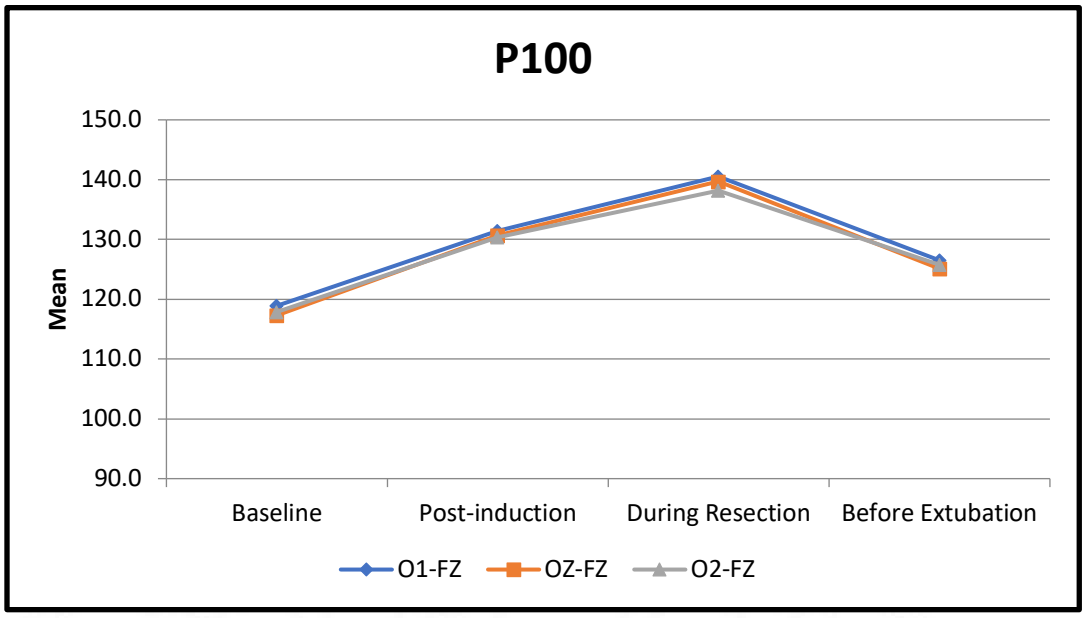


Fig 17: shows the P100 latency changes at different time points

E) Analysis Of N75-P100 Amplitude

Table 4.5: shows the changes in N75-P100 mean amplitude.

MONTAGE		BASELINE	POST-INDUCTION	DURING RESECTION	BEFORE EXTUBATION
O1-FZ	MEAN±SD (in µv)	8.944±3.4	4.756±1.41	3.540±1.69	5.324±1.42
	% Change from baseline		-46.8%	-60.4%	-40.5%
	P-value		0.0005	0.0005	0.0005
OZ-FZ	MEAN±SD (in µv)	8.956±3.6	4.820±1.3	3.448±1.6	5.444±1.6
	%Change from baseline		-46.2%	-61.5%	-39.2%
	P-value		0.0005	0.0005	0.0005
O2-FZ	MEAN±SD (in µv)	8.888±3.6	4.736±1.34	3.444±1.76	5.324±1.42
	%Change from baseline		-46.7%	-61.3%	-39.0%
	P-value		0.0005	0.0005	0.0005

Repeated measures of ANOVA was used for the analysis

Analysis of the amplitude of the N75-P100 on the right side showed a baseline of 8.888±3.6m µv which decreased significantly to 4.736±1.34 µv (46.7%). The decrease was very significant during the resection times with a mean of 3.444±1.76 µv(61.3%) and at the end of the surgery it decreased to 5.420±1.59 µv(39%).

The baseline amplitude on the left was 8.944±3.4µv. post induction there was 46.8% decrease with a mean of 4.756±1.41 µv. The decrease was maximum during the resection times with 60.4% and a mean of 3.540±1.69 µv. at the end of the surgery the decrease was 40.5% from baseline with a mean of 5.324±1.42µv.

The baseline amplitude of the OZ-FZ montage was analysed. It showed a baseline mean of 8.956±3.6µv. Post induction there was a 46.2% decrease with a mean of 4.820±1.3µv. The decrease was maximum during the resection times with 61.5% and a mean of 3.448±1.6µv. At the end of the surgery the decrease was 39.2% from baseline with a mean of 5.444±1.6µv.(Fig 18)

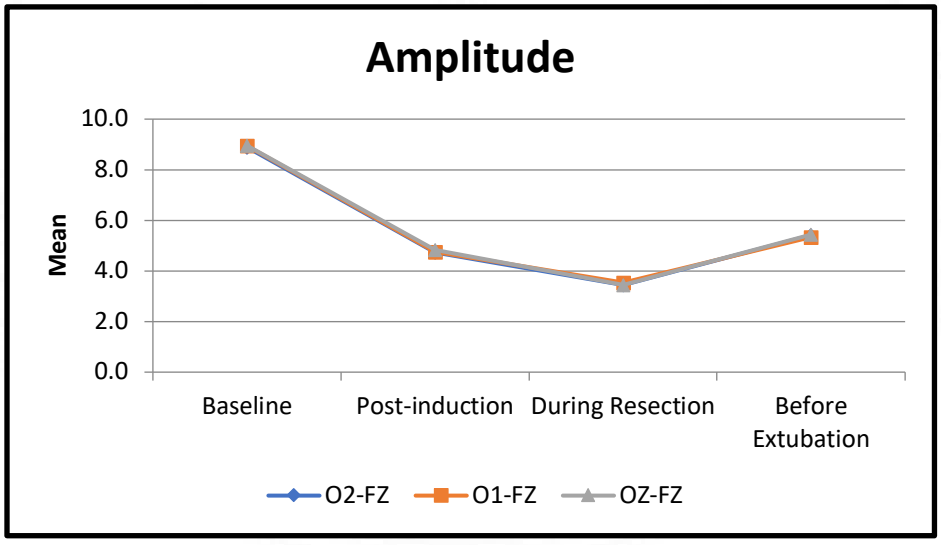


Fig 18: shows the N75-P100 amplitude changes at different time points

Pre-Operative Perimetry With Changes In VEP

We did an analysis between the pre-operative perimetry and the changes in the latency of N75 and P100 using Kruskal Wallis test.

F) N75 Latency And Preoperative Visual Defects

Table 4.6: shows the effects of pre-op visual defects on N75 latency.

MONTAGE	Type of defect		Baseline	Post-Induction	During Resection	Before Extubation
O1-FZ	**Normal**	Mean±SD (In ms)	87.9±13.1	101±16.3	108.6±12.4	95.4±14.4
	Bilateral	Mean±SD (In ms)	92.7±14	105.3±18.5	117.7±16.7	108.3±13.1
	unilateral	Mean±SD (In ms)	83.8±15.4	91.3±19.8	101.1±17.4	90.2±18.4
		P-Value	0.386	0.346	0.094	0.077
MONTAGE			Baseline	Post-Induction	During Resection	Before Extubation
OZ-FZ	**Normal**	Mean±SD (In ms)	89.1±15.7	101.5±17.4	107.6±9.4	94.9±14.1

	Bilateral	Mean±SD (In ms)	91.4±13.8	103.6±17.7	116.3±15.9	108.6±14.6
	unilateral	Mean±SD (In ms)	80.5±11.4	88.3±15.8	99.8±16.2	90.5±18.5
		P-Value	0.224	0.165	0.081	0.065
MONTAGE			Baseline	Post-Induction	During Resection	Before Extubation
O2-FZ	**Normal**	Mean±SD (In ms)	87.8±13.3	101.4±17.5	108.9±12.6	97.6±19.4
	Bilateral	Mean±SD (In ms)	91.2±13.7	103.3±17	116.2±15	106.9±13.7
	unilateral	Mean±SD (In ms)	81.2±10.8	89.4±15.8	99.2±15.8	89.8±16.5
		P-Value	0.293	0.237	0.060	0.102

We analysed the correlation between pre-operative field defects based on perioperative perimetry and the latency of N75 changes. We found that the increase in latency was higher in patients with bilateral visual field defect as compared with the patients with normal and unilateral defect; however, the changes were not statistically significant.

G) P100 latency and pre-op visual filed defects

Table 4.7: shows the effects of pre-op visual defects on P100 latency.

MONTAGE	Type of defect		Baseline	Post-Induction	During Resection	Before Extubation
O1-FZ	Normal	Mean±SD (In ms)	109.6±17.5	128.9±14	132.6±15.3	115.4±20.9
	Bilateral	Mean±SD (In ms)	127.8±21.3	137.7±16.6	149.4±14.3	138.4±12
	unilateral	Mean±SD (In ms)	115.9±16.7	125.6±14.4	136.5±19.1	121.2±17.1
		P-Value	0.168	0.252	0.095	0.032
MONTAGE			Baseline	Post-Induction	During Resection	Before Extubation
OZ-FZ	Normal	Mean±SD (In ms)	109.7±17.3	129±13.9	131.9±14.8	115.3±20.7
	Bilateral	Mean±SD (In ms)	**125.8±19.1**	**137.8±14.1**	**149.3±13.8**	**137.5±11.5**
	unilateral	Mean±SD (In ms)	113.3±13.8	123.1±11.5	134.6±18.9	118.3±16.1

		P-Value	0.141	0.080	0.054	0.024
MONTAGE			Baseline	Post-Induction	During Resection	Before Extubation
O2-FZ	Normal	Mean±SD (In ms)	109.4±17.7	127.5±15.5	131.1±14.6	116±22
	Bilateral	Mean±SD (In ms)	127.8±18.8	138.2±15.3	145.4V19.9	137.1±12.2
	unilateral	Mean±SD (In ms)	113±13.9	123.2±12.6	135.3±20.4	120±18.6
		P-Value	0.085	0.124	0.235	0.043

We analysed the changes in latency of the P100 waveform with the pre-operative perimetry defects. We observed that at all time points compared to the patients with normal perimetry , the increase in latency was higher in patients with unilateral defects and greatest change was seen in patients with bilateral defects.. Although at the end of the surgery, the increase in latency of the P100 were significant in the OZ-FZ and O1-FZ montages in patients with bilateral field defects compared to patients without defect and unilateral defect.

H) N75-P100 Amplitude And Pre-Operative Perimetry

Table 4.8: shows the effects of pre-op visual defects on N75-P100 amplitude.

MONTAGE	Type of defect		Baseline	Post-Induction	During Resection	Before Extubation
O1-FZ	Normal	Mean±SD (In μv)	9.8±1.7	5.4±0.6	3.5 ±1	4.6±0.7
	Bilateral	Mean±SD (In μv)	8.8±4.5	5±0.7	2.9±1.3	4.4±1.3
	unilateral	Mean±SD (In μv)	8.3±3.2	5.7±2.4	4.4±2.3	5.3±1.9
		P-Value	0.160	0.584	0.345	0.851
MONTAGE			Baseline	Post-Induction	During Resection	Before Extubation
OZ-FZ	Normal	Mean±SD (In μv)	9.6±2.2	5.5±0.5	3.5±1.1	5.0±0.6
	Bilateral	Mean±SD (In μv)	8.9±4.9	4.8±0.6	2.7±1.1	4.3±1.0
	unilateral	Mean±SD	8.4±3.1	6.1±2.7	4.3±2.1	5.3±2.1

		(In µv)				
		P-Value	0.316	0.134	0.095	0.254
MONTAGE			Baseline	Post-Induction	During Resection	Before Extubation
O2-FZ	Normal	Mean±SD (In µv)	9.6±1.9	5.4±0.5	3.6±1.2	5.0±0.6
	Bilateral	Mean±SD (In µv)	8.9±4.8	4.8±0.6	2.7±1.1	4.3±1.0
	unilateral	Mean±SD (In µv)	8.2±3.3	6.2±2.6	4.3±2.5	5.1±2.0
		P-Value	0.208	0.241	0.109	0.302

Baseline amplitude and decrease in amplitude following anaesthesia induction were similar in patients pre-operative visual field defects compared to normal. The drop in amplitude was higher in the patients with bilateral defects as compared with patients with a normal perimetry and unilateral defects during resection phase. The changes were not significant statistically.

5)Post-Operative Data

A) POST OPERATIVE PERIMETRY

Table 5.1 shows the visual field assessment using perimetry in postoperative period.

Visual Field	Numbers(%)
No change compared to pre-op	8(32)
Improved compared to pre-op	9(36)
Not done	8(32)

We lost follow up of Post-operative perimetry for 8 of our patients due to the ongoing pandemic. Out of 17 patients, 8 (32%) of our patients had no new change in the perimetry. The rest of the 9 (36%) patients had improved perimetry in the post-operative period. None had deterioration in vision at 3 months follow up perimetry data.

B) Correlation Between Pre-Operative And Post-Operative Perimetry

Table 5.2 shows the correlation between the pre-operative and post-operative perimetry.

	Preoperative findings (n=25)	Post-op perimetry			
		Unchanged	Improved	Missing data (excluded)	Total
Pre-op perimetry	Normal (7)	6	0	1	7
	Unilateral defect (10)	1	5	4	10
	Bilateral defect (8)	1	4	3	8
Total		8	9	8	25

We divided the pre-operative field defects into three groups, namely patients with normal perimetry, patients with unilateral and patients with bilateral defects. In the post-operative period we segregated them into patients in whom the defect was unchanged/ normal and in whom there were improvements in perimetry. A chi-square test was done comparing pre and postoperative perimetry findings which revealed a p-value of 0.005 suggesting significant improvement in the post-operative visual function.

C) Post Op Visual Acuity

Table 5.3: shows the Post-op visual acuity in all the patients

VISUAL ACUITY	Number (%)
6/6	20 (80)
6/12	1 (4)
6/18	1 (4)
6/24	1 (4)
Finger counting at 6 feet	1 (4)
Finger counting at 1 feet	1 (4)

Among the 25 patients, 5 of our patients showed improvement in the visual acuity in the post-operative period. In two of the patients the vision improved to 6/6 bilaterally.

D) Pre- Operative Perimetry And Pre-Operative Visual Acuity

Table 5.4: shows the correlation between pre-op visual acuity and pre-op perimetry in all the patients

		Pre-op VA-Severity			
		Normal	Moderate	Blind	TOTAL
Pre-op VF	Normal	7	0	0	7
	unilateral	6	0	2	8
	bilateral	7	2	1	10
		20	2	3	25

We used Pearson Chi square test to find the correlation between the pre-operative VA and field defect. The p value was 0.240 which suggested that there was no correlation between the two.

E) Post-Operative Perimetry And Post-Operative Visual Acuity

Table 5.5: shows the correlation between post-op-op visual acuity and post-op perimetry in all the patients

		Post-Op VF			
		Improved	No Change	Missing Data (Excluded)	TOTAL
Post-Op VA	Normal	6	7	7	20
	Mild	1	0	0	1
	Moderate	1	0	1	2
	Blind	0	1	1	2
Total		8	8	9	25

A Pearson Chi square test between the post-operative visual acuity and post-operative perimetry revealed a P-value of 0.661 suggesting no correlation.

F) Analysis Of Post-Operative Perimetry And N75 Latency

We analysed the post-operative perimetry changes (Improved (8 patients) Vs no change(9 patients) with the latency of the N75 and P100 waveforms during resection and at the end of the surgery.

Table 5.6: Correlation between post-op perimetry data and N75 latency during resection

MONTAGE	Type of defect		During Resection	Before Extubation
O1-FZ	Improved from preoperative status (8)	Mean±SD (In ms)	111.8±11.6	100.8±15.4
	No change from the pre-operative status (9)	Mean±SD (In ms)	109.9±14.6	96.8±17.3
		P-Value	0.776	0.633
MONTAGE	Type of defect		During Resection	Before Extubation
OZ-FZ	Improved from preoperative status(8)	Mean±SD (In ms)	110.4±11.1	101.0±15.4
	No change from the pre-operative status (9)	Mean±SD (In ms)	108.5±11.9	95.8±16.5
		P-Value	0.749	0.521

MONTAGE	Type of defect		During Resection	Before Extubation
O2-FZ	Improved from preoperative status	Mean±SD (In ms)	110.2±11.6	100.5±14
	No change from the pre-operative status	Mean±SD (In ms)	109.3±13.6	97.5±19.9
		P-Value	0.888	0.733

G)ANALYSIS OF POST-OPERATIVE PERIMETRY AND P100 LATENCY

Table 5.7: Correlation between post-op perimetry and P100 latency

MONTAGE	Type of defect		During Resection	Before Extubation
O1-FZ	Improved from preoperative status	Mean±SD (In ms)	144.0±14.8	125.9±16.7
	No change from the pre-operative status	Mean±SD (In ms)	135.8±13.2	119.3±21.6
		P-Value	0.260	0.503
MONTAGE	Type of defect		During Resection	Before Extubation
OZ-FZ	Improved from preoperative status	Mean±SD (In ms)	143.3±16.1	124.4±17.2
	No change from the pre-operative status	Mean±SD (In ms)	135.0±12.7	118.6±20.8
		P-Value	0.274	0.558
MONTAGE	Type of defect		During Resection	Before Extubation

O2-FZ	Improved from preoperative status	Mean±SD (In ms)	138.9±22.2	125.3±18.8
	No change from the pre-operative status	Mean±SD (In ms)	133.9±12.2	119.3±21.9
		P-Value	0.581	0.561

Analysis of the post-operative perimetry data with the N75 and P100 latency during resection and at the end of the surgery shows that the latency did not affect the postoperative perimetry findings.

H) Post-Operative Complications

Table 5.8: Frequency of post-op complications

COMPLICATIONS	FREQUENCY (%)
None	19(76%)
CSF leak	3(12)
3rd cranial nerve palsy	2(8)
CSF leak with meningitis	2(80

The most common complication in the post-operative period was cerebrospinal fluid leak (CSF) in 3(12 %) of the patients. This was followed by transient third cranial nerve palsy in 2 (8%)

of our patients and one patient had recurrent CSF leak with meningitis. There was no complication in 19 (76%) of our patients.

8. DISCUSSION

Discussion

In this study we tried to evaluate the role of fVEP on the intraoperative changes during different stages of anaesthesia and surgery in patients undergoing trans nasal trans sphenoidal endoscopic surgery for lesions of sellar supra sellar region and tried to assess the effects of preoperative visual function on fVEP. Moreover we tried to assess the impact of fVEP changes on postoperative visual functions.

Reports show that the usefulness of the intra-operative fVEP recordings is limited by its poor repeatability and lack of correlation with the post-operative visual outcome. (18) We hypothesized that Flash visual evoked potential is useful in real time monitoring of intraoperative visual function and thereby improves postoperative visual outcome. Based on our results, we found that our hypothesis is true. However, we were able to obtain stable recordings throughout the procedure both in patients with normal and altered visual functions. The important findings based on our study results are;

1) We were able to obtain stable VEP recordings throughout the intraoperative period.
2) We found significant prolongation of VEP recordings from baseline values to post-induction. The increase was 12.3% for N75 and 10.3% for P100 latencies. The amplitude change between N75-P100 was 46.6% decrease.
3) The change in latencies and amplitude were over and above the baseline values during the resection times. The increase was 33.3% for N75, 7.8% for P100 latency and 15.1% decrease for N75-P100 amplitude.

4) At the end of resection and just before extubation, when the anaesthetic agents were stopped, the N75 and P100 latencies and N75-P100 amplitudes returned to pre-resection levels but never touched the awake baseline.
5) Analysis of the post-operative perimetry with the VEP recordings at the end of surgery showed that the increase in latency was more in the patients with no defects as compared with patients who had an improved perimetry. The results were not statistically significant.

Out of the 25 recruited patients, 21 patients had optic chiasmal compression in the MRI. Three among those patients did not show any signs of decrease in visual acuity and field defect. 11 of our patients had a visual acuity of 6/6 in spite of having a field defect in the preoperative perimetry. This was similar in our study where the pre-operative visual acuity showed no correlation to the pre-operative perimetry. The most common defect was a bitemporal hemianopia. These finding are in accordance with the results of the study by Siddharth Ogra, *et. al*, in which they analysed the visual acuity and perimetry at presentation in patients with pituitary adenoma. (45) The study showed that bitemporal defects were most common field defects (41%) seen in chiasmal compression and were associated with increased age and non-functioning tumours. They highlighted that patients with bitemporal visual field loss secondary to chiasmal compression from pituitary tumour can present with excellent visual acuity.

Flash VEP stimulus was provided by red light emitting diodes (LED) fitted to a google with an adjustable head band over the closed eyes. we secured the googles with water proof tapes. This prevented betadine solution from penetrating inside and displacement of the googles throughout the procedure. This was similar to Chack, et. al, and Kodama, et. al, who successfully

obtained VEP recordings with a flash red LED. (46, 35) Our stimulus frequency was 2Hz with an average of 500 trials. Sasaki, et. al, utilized ERG to ensure continuous stimulation of retina because their surgeries involved frontal scalp flap reflection which could cause deviation of the light axis .(28) Yoshinobu, et. al, studied the usefulness of VEP in trans sphenoidal surgery in 33 patients with sellar and suprasellar tumours. They demonstrated stable and consistent VEP recording throughout the procedure that was attributed to adequate high-power device with ERG recording in order to ascertain retinal light stimulation.(26) We did not use ERG stimulation. We utilized an adjustable band that was tightened to the head size, used gauzes and water proof plasters to fix it in place. (Fig 9b) Our surgeries involved trans nasal trans sphenoidal route and hence there was no disruption of the googles and the light axis. With this technique we did not encounter any loss of VEP in the peri-operative period and none of our patients had visual deterioration in the post-operative period. Hence, we did not encounter problems during monitoring. A subdural needle electrode was used to lower the impedance and for better resolution.(47)

Anaesthetic Technique

Several reports have been published in the literature regarding the usefulness of intraoperative VEPs. Along with the surgical dissection, hypotension, hypothermia and anaesthetic technique has also been reported as a cause of instability in VEPs. Cedzich, et. al, in their study recorded flash VEPs in 35 patients with tumours involving the optic pathway. They recorded both reversible and permanent loss of signals, but they were independent of the surgical manipulations. In addition to the random changes in the intraoperative period, there was also lack of correlation with the postoperative outcome. They concluded by saying that the combination of anaesthesia and surgical manipulation led to the loss of signals. (48) Sebel, et. al, and Domino, et. al, observed

that the volatile anaesthetics and nitrous oxide prolonged the latencies and decreased the amplitude of the VEPs. (49,50) Wiedemayer, et. al, reported a 8% prolongation of P100 latency and a loss of P100-N145 amplitude of up to 60% with total intravenous anaesthesia(TIVA) compared to awake patients. (3) However Kodama, et. al, could successfully record VEP in 53 patients using TIVA based anaesthesia. (35) Alberto A. Uribe, et. al, in their study compared VEP monitoring in spine surgeries under TIVA and balanced anaesthesia. They concluded by stating that TIVA is associated with higher VEP amplitude and shorter latencies than balanced general anaesthesia.(51) The typical agents used in their study are propofol, fentanyl, and muscle relaxants like rocuronium. Thus we used air oxygen mixture with propofol based TIVA with a target controlled infusion pump(TCI).

During the intraoperative course, there was a significant increase in latency of the N75 and P100 waves and decrease in amplitude of the N75-P100 waveform from baseline to post-anaesthesia induction. The N75 latencies showed a higher percentage change (12.5%) compared to the P100 latencies (10%) in all three montages. Our results were in accordance with study by Chi, et. al, who found that enflurane causes amplitude reduction of VEPs, but there was significant prolongation of latency in N75, but P100 was prolonged only if enflurane concentration is more than 1 MAC. (62) In a recent study of sevoflurane was found to have significant suppression of the VEP amplitudes even at lower concentrations compared to Propofol. (63) We have used TIVA based technique, and we found similar effects of TIVA on N75 and P 100 waves. We were able to obtain stable readings throughout the procedure even with longer operating times and the latency changes but not the amplitude were restored back to the baseline at the end of the surgery.

The physiological parameters like the partial pressure of CO_2 and partial pressure of O_2 were maintained stable throughout the procedure. The mean arterial pressure was maintained within 10% of baseline while recording the VEP. Analgesia was maintained with fentanyl infusions and boluses of intravenous labetalol was used to maintain blood pressure. BIS was maintained between 40 to 60 throughout the intraoperative course.

All our patients had deterioration in VEP waveforms during surgery that restored back to baseline at the end of surgery. We analysed the latencies of N75 and P100 with the pre-operative perimetry results. 10 of our patients had bilateral deficits, 8 of them had unilateral deficits and 7 of them presented with a normal perimetry. This was similar to studies by Ogra, et. al, Poon, et. al, and Klauber, et. al, where bitemporal defect was the most common perimetric finding followed by unilateral defects in patients with sellar and supra sellar mass .(45, 52 , 53)

We found that in patients with bilateral defects, the increase in latency of the N75 and P100 waves was greater as compared to patients with unilateral defects and normal field. However there was no significant difference in amplitude of the waves. This finding was consistent in all the three montages monitored. The magnitude of the multifocal VEP latencies in awake patients have been correlated with the size of visual field defect in perimetry. (18) To the best of our knowledge correlation of the baseline VEPs with the perimetry has not been done. Although, flash VEPs are not capable of reflecting filed defect like the pattern VEPs which uses half filed or quadrant stimulation, the findings in our study confirm that the increase in latency and decrease in amplitude can be higher in patients with field defects compared to preoperative normal perimetry. This is similar to Jayaraman, et. al, study which reported reduction in amplitude and prolongation in latencies in patients with chiasmal compression.(54)

The decrease in amplitude from baseline to post-induction was 46%. Kodama, et. al, and Sasaki, et. al, have used a warning criterion that an amplitude decrease of >50 % and a latency increase of >10% from baseline control levels needs a cessation of the surgical procedure until recovery of the fVEP occurred and provided that the other factors like anaesthesia, use of bipolar cautery could not be used to explain the amplitude changes. (35, 28) Since, the changes were attributed to anaesthetic parameters we proceeded with the surgery. The increase in latency of N75 and P100 waveforms were 44% and 18% respectively from the baseline compared to the resection phase. Any significant prolongation in the P100 absolute latency signifies involvement of one of the optic nerve. When there is a bilateral prolongation of latencies, the lesion could be in both optic nerves, the optic chiasm, or the visual pathway posterior to the chiasm.(55) Since P100 is the most consistent and least variable peak, we decided to proceed with the surgery despite significant changes in N75 latency. The decrease in amplitude of N75-P100 waveform was also maximum during the resection phase.(60%) Although, the change when compared to the post-induction recording was only 14%, it was not statistically significant. We also observed that the changes were higher when the duration of resection was longer and in giant adenomas when the chances of ischemic injury or retraction over the optic apparatus is high.

At the end of surgery the N75 latency approached post-induction levels in all three montages while P100 latencies were comparable with baseline. The amplitude has decreased by 39% compared to the baseline at the end of the surgery. These changes are similar to Kamio, et. al, study that compared the usefulness of intraoperative VEP monitoring in trans sphenoidal surgeries. (26) They obtained stable recordings in all 28 of the 33 patients. They reported displacement of stimulator googles in 3 patients and severe pre-operative visual impairment in 2 patients as the cause of failure to obtain VEP signals. Similar to our study, in 4 of their cases they

experienced transient decrease in amplitude which recovered at the end of the surgery. These patients did not have any post-operative deficit. While in one patient, permanent loss of amplitude was recorded and the patient had a new onset bitemporal defect in the post-operative period. Takaaki, et. al, also showed similar results in their study for extended endoscopic trans nasal excision of the craniopharyngioma. (56) Intraoperative VEPs were recorded in all 7 of their patients. 5 of their cases showed stable recordings and in two of their patients they found a significant reduction in amplitude, which had recovered at the end of the surgery. There was no deterioration in the post-operative visual function.

We correlated the intraoperative changes in VEP with the post-operative perimetric findings. The changes in amplitude and latency during resection phase did not impact the postoperative perimetry. We did not encounter any permanent loss of potential and the potentials returned back to pre-resection values at the end of surgery. These changes could signify that visual function is not affected. We believe that certain factors could have impacted our findings like the number of patients with postoperative visual loss was zero, the changes during resection phase was < 20% and postoperatively in 8 patients we could not obtain the perimetry values, and the postoperative testing of perimetry was done at 2months post-surgery. Also, quadrant stimulation is required to pick up minor improvements which is not possible with fVEPs under anaesthesia. This finding was similar to lzabel Costa E Silva, et. al, in which the application of intra-operative flash VEPs was explored in 15 patients. (57) They introduced a grading system for the changes in the amplitude and latency. F-VEP (flash VEP) recordings were carried out before, during and after operation for each patient. They found no significant correlation between F-VEP and visual acuity and visual field. There was an association between intraoperative F-VEP changes and immediate postoperative clinical condition, although this was difficult to verify statistically in their study due

to small number. Chacko, et. al, studied intraoperative VEPs in 36 patients and indicated that patients undergoing surgery with VEP monitoring had a greater improvement in visual field defects than those who were operated without such intervention. (46)

We also found a significant improvement in the post-operative visual acuity in our patients compared to their preoperative status. However , there was no correlation between the post-operative visual acuity and post-operative perimetry. This was similar to Cohen et al., findings. Cohen, et. al, studied the recovery of visual function after trans sphenoidal surgery in 100 patients. (58) Also 70% of the patients were followed up for six months. The preoperative visual acuity was highly predictive of outcome. Patients with mild impairment of visual acuity had a better outcome compared to the ones with severe impairment. No such correlation was found for visual field. In spite of a severely compromised field, all patients had a significant improvement in the postoperative period. The duration of the preoperative visual complaints correlated with the postoperative outcome significantly. There was no correlation with a secreting pituitary adenoma and visual outcome.

Similar to our study, Fumihiko Nishimura, et. al, studied the efficacy of the VEP in the intraoperative period on 82 patients. (59) The delivery of optimal flash stimuli to the retina was confirmed by simultaneously performing a ERG recording with VEP . They found that a minimum visual acuity of 0.4 is needed for recording the flash VEP. Patients with decreased and restored VEP amplitude, eight (31%) eyes had improved postoperative visual function and 18 (69%) eyes had unchanged visual function in the postoperative state. In the group where VEP amplitude decreased and was maintained at a decline of 50% or less, all the examined eyes had unchanged visual function in the postoperative state. Even with TIVA they noticed some degree of VEP changes, but they were able to obtain stable waveforms even with longer operating times. Lighter

and more durable goggles and a careful goggle setup resulted in a stable delivery of stimuli. They hypothesized that a transient VEP decrease as an indication of optic nerve injury and its recovery or stability of the amplitude as an indication of an intact optic nerve. However, the visual outcomes of the patients whose VEP changes recovered after an initial decrease but showed no disappearance, were unchanged and not worsened. Postoperative hemianopsia could be detected as sudden VEP changes, but intraoperative VEP monitoring failed to detect quadrantanopia in their study. There is no index for the improvement of visual acuity observed postoperatively.

Patients in our study had greater improvement in the postoperative vision due to better intraoperative preservation of VEPs and the return of the values to pre resection values at the end of surgery signifies that the optic nerve was intact. Our study shows greater knowledge on the pattern of the intraoperative VEPs changes on integrity of visual pathway and preservation of visual function postoperatively.

9. LIMITATIONS

Limitations

Our study has a few limitations.

1. We have noted more prolonged latency in VEP recordings in patients with preoperative field defects compared to those with normal field. The number of patients with defects were small to evaluate the effects of intraoperative changes with postoperative visual field. Future study with adequate sample size specific for those with field defects may be needed. Moreover we could not get the postoperative data in few patients which would have affected our overall results of postoperative visual function evaluation.
2. We have maintained depth of anaesthesia and anaesthetic doses constant. However there were significant changes compared to baseline following anaesthesia induction. The change in VEP values were significant even with TIVA. We were not able to completely alleviate the effects of anaesthetics.
3. Time during averaging for 500 waves can miss out on the critical surgical steps that can lead to injury of the visual pathway.
4. Ours is a flash VEP and hence it cannot be applied to patients with loss of perception to light where ERG may be useful.
5. We did not do the fVEP recordings after extubation as the recording done before extubation reached near baseline after reversal.

10. SUMMARY

Summary

One of the main goals of surgeries involving the visual pathways is the preservation and thereby preventing any inadvertent damage. This study was conducted to evaluate the utility of VEP on the peri-operative visual function during trans nasal transsphenoidal resection of sellar suprasellar lesions. Our study included a total of 25 patients aged 18-60 years belonging to ASA grade I and II with a GCS of 15 posted for elective endoscopic trans nasal trans sphenoidal excision of sellar and supra sellar lesions based on preoperative MRI/CT.

A stable VEP recording were obtained throughout the intraoperative period without loss of signals using TIVA based anaesthetic technique. We noted significant increase of 12.3% for N75 and 10.3% for P100 latencies from baseline values during a stable post-anaesthesia induction period. The amplitude between N75-P100 decreased to 46.6%. However these changes are within the limits of warning criteria of >20% latency prolongation and 50% amplitude decrease for evoked potentials. The latencies and amplitude changes during the resection times with an increase of 33.3% for N75, 7.8% for P100 latency and 15.1% decrease for N75-P100 amplitude compared to baseline. Once the surgery is over and anaesthetic were cut off, the latencies and amplitude reached the pre-resection levels but never touched the awake baseline. We did not do a VEP recoding post-extubation due to technical difficulties of placement of goggles in the immediate post-operative period.

There was no intraoperative loss of signal. Patients with bilateral defect had more prolonged latency following anaesthesia and during resection which implies more severe compression of the optic pathway. We did not find correlation of preoperative visual

function with intraoperative VEP due to low sample size of patients with por visual functions. The study group did not show deterioration in visual function post-operative period. Visual function testing at 3-months postoperatively showed significant improvement in the visual function.

11. CONCLUSION

Conclusion

The current study using flash Visual evoked potential in patients with seller supra sellar mass lesions undergoing endoscopic resection showed that TIVA based anaesthetic technique caused prolonged latencies of N75 and P100 waves, but did not exceed the warning criteria for changes in VEP. We found that bilateral preoperative visual defects had more VEP changes compared to normal and unilateral defects at baseline and during surgery. Though we could not find correlation between preoperative and postoperative visual functions with VEP changes, a future study is needed to address this issue.

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13. APPENDICES

1) Technical Advisory Committee Form.
2) Institutional Ethics Committee Form.
3) Patient Information Sheet-English.
4) Patient Information Sheet-Malayalam.
5) Consent Form-English.
6) Consent Form-Malayalam.
7) Proforma.
8) Master Chart.
9) Plagiarism Report.

Technical Advisory Committee (Clinical Studies)

SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY
THIRUVANANTHAPURAM – 695011, INDIA

TAC Registration No: SCT-/S/2019/931 **Date:10.06.2019**

Project title: COMPARISON OF PREOPERATIVE VISUAL FIELD ASSESSMENT USING CLINICAL TESTING, STATIC AUTOMATED PERIMETRY AND VISUAL EVOKED POTENTIAL ON THE POSTOPERATIVE VISUAL FUNCTION IN PATIENTS UNDERGOING ENDOSCOPIC RESECTION OF SELLAR AND SUPRASELLAR TUMOURS.

Principal Investigator:
Dr Aishvarya Shree.N M.D.,Senior Resident, Neuro Anaesthesia, Department of Anaesthesiology, SCTIMST
Co-Principal Investigator(s)
Dr Manikandan S, M.D., P.D.C.C., Professor and Incharge, Division of NeuoAnaesthesia, Department of Anaesthesiology, SCTIMST
Dr Ajay Prasad Hrishi, M.D., D.M., Assistant Professor, Division of NeuroAnaesthesia, Department of Anaesthesiology, SCTIMST
Dr. Prakash Nair, M.S., MCH, Assistant Professor, Department of Neurosurgery, SCTIMST

Members who participated in the TAC meeting on 01/06/2019
Dr. Rupa Sreedhar (Chairperson)
Dr. Sankara Sarma P
Dr. Prasantakumar Dash
Dr. Sylaja. P.N
Dr. Ashalatha
Dr. Krishna Kumar K
Dr. Sanjay G
Dr. Bijulal S
Dr. Syam K
Dr. Jayadevan ER
Dr. K. Shivakumar (Member Secretary)

Dr. Jayadevan ER, Dr. Sylaja. P.N, Dr. Bijulal S, Dr. Ashalatha, Dr. Rupa Sreedhar, Dr. Prasantakumar Dash and Dr. Sanjay G stayed away from the proceedings when the projects in which they are involved as investigator were discussed (#921, 925, 929, 934, 937, 938, 942, 943, 945, 948).

Risk Classification of the project (Minimum/ Moderate/ High): Minimum

Requirement of DSMB: No

Recommended members of DSMB: Not applicable

Recommendations of TAC:
Recommended for consideration of IEC.

The PI may note that there can be no additions / alterations in the documents approved by TAC when they are submitted to the IEC.

Signature of the Member Secretary, TAC (Clinical Studies)

Copy to IEC

श्री चित्रा तिरुनाल आयुर्विज्ञान और प्रौद्योगिकी संस्थान, त्रिवेन्द्रम
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Institutional Ethics Committee

(IEC Regn No. ECR/189/Inst/KL/2013/RR-16)

SCT/IEC/1400/JULY-2019

22.08.2019

Dr. Aishwarya Shree N
Senior Resident, Department of Ananesthesiology
SCTIMST, Thiruvananthapuram

Dear Dr. Aishwarya Shree,

The Institutional Ethics Committee reviewed and discussed your application to conduct the study entitled "COMPARISON OF PREOPERATIVE VISUAL FIELD ASSESSMENT USING CLINICAL TESTING, STATIC AUTOMATED PERIMETRY AND VISUAL EVOKED POTENTIAL ON THE POSTOPERATIVE VISUAL FUNCTION IN PATIENTS UNDERGOING ENDOSCOPIC RESECTION OF SELLAR AND SUPRASELLAR TUMOURS (IEC/1400)" on 26th July, 2019.

The following documents were reviewed:

Original submission

1. *Covering Letter addressed to the Chairperson, IEC, SCTIMST dated 18.06.2019 with checklist*
2. *TAC Approval Letter*
3. *IEC Application Form*
4. *Project Proposal*
5. *Proforma*
6. *Patient Information Sheet and Informed Consent Form in English and Malayalam*
7. *CV of Principal Investigator and Co-Principal Investigators*

Revised submission

1. *Covering Letter addressed to the Chairperson, IEC, SCTIMST dated 14.08.2019 with checklist*
2. *Forwarding Letter from the guide*
3. *TAC Approval Letter*
4. *IEC Application Form*
5. *Project Proposal*
6. *Proforma*
7. *Patient Information Sheet and Informed Consent Form in English and Malayalam*
8. *CV of Principal Investigator and Co-Principal Investigators*

The following members of the Ethics Committee were present at the meeting held on 26th July, 2019 at Noshir H Wadia Conference Hall, AMCHSS, SCTIMST

SL. No.	Member Name	Highest Degree	Gender	Scientific /Non Scientific	Affiliation with Institution(s)
1.	Dr. Harikrishnan S	MD, DM (Cardiology) DNB (Cardiology)	Male	Clinician	Yes
2.	Dr. Kala Kesavan. P	MBBS, MD	Female	Basic Medical Scientist	No
3.	Smt. Sathi Nair	MA (English Literature)	Female	Lay Person	No
4.	Dr. Christina George	MD Psychiatry	Female	Clinician	No
5.	Dr. Mala Ramanathan	PhD	Female	Social Scientist (Member Secretary)	Yes

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,

Mala Ramanathan
Member Secretary, IEC

PATIENT INFORMATION FORM

TITLE:

Comparison of preoperative visual field assessment using clinical testing, static automated perimetry and visual evoked potential on the postoperative visual function in patients undergoing endoscopic resection of sellar and suprasellar tumours.

Name of the Investigators:

Dr. Aishvarya Shree N(PI), Dr.Manikandan S(guide and CO-PI), Dr. Ajay Prasad Hrishi(Co guide and CO-PI) , Dr. Prakash Nair(CO-PI)

You are being requested to participate in the above titled study which is being conducted to evaluate the usefulness of preoperative clinical testing, static automated perimetry and visual evoked potential monitoring on the visual function in the postoperative period. We have planned to recruit 28 people with sellar and suprasellar tumours posted for elective neurosurgical procedure at SCTIMST, Trivandrum.

What is clinical visual field testing?

It is a non-invasive method employed by clinicians where the patient is asked to look straight ahead and follow the examiners fingers. The clinician will evaluate the patient's field of vision by the patient's ability to identify the fingers in different directions.

What is static automated perimetry?

It is a non-invasive measurement of visual field which can detect the field of vision by automated techniques. In this test, pinpoint flashes of light of varying sizes and brightness are projected within the large bowl. The patient is asked to look at the center of the bowl and press a button each time the light is seen.

What is visual evoked potential?

It is a non-invasive method in which a LED light is flashed in the eyes and the resultant response is recorded using electrodes placed in scalp. Monitoring intraoperative visual evoked potentials (VEPs) assesses the functionality of the optic pathway from the eye to the visual area in the brain and allows visual impairment to be avoided or minimized.

If you take part what will you have to do?

Preoperatively, the visual field will be routinely assessed by clinical method and static automated perimetry. On the day of surgery, you will be taken inside the neuro Operation Theatre. Non- invasive monitors to check your heart beat, blood pressure and oxygen saturation level will be attached. A 18G venous cannula will be inserted under local anaesthesia in the hand for fluid and drug administration. Baseline VEP will be recorded as per protocol. VEPs will be measured using the flash VEP technique in which you will receive light stimuli directly to your eyes through LED goggles. Anaesthesia will be induced according to standard protocol followed in the hospital. After that you will be fully sedated and paralyzed and you will be connected to ventilator. VEP s will be recorded throughout tumour resection and just before extubation. On the third postoperative day, visual field will be tested by clinical method and static automated perimetry.

Does VEP, static automated perimetry and clinical field testing have any side effects?

All these procedures are non-invasive and they don't carry any risk to your vision. Adverse events from doing these procedure is nil.

Can you withdraw from this study after it starts?

Your participation in this study is entirely voluntary and you are also free to decide to withdraw permission to participate in this study. If you do so, this will not affect your usual treatment at this hospital in any way. In addition, if you experience any side effects, the study will be stopped and you will be given treatment for the side effects.

Will you have to pay for the cost of using the test?

These are used as a part of anaesthesia procedure for surgery. So no extra money will be charged for it.

Will your personal details be kept confidential?

The results of this study will be used for thesis submission as a part of academic research and will be submitted to a medical journal for publication, but you will not be identified by name in any publication or presentation of results. However, your medical notes may be reviewed by people associated with the study, without your additional permission, should you decide to participate in this study.

If you have any further questions, please ask Dr. Aishvarya shree (Principal investigator) mobile number: 9965904567. Email: iceshree@sctimst.ac.in.

For technical advisory committee contact, please ask Dr. Mala Ramanathan, telephone number: 0471-2524234. Email: iec.mem.sec@sctimst.ac.in

രോഗികൾക്കുള്ള കാര്യവിവരണപത്രം

ശീർഷകം: സെല്ലാർ, സൂപ്പർസെല്ലാർ മുഴകളുടെ ഭാഗങ്ങൾ നീക്കംചെയ്യാനുള്ള എൻഡോസ്കോപ്പി ശസ്ത്രക്രിയയ്ക്ക്മുൻപുള്ള ക്ലിനിക്കലായ പ്രവർത്തനതല പരിശോധനയിലുടെയുള്ള കാഴ്ചയുടെ പ്രവർത്തനതലം വിലയിരുത്തലും, സ്ഥിരവും സ്വയംപ്രേരിതവുമായ പ്രവർത്തനതലവും കാഴ്ചയുടെ പ്രേരിതമായ ശേഷിയും ശസ്ത്രക്രിയാനന്തരമുള്ള കാഴ്ചയുടെ പ്രവർത്തനവുമായുള്ള താരതമ്യം.

ഗവേഷകരുടെ പേര്:

ഡോ. ഐശ്വര്യ ശ്രീ എൻ (പ്രധാന ഗവേഷക)
ഡോ. മണികണ്ഠൻ എസ്, (ഗൈഡും സഹ ഗവേഷകനും)
ഡോ. അജയ് പ്രസാദ് ഹൃഷി, (സഹ ഗൈഡും സഹ ഗവേഷകനും)
ഡോ. പ്രകാശ് നായർ (സഹ ഗവേഷകൻ)

ശസ്ത്രക്രിയയ്ക്ക് മുമ്പുള്ള കാഴ്ചയുടെ പ്രേരിതമായ ശേഷിയുടെ നിരീക്ഷണവും ശസ്ത്രക്രിയാനന്തരമുള്ള സ്ഥിരവും സ്വയംപ്രേരിതവുമായ പ്രവർത്തനതലവും വിലയിരുത്തുന്നതിന്റെ പ്രയോജനക്ഷമതയും ശസ്ത്രക്രിയാനന്തരമുള്ള കാഴ്ചയുടെ പ്രവർത്തനവും പഠിക്കുന്ന ഈ പഠനത്തിൽ പങ്കെടുക്കാൻ താങ്കളോടഭ്യർത്ഥിക്കുന്നു. സെല്ലാർ, സൂപ്പർസെല്ലാർ മുഴകളുള്ള ഈ ആശുപത്രിയിലെ 28 രോഗികളെ ഈ പഠനത്തിൽ പങ്കെടുപ്പിക്കാൻ ഞങ്ങളാസൂത്രണം ചെയ്യുകയാണ്.

ക്ലിനിക്കൽ ഫീൽഡ് ടെസ്റ്റിംഗ് എന്നാലെന്ത് ?

രോഗിയോട് നേരെ നോക്കാനും പരിശോധകന്റെ വിരലുകൾ പിന്തുടരാനും ആവശ്യപ്പെടുന്ന ശരീരത്തിൽ കടക്കാതെയുള്ള ഒരു രീതിയാണിത്. വ്യത്യസ്ത ദിശകളിൽ ചലിപ്പിക്കുന്ന പരിശോധകന്റെ വിരലുകൾ രോഗിയുടെ കണ്ടെത്തുന്നതിന്റെ അടിസ്ഥാനത്തിൽ രോഗിയുടെ കാഴ്ച്ചയുടെ തലം വിലയിരുത്തുന്നു.

സ്ഥിരമായ സ്വയംപ്രേരിതമായ പ്രവർത്തനതലം എന്നാലെന്ത്?

ശരീരത്തിൽ പ്രവേശിക്കാതെ കാഴ്ചയുടെ പ്രവർത്തനതലം അളക്കുന്ന, സ്വയംപ്രേരിതമായ സങ്കേതങ്ങളാണിത്. ഈ പരിശോധനയിൽ വലിയ പാത്രത്തിൽ വ്യത്യസ്ത വലുപ്പത്തിലും പ്രകാശതീവ്രതയിലുമുള്ള സൂചിമുനപോലുള്ള പ്രകാശരശ്മികൾ പ്രയോഗിക്കുന്നു. രോഗിയോട് പാത്രത്തിന്റെ നടുക്ക് നോക്കാനാവശ്യപ്പെടുകയും പ്രകാശം കാണുന്ന സമയത്ത് ഒരു ബട്ടൺ അമർത്താനാവശ്യപ്പെടുകയും ചെയ്യുന്നു.

കാഴ്ചയുടെ പ്രേരിതമായ ശേഷി എന്നാലെന്ത്?

എൽഇഡി പ്രകാശം കണ്ണിലേക്കടിച്ച് അതിന്റെ ഫലമായുണ്ടാകുന്ന പ്രതികരണം നെറ്റിയിൽ ഘടിപ്പിച്ച ഇലക്ട്രോഡുകൾ വഴി യന്ത്രത്തിൽ രേഖപ്പെടുത്തുന്ന ശരീരത്തിൽ പ്രവേശിക്കാതെയുള്ള രീതിയാണിത്. ശസ്ത്രക്രിയാ സമയത്തെ കാഴ്ചയുടെ പ്രേരിത ശേഷി (വിഇപി) നിരീക്ഷിക്കുന്നത് കണ്ണിൽനിന്നും തലച്ചോറിലെ കാഴ്ചയുടെ പ്രദേശത്തേയ്ക്കുള്ള കണ്ണിന്റെ പാതയുടെ പ്രവർത്തനശേഷി വിലയിരുത്താനും കാഴ്ചയ്ക്കുണ്ടാകുന്ന പരുക്ക് ഒഴിവാക്കുകയോ കുറയ്ക്കുകയോ ചെയ്യാനും സഹായിക്കും.

താങ്കൾ പങ്കെടുക്കുകയാണെങ്കിൽ എന്തു ചെയ്യണം?

ശസ്ത്രക്രിയയ്ക്കുമുന്ന് പതിവായി കാഴ്ചയുടെ മേഖലയിലെ കുഴപ്പങ്ങൾ ക്ലിനിക്കൽ ഫീൽഡ് പരിശോധനയും സ്റ്റാറ്റിക് ആട്ടോമേറ്റഡ് പ്രൈമറിയുമുപയോഗിച്ച് വിലയിരുത്തും. ശസ്ത്രക്രിയാദിവസം താങ്കളെ ശസ്ത്രക്രിയാമുറിയിലേയ്ക്ക് കൊണ്ടുപോകും. താങ്കളുടെ പൃദയമിടിപ്പ്, രക്തസമ്മർദ്ദം പ്രാണവായുവിന്റെ പൂരിതാവസ്ഥ എന്നിവ ശരീരത്തിൽ പ്രവേശിക്കാതെ പരിശോധിക്കുന്ന ഉപകരണങ്ങൾ ഘടിപ്പിക്കും. ദ്രാവകങ്ങളും മരുന്നും നൽകാൻ പ്രാദേശികമായ മരവിപ്പിക്കലിന് വിധേയമാക്കി ഒരു 18 ജി വീനസ് കാനുല കൈയിൽ കടത്തും. അടിസ്ഥാന വിഇപി പെരുമാറ്റച്ചട്ടപ്രകാരം രേഖപ്പെടുത്തും. ആശുപത്രിയിലെ അംഗീകൃത പെരുമാറ്റച്ചട്ടപ്രകാരമുള്ള മയക്കൽ നൽകും, അതിനുശേഷം താങ്കൾ പൂർണ്ണമായും മയങ്ങുകയും നിശ്ചലമാവുകയും താങ്കളെ കൃത്രിമ ശ്വസനസഹായിയുമായി ബന്ധിപ്പിക്കുകയും ചെയ്യും. മുഴ ഭാഗികമായി നീക്കംചെയ്യുന്ന മുഴുവൻ സമയവും കുഴലുകൾ മാറ്റുന്നതിന് തൊട്ടുമുമ്പും വിഇപികൾ അളക്കും. ശസ്ത്രക്രിയ കഴിഞ്ഞുള്ല മൂന്നാം ദിവസവും ക്ലിനിക്കൽ രീതിയിലും സ്റ്റാറ്റിക് ആട്ടേമേറ്റഡ് പെരിമെട്രിയിലും കാഴ്ചയുടെ പ്രവർത്തനതലം പരിശോധിക്കും.

വിഇപിക്കും സ്ഥിരവും സ്വയംപ്രേരിതവുമായ പ്രവർത്തനതലം അളക്കുന്നതിലും എന്തെങ്കിലും പാർശ്വ ഫലങ്ങളുണ്ടോ?

ഈ രണ്ട് നടപടികളും ശരീരത്തിൽ പ്രവേശിക്കാത്തതും താങ്കളുടെ കണ്ണുകൾക്ക് ഒരു അപായവുമുണ്ടാക്കാത്തതുമാണ്. ഈ നടപടി ചെയ്യുമ്പോൾ ദേഷകരമായി ഒന്നും സംഭവിക്കില്ല.

താങ്കൾക്ക് പഠനമാരംഭിച്ചശേഷം പിന്മാറാമോ?

പഠനത്തിലുള്ള താങ്കളുടെ പങ്കാളിത്തം പൂർണ്ണമായും സ്വമേധയായുള്ളതും പഠനത്തിനുള്ള സമ്മതം പിൻവലിക്കാൻ താങ്കൾക്ക് സ്വാതന്ത്ര്യമുള്ളതുമാണ്. താങ്കളങ്ങിനെ ചെയ്യുന്നതുകൊണ്ട് താങ്കളുടെ ഈ ആശുപത്രിയിലെ ചികിത്സയെ ഒരുവിധത്തിലും ബാധിക്കില്ല. കൂടാതെ താങ്കൾക്കെന്തെങ്കിലും പാർശ്വഫലങ്ങളനുഭവിക്കേണ്ടിവന്നാൽ പഠനം നിർത്തുകയും പാർശ്വഫലങ്ങൾക്ക് ചികിത്സ നൽകുകയും ചെയ്യും.

.പഠനവുമായി ബന്ധപ്പെട്ട് താങ്കൾക്ക് പരുക്കുണ്ടായാലെന്തുചെയ്യും?

താങ്കൾക്ക് പരുക്കൊന്നുമുണ്ടാകുമെന്ന് ഞങ്ങൾ പ്രതീക്ഷിക്കുന്നില്ല, പക്ഷേ പഠനവുമായി ബന്ധപ്പെട്ട് എന്തെങ്കിലും പാർശ്വഫലങ്ങളോ പ്രശ്നങ്ങളോ ഉണ്ടായാൽ അവ താങ്കൾക്ക് അധികച്ചിലവില്ലാതെ ചികിത്സിക്കും.. എന്തായാലും, ഞങ്ങൾക്ക് സാമ്പത്തികമായ നഷ്ടപരിഹാരം നൽകാനാവില്ല.

ഈ ഉപകരണം ഉപയോഗിക്കുന്നതിന് താങ്കൾ പണം മുടക്കണോ?

ഇവ ശസ്ത്രക്രിയയ്ക്ക് വേണ്ടിയുള്ള മയക്കലിന്റെ ഭാഗമാണ്. അതുകൊണ്ട് അധികമായി പണം നൽകേണ്ടതില്ല.

താങ്കളുടെ വ്യക്തി വിവരങ്ങൾ രഹസ്യമായി സൂക്ഷിക്കുമോ?

പഠനഫലങ്ങൾ അക്കാഡമിക്ക് ഗവേഷണത്തിന്റെ ഭാഗമായ തീസിസ് സമർപ്പിക്കാനും വൈദ്യശാസ്ത്ര ജേർണലിൽ പ്രസിദ്ധീകരിക്കാനും ഉപയോഗിക്കുമെങ്കിലും താങ്കളെ പേരുകൊണ്ടോ മറ്റുവിധത്തിലോ തിരിച്ചറിയാനിടയാക്കുന്നതൊന്നും പ്രസിദ്ധീകരണത്തിലോ പ്രദർശനങ്ങളിലോ ഒരിടത്തും ഉണ്ടാകില്ല. താങ്കൾ പഠനത്തിൽ പങ്കെടുക്കാൻ സമ്മതിച്ചാൽ, താങ്കളുടെ ചികിത്സാവിവരങ്ങൾ താങ്കളുടെ പ്രത്യേക അനുമതി കൂടാതെതന്നെ പഠനവുമായി ബന്ധപ്പെട്ടവർ പരിശോധിച്ചേക്കാം

താങ്കൾക്ക് കൂടുതൽ ചോദ്യങ്ങളുണ്ടെങ്കിൽ, ദയവായി ചോദിക്കുക ഡോ. ഐശ്വര്യ ശ്രീ (പ്രധാന ഗവേഷക) ഫോൺ. 9965904567. ഇമെയിൽ iceshree@sctimst.ac.in.

പഠനത്തിൽ നിന്നും സ്വതന്ത്രമായ ബന്ധപ്പെടാനുള്ള വ്യക്തി മെമ്പർ സെക്രട്ടറി, ഇൻസ്റ്റിറ്റ്യൂഷണൽ എത്തിക്സ് കമ്മിറ്റി (ഫോൺ 0471- 2524234) ഓഫീസ് എക്സ്റ്റൻഷൻ നമ്പർ 234 ഇമെയിൽ mala@sctimst.ac.in

CONSENT FORM

Comparison of preoperative visual field assessment using clinical testing, static automated perimetry and visual evoked potential on the postoperative visual function in patients undergoing endoscopic resection of sellar and suprasellar tumours.

Participant's name: Age (in years):

I_____, son/daughter of _____

Declare that (Please tick boxes)

- I have read the above information provided to me regarding the study comparison of preoperative visual field assessment using clinical testing, static automated perimetry and visual evoked potential on the post operative visual function in patients undergoing endoscopic resection of sellar and suprasellar tumours. ( )
- I have clarified any doubts that I had. [ ]
- I also understand that my participation in this study is entirely voluntary and that I am free to withdraw permission to continue to participate at any time without affecting my usual treatment or my legal rights [ ]
- I understand that the study staff and institutional ethics committee members will not need my permission to look at my health records even if I withdraw from the trial. I agree to this access [ ]
- I understand that my identity will not be revealed in any information released to third parties or published [ ]
- I voluntarily agree to take part in this study [ ]
- I have been provided with the contact numbers of the principle investigator, in case I want to know more about the study and participants rights [ ].
- I received a copy of this signed consent form [ ]

Name:

Signature:

Date:

Name of witness:

Relation to participant:

Signature:

Person Obtaining Consent

I attest that the requirements for informed consent for the medical research project described in this form have been satisfied. I have discussed the research project with the participant and explained to him or her in nontechnical terms all of the information contained in this informed consent form, including any risks and adverse reactions that may reasonably be expected to occur. I further certify that I encouraged the participant to ask questions and that all questions asked were answered.

Name:

Signature: Date:

സമ്മതപത്രം

ശീർഷകം: സെല്ലാർ, സൂപ്പർസെല്ലാർ മുഴകളുടെ ഭാഗങ്ങൾ നീക്കംചെയ്യാനുള്ള എൻഡോസ്കോപ്പി ശസ്ത്രക്രിയയ്ക്ക്മുൻപുള്ള ക്ലിനിക്കലായ പ്രവർത്തനതല പരിശോധനയിലുടെയുള്ള കാഴ്ചയുടെ പ്രവർത്തനതലം വിലയിരുത്തലും, സ്ഥിരവും സ്വയംപ്രേരിതവുമായ പ്രവർത്തനതലവും കാഴ്ചയുടെ പ്രേരിതമായ ശേഷിയും ശസ്ത്രക്രിയാനന്തരമുള്ള കാഴ്ചയുടെ പ്രവർത്തനവുമായുള്ള താരതമ്യം.

പങ്കാളിയുടെ പേര്:
ജനനതീയതി/വയസ്സ് (വർഷത്തിൽ)

ഞാൻ.....പുത്രൻ/പുത്രി..... (ദയവായി കോളങ്ങളിൽ ശരിയടയാളപ്പെടുത്തുക)

മുകളിൽ പറഞ്ഞ സെല്ലാർ, സൂപ്പർസെല്ലാർ മുഴകളുടെ ഭാഗങ്ങൾ നീക്കംചെയ്യാനുള്ള എൻഡോസ്കോപ്പി ശസ്ത്രക്രിയയ്ക്ക്മുൻപുള്ള ക്ലിനിക്കലായ പ്രവർത്തനതല പരിശോധനയിലുടെയുള്ള കാഴ്ചയുടെ പ്രവർത്തനതലം വിലയിരുത്തലും, സ്ഥിരവും സ്വയംപ്രേരിതവുമായ പ്രവർത്തനതലവും കാഴ്ചയുടെ പ്രേരിതമായ ശേഷിയും ശസ്ത്രക്രിയാനന്തരമുള്ള കാഴ്ചയുടെ പ്രവർത്തനവുമായുള്ള താരതമ്യം. എന്ന പഠന സംബന്ധിയായി എനിക്കു നൽകിയ വിവരങ്ങൾ വായിച്ചു എന്നു പ്രസ്താവിക്കുന്നു.[ ]

- എന്റെ എല്ലാ സംശയങ്ങളും പരിഹരിച്ചു.[ ]
- എന്റെ ഈ പഠനത്തിലുള്ള പങ്കാളിത്തം പൂർണ്ണമായും സ്വമേധയാ ആണെന്നും അനുവാദം എനിക്ക് ഏതുസമയത്തും എന്റെ ചികിത്സയെയോ നിയമപരമായ അവകാശങ്ങളെയോ ബാധിക്കാതെ പിൻവലിക്കാൻ അവകാശമുണ്ടെന്നും ഞാൻ മനസ്സിലാക്കുന്നു. [ ]
- ഞാൻ ഈ പഠനത്തിൽ നിന്നും പിൻമാറിയാലും പഠനം നടത്തുന്നവർക്കും സ്ഥാപനത്തിലെ നൈതിക കമ്മിറ്റി അംഗങ്ങൾക്കും എന്റെ ആരോഗ്യരേഖകൾ പരിശോധിക്കുന്നതിന് എന്റെ അനുവാദം ആവശ്യമില്ലെന്ന്ഞാൻ മനസ്സിലാക്കുന്നു. അതിനോട് ഞാൻ യോജിക്കുന്നു. [ ]
- എന്നെ തിരിച്ചറിയാനുതകുന്ന വിവരങ്ങൾ ഒന്നും മൂന്നാം കക്ഷികൾക്കു നൽകുകയോ പ്രസിദ്ധീകരിക്കുകയോ ചെയ്യില്ലെന്ന് ഞാൻ മനസ്സിലാക്കുന്നു. [ ]
- ഞാൻ സ്വമേധയാ പഠനത്തിൽ പങ്കെടുക്കാൻ സമ്മതിക്കുന്നു. [ ]
- സമ്മതപത്രത്തിന്റെ ഒപ്പിട്ട ഒരു കോപ്പി എനിക്കു കിട്ടി [ ]

പങ്കെടുക്കുന്നയാളുടെ പേര്

ഒപ്പ്

തീയതി

സാക്ഷിയുടെ പേര്

ഒപ്പ്

പങ്കെടുക്കുന്ന ആളുമായുള്ള ബന്ധം

തീയതി

(സമ്മതം വാങ്ങുന്നയാൾ)

മെഡിക്കൽ റിസർച്ച് പ്രോജക്ടിനാവശ്യമായ സമ്മതപത്രത്തിനു വേണ്ടുന്ന എല്ലാ ഘടകങ്ങളും തൃപ്തികരമായി നിർവഹിച്ചിരിക്കുന്നുവെന്ന് ഞാൻ ബോധ്യപ്പെടുത്തുന്നു. പഠനപങ്കാളിയുമായി ഗവേഷണപദ്ധതിയെപ്പറ്റി സാങ്കേതികേതര പദങ്ങളുപയോഗിച്ച് എല്ലാ

വിവരങ്ങളെപ്പറ്റിയും ചർച്ച നടത്തുകയും പ്രതീക്ഷിക്കാവുന്ന അപകടസാധ്യതകളും പാർശ്വഫലങ്ങളും വിശദീകരിക്കുകയും ചെയ്തു. പങ്കാളിയെ ചോദ്യങ്ങൾ ചോദിക്കാൻ പ്രേരിപ്പിക്കുകയും എല്ലാ ചോദ്യങ്ങൾക്കും ഉത്തരം നൽകുകയും ചെയ്തു എന്നും ഞാൻ സാക്ഷ്യപ്പെടുത്തുന്നു.

സമ്മതപത്രം വാങ്ങുന്ന ആളുടെ പേര്

ഒപ്പ്

പ്രധാന ഗവേഷക

PROFORMA

TITLE:

Comparison of preoperative visual field assessment using clinical testing, static automated perimetry and visual evoked potential on the postoperative visual function in patients undergoing endoscopic resection of sellar and suprasellar tumours.

Sl NO: DATE: AGE: SEX:

DIAGNOSIS:

PREOPERATIVE COMPLAINTS:

PREOPERATIVE MRI:

ASA GRADE:

DATE OF SURGERY:

BASELINE PARAMETERS:

HEART RATE: MAP: SPO2:

A. FIELD OF VISION (clinical testing by confrontation method):

	RIGHT			LEFT		
	Preop	postop	%	preop	postop	%
Lateral						
Medial						
Superior						
Inferior						

B. STATIC AUTOMATED PERIMETRY:

	RIGHT			LEFT		
	Preop	Postop	%	preop	postop	%
Lateral						
Medial						
Superior						
inferior						

C.VISUAL EVOKED POTENTIAL:

Time points	N 75 latency			P100 latency			N75-P100 amplitude
	O1-FZ	OZ-FZ	O2-FZ	O1-FZ	OZ-FZ	O2-FZ	
Baseline							
Post-induction							
Before dural opening							
During resection							
15mins							
30 mins							
45 mins							
60 mins							
At the end of resection							
Before extubation							

NAME AND SIGNATURE OF THE INVESTIGATOR (with date):

Sl No	Age	SEX	'EIGHT (in kg	EIGHT(in cm	Body mass index	pre-op complaints	Diagnosis
1	53	F	64	155	26.7	headache and Bilateral visual disturbance	Pituitary macroadenoma-non functioning
2	33	M	55	160	21.5	headache and unilateral visual disturbance	Pituitary macroadenoma-non functioning
3	45	M	79	173	26.4	headache	Pituitary macroadenoma-non functioning
4	19	F	64	158	25.8	headache	Pituitary macroadenoma-non functioning
5	39	F	65	156	26.7	headache and Bilateral visual disturbance	Pituitary macroadenoma-non functioning
6	48	M	73	170	25.4	headache and unilateral visual disturbance	Pituitary macroadenoma-non functioning
7	39	F	61	151	26.7	headache and Bilateral visual disturbance	Pituitary macroadenoma-non functioning
8	57	M	60	168	21.5	headache and Bilateral visual disturbance	Pituitary macroadenoma-non functioning
9	22	F	58	158	23.2	headache and Bilateral visual disturbance	Pituitary macroadenoma- non functioning
10	41	F	51	155	21.2	headache and Bilateral visual disturbance and oligomennorhoea	Pituitary macroadenoma-prolactinoma
11	35	M	64	160	25.2	headache and decrease in libido	Pituitary macroadenoma-non functioning
12	30	M	58	165	21.5	headache and Bilateral visual disturbance	Pituitary macroadenoma- non functioning
13	47	F	52	156	21.3	headache and Bilateral visual disturbance	Pituitary macroadenoma-non functioning
14	18	M	44	154	18.8	headache, nausea and vomiting	craniopharyngioma
15	60	F	49	152	21.5	headache and Bilateral visual disturbance	Pituitary macroadenoma-non functioning
16	46	F	62	156	25.7	headache and unilateral visual disturbance	sellar and suprasellar meningioma
17	18	F	58	149	26.1	headache and Bilateral visual disturbance	Pituitary macroadenoma-non functioning
18	24	F	58	154	24.7	headache, nausea , vomiting and weakness of right upper and lower limb	Pituitary macroadenoma-non functioning
19	24	M	53	155	22.2	eadache, change in facial contour and increase in width of fingers and toe	pituitary microadenoma-GH secreting
20	29	F	50	163	18.9	headache , unilateral visual disturbance and lactorrhoea	pituitary macroadenoma-prolactinoma
21	40	M	80	175	26.2	headache and Bilateral visual disturbance	Pituitary macroadenoma-non functioning
22	58	F	63	158	25.2	headache and Bilateral visual disturbance	Pituitary macroadenoma-non functioning
23	34	M	68	170	23.7	headache	pituitary microadenoma-TSH secreting
24	57	M	77	167	27.3	headache and Bilateral visual disturbance	Pituitary macroadenoma-non functioning
25	34	F	49	156	20.4	headache and Bilateral visual disturbance	Pituitary microadenoma-cushings disease

size of the lesion	procedure	COMORBIDITY	ASA GRADE	Fundus Examination
1.5x2x2.1cm	Trans nasal trans sphenoidal excision	Diabetes mellitus	II	Normal
3.4x2.5x2.6cm	Trans nasal trans sphenoidal excision	nil	I	Normal
2x2x1.9cm	Trans nasal trans sphenoidal excision	systemic hypertension	II	Normal
1.5x2x1.5cm	Trans nasal trans sphenoidal excision	nil	I	Normal
2.9x2.8x2.5cm	Trans nasal trans sphenoidal excision	nil	I	Normal
2.9x1.9x1.7cm	Trans nasal trans sphenoidal excision	nil	I	Normal
3x1.5x1cm	Trans nasal trans sphenoidal excision	nil	I	Normal
2x1x2cm	Trans nasal trans sphenoidal excision	systemic hypertension	II	Normal
4x3.5x2cm	Trans nasal trans sphenoidal excision	nil	I	Normal
4.3x2.9x2.9cm	Trans nasal trans sphenoidal excision	Hypothyroid	II	Normal
1.7x2.1x2.0cm	Trans nasal trans sphenoidal excision	nil	I	Normal
2.5x2x1.5cm	Trans nasal trans sphenoidal excision	nil	I	Normal
1.5x2.1x1.3cm	Trans nasal trans sphenoidal excision	nil	I	Normal
4x4x2cm	Trans nasal trans sphenoidal excision	nil	I	left side papilloedema
2.3x1.8x1.3cm	Trans nasal trans sphenoidal excision	diabetes mellitus	II	Normal
3.6x3x2.5cm	Trans nasal trans sphenoidal excision	nil	I	Normal
1x2.5x2cm	Trans nasal trans sphenoidal excision	nil	I	Normal
3x2.5x3cm	Trans nasal trans sphenoidal excision	nil	I	B/L papillodema
4.4x1.6x4cm	Trans nasal trans sphenoidal excision	diabetes mellitus and hypertension	II	Normal
2.3x1.6x2.5cm	Trans nasal trans sphenoidal excision	hypothyroid	II	Normal
1.5x1x2cm	Trans nasal trans sphenoidal excision	nil	I	Normal
2x1.5x1.8	Trans nasal trans sphenoidal excision	diabetes melitus and hypothyroid	II	Normal
1.5x0.8x0.9cm	Trans nasal trans sphenoidal excision	hyperthyroid	II	Normal
1.2X2.0X1.3cm	Trans nasal trans sphenoidal excision	nil	I	Normal
1.0x1.4x0.9cm	Trans nasal trans sphenoidal excision	nil	I	Normal

PRE-OP PARAMETERS		
VISUAL ACQUITY		Perimetry
RIGHT	LEFT	
6 by6	6by6	Bi Temporal Hemoanopia
6 by6	Finger counting at 1Feet	left pheripheral field constriction
6by6	6by6	Bi Lateral Superior Quadrantanopia
6by6	6by6	normal
6by 18	finger counting at 1Feet	Right temporal hemianopia and left vision loss
6 by 6	5by 60	left temporal hemianopia and right early junctional scotoma
6by 6	6by 6	normal
6by6	6by6	normal
6 by 9	6by6	right superior quadrantanopia
6by6	6by6	left temporal hemoanopia
6by6	6by6	normal
6by6	6by6	Bi Temporal hemianopia
6by6	6by6	right temporal hemianopia
6by6	6by6	left temporal hemianopia
6by24	6by36	Rt sup temporal and left nasal defect
6by6	6by6	left temporal hemianopia with left superior nasal quadrant defect
6 by 6	6by 6	Pheripheral field constriction
6by9	6by6	BiTemporal Hemoanopia
6 by 6	6by 6	normal
6by6	6by6	normal
6by6	6by6	left superior temporal quadrantanopia
6by18	6by36	BiTemporal Hemianopia
6by6	6by6	left temporal hemianopia
6by6	6by6	B/L pheripheral field constriction
6by6	6by6	normal

HEART RATE				MEAN ARTERIAL PRESSURE			
BASELINE	POST-INDUCTION	DURING RESECTION	BEFORE EXTUBATION	BASELINE	POST-INDUCTION	DURING RESECTION	BEFORE EXTUBATION
74	67	56	76	95	90	90	97
78	60	54	78	73	75	76	78
86	75	67	84	105	100	100	105
82	76	87	80	85	87	88	83
89	68	76	87	102	92	92	100
71	70	67	70	94	80	78	94
85	78	70	79	91	87	86	90
84	70	65	83	100	90	91	100
75	76	64	79	83	81	81	83
74	65	78	82	85	85	85	85
76	56	56	67	92	90	98	90
89	78	78	61	90	87	90	90
85	76	67	73	99	95	86	98
87	76	61	89	89	85	80	89
75	65	60	90	93	90	81	93
92	83	78	82	91	82	80	90
85	67	65	73	104	99	86	102
84	75	78	70	95	90	89	95
55	65	67	69	105	92	87	100
64	50	68	73	106	101	91	95
68	55	60	74	94	91	85	94
78	65	63	65	97	88	88	98
69	50	55	79	94	89	89	94
71	76	67	80	96	90	91	96
89	89	70	90	94	89	90	94

END TIDAL CO2				
BASELINE	POST-INDUCTION	DURING RESECTION	BEFORE EXTUBATION	SPO2
34	32	35	35	100
33	33	34	34	100
32	34	36	36	98
31	32	34	34	100
35	35	32	32	100
36	36	36	36	100
32	35	35	35	100
36	34	34	34	100
37	35	35	35	100
31	31	37	37	99
32	32	32	32	100
33	33	34	34	98
34	37	35	35	100
35	34	36	36	100
36	35	37	37	99
33	32	32	32	99
37	33	33	33	100
36	36	34	34	99
37	37	35	35	100
32	31	35	35	98
33	32	36	36	100
30	30	34	34	100
36	34	32	32	99
32	35	33	33	100
34	32	31	31	100

VEP-N75/P100

BASELINE					
O1-FZ-N75(L)	O1-FZ-P100(L)	OZ-FZ-N75	OZ-FZ-P100	O2-FZ-N75(R)	O2-FZ-P100®
86.4	137	86.4	137	86.4	137
65.4	98.3	65.4	98.3	65.4	98.3
86.8	115	86.8	115	86.8	115
108	143	108	143	108	143
98.7	145	95	144	85	141
109	139	100	120.4	95.2	115.3
90.3	110	90.3	110	90.3	110
87.3	107	87.3	107	87.3	107
75	110	75	110	75	110
95	115	95	115	95	115
80	99	78	101	80	98
100.3	139.7	95	120	101	135
76	130	75	128	76	130
75	100	76.7	100	76	100
80	100	79.4	115	82	117.3
78.6	95.3	75	90.3	78	92.3
120	160	119	155	118	157
75	139	76	135	74	136
100	120	111	119	100	120
68.7	96.7	68	96	68	96
100	135	77	135	77	135
95	110	95	110	95	110
75	100	80	100	90	100
106	137	106	137	106	137
81	91.7	81	91.7	81	91.7

POST INDUCTION					
O1-FZ-N75(L)	O1-FZ-P100(L)	OZ-FZ-N75	OZ-FZ-P100	O2-FZ-N75®	O2-FZ-P100®
90.6	140	90.6	140	90.6	140
60.3	112.7	60.3	112.7	60.3	112.7
90	125	90	125	90	125
110	150	110	150	110	150
130	148	126	145	123	146
120.3	145	110	130	100	125
113	133	113	133	113	133
98.7	130	98.7	130	98.7	130
80	122	80	122	80	122
105	125	105	125	105	125
95	120	94	121	93	110
100	143.3	101	140	100	136
95	140	96	140	110	145
80	110	80	110	85	110
100.3	131.1	90	130.2	95	140.7
89	104	88	115	88.3	109.3
134	142	130	140	129	145
84	140	85	139	83	135
120	140	125	140	125	140
70	122	70	122	70	122
110	140	85	135	85	136
110	135	110	135	109	136
80	110	90	110	90	110
125	169	125	169	125	169
100	107.3	100	107.3	100	107.3

DURING RESECTION					
O1-FZ-N75(L)	O1-FZ-P100(L)	OZ-FZ-N75	O2-FZ-P100®	O2-FZ-N75®	O2-FZ-P100®
90.6	147	90.6	147	90.6	147
77.3	114.7	77.3	114.7	77.3	114.7
95.1	120	95.1	120	95.1	120
110	150	110	150	110	150
129	148.3	125	147	122	143
120.3	145	110	130	100	125
100	118	100	118	100	118
109	140	109	140	109	140
95	132	95	132	95	132
106	124	106	124	106	124
100	130	101	128	101	125
110	145	109	154	110	149
100	145	100	145	105	156
95	120	95	120	95	120
137	170	130	165	128	170.1
121	146	121	146	123.3	146.4
142	164	143	165	140	160
115	149	112	145	116	150
135	150	127	147	136	145
101	130	101	130	101	130
85	136	85	136	85	136
112	140	112	140	112	104
130	175	130	175	130	175
125	164.3	125	164	125	164
105	110	105	110	105	110

BEFORE EXTUBATION					
O1-FZ-N75(L)	O1-FZ-P100(L)	OZ-FZ-N75	O2-FZ-P100(R)	O2-FZ-N75 (R)	O2-FZ-P100(R)
88.4	146	88.4	146	88.4	146
62.7	128.7	62.7	128.7	62.7	128.7
90	115	90	115	90	115
110	150	110	150	110	150
119	144	115	140.1	110	140.1
100	130	102	120	95	115
90	109	90	109	90	109
90	110	90	110	90	110
80	108	80	105	80	108
100	106	100	106	100	106
81	100	80	100	78	99
100	135	100	136	99	129
80	110	80	110	87	115
77	102	77	102	77	102
100.1	143	95.4	140	93	139.1
121	143	121	143	123	144.7
119	150	123	155	120	156
120	153	128	145	121	146
121	140	119	139	136	145
86	99	85	99	89	99
102	135	102	125	102	125
105	125	105	125	105	125
120	150	120	150	115	160
120	130	120	130	120	130
90	100	90	100	90	100

AMPLITUDE

BASELINE			post induction		
RIGHT	LEFT	OZ-FZ	RIGHT	LEFT	OZ-FZ
22	21	22.5	4.5	5	5
4.5	5.2	5.2	4.2	4	4.2
11	9.5	10	4.1	5	4.1
11.7	10.6	11.7	4.9	4.9	4.9
7.4	7	6.9	4.1	4.1	4.1
7.6	8.2	8.2	3.4	4.5	5
8	9.1	8	4.1	4.1	4.1
12	12	12	5.9	6	5.9
7.2	6.5	7	5.6	5	5.6
15	15	15	9.5	9.8	10
8.5	8.5	8.5	4.4	4.5	4.5
6	5.5	5.5	3	2.9	2.9
4.5	5	5.5	3.2	4	3.2
8.5	7.5	8	6	6	5.5
6.9	7	6.9	5.5	6.4	5.5
8	9	8.5	5	5.3	5
6.9	7	7.5	5.4	5.4	5.4
6.8	7	7	4.5	4.5	4.5
9	8.7	8	5.1	4	5.1
7.1	8	7.1	5.5	4	5.5
9.5	10	9.5	4.1	4.1	4.1
8	8.5	8.3	4	3	4
9.1	9.3	9.1	5	5	5
6	6.5	6	2.4	2.4	2.4
11	12	12	5	5	5

during resection			before extubation		
RIGHT	LEFT	OZ-FZ	RIGHT	LEFT	OZ-FZ
3.5	3.5	3.5	5	5	5
3	4	4.4	4.5	4	4.5
3.9	4.5	3	5.5	6	5.5
2.3	2.6	2.1	4.9	5.6	5.6
2	2.5	2.5	4.3	4.4	4.1
3.9	4.3	4.3	7.5	6.6	7.5
4.8	4.6	4.5	5.5	5.7	5.5
4.5	4	4.5	6	5.9	6
4	4	3.8	5.5	4.5	5.5
10	9.6	9	12	11	12
3	3	2.9	5.5	4.5	5.5
1.8	1.8	1.8	5	4.9	4.9
1.2	1.2	1.2	4	3.4	3.9
3.9	3.9	3.9	5.5	5.1	5.5
1.2	1.2	1.2	4.4	4.5	4.5
3.3	4.2	4.2	4.5	5	4.5
3.9	3.9	3.9	5.7	6	5.9
1.2	1.2	1.2	3.8	3.8	3.8
5	4.9	4.9	5.1	5.1	5.1
2.3	2.3	2.3	4.8	4.8	4.8
4.3	3.9	3.9	4	4.8	4
3.5	4.1	3.5	5.1	5.1	5.1
4.2	4	4.2	6.2	6.2	6.2
2.4	2.1	2.4	5	5	5
3	3.2	3.1	6.2	6.2	6.2

Duration of surgery (in hours)	POST-OP VISUAL ACUITY		post op vf
	RIGHT	LEFT	
4	6 BY 6	6 BY 6	not done
6	6 BY 6	FC @6 FEET	not done
5	6 BY 6	6 BY 6	improved-b/l superior quadrantanopia
5.5	6 BY 6	6 BY 6	NO CHANGE-NORMAL
7.5	6by 18	finger counting at 1Feet	ANGE-Right temporal hemianopia and left visi
6	6 BY 6	6 BY18	IMPROVED-b/l junctional scotoma
5	6 BY 6	6 BY 6	NO CHANGE-normal
5	6 BY 6	6 BY 6	NO CHANGE-normal
7.5	6 BY 6	6 BY 6	improved-normal
6	6 BY 6	6 BY 6	Improved-normal
5.5	6 BY 6	6 BY 6	NO CHANGE-nodefect
5	6 BY 6	6 BY 6	improved- BI temporal hemianopia
4	6 BY 6	6 BY 6	improved -right temporal hemianopia
5	6 BY 6	6 BY 6	NO CHANGE-left temporal hemianopia
5.5	6 BY 24	6 BY 24	not done
6	6 BY 6	6 BY 6	improved-normal
4	6 BY 6	6 BY 6	not done
4	6 BY 6	6 BY 6	not done
4.5	6 BY 6	6 BY 6	NO CHANGE-normal
5	6 BY 6	6 BY 6	NO CHANGE-normal
4	6 BY 6	6 BY 6	not done
4	6 BY 12	6 BY 12	improved -bi temporal hemianopia
3.5	6 BY 6	6 BY 6	IMPPROVED-normal
3	6 BY 6	6 BY 6	not done
3	6 BY 6	6 BY 6	not done

post op complications	No of days in ICU	Total No of days in hospital
post op csf leak	5	20
none	1	13
none	1	8
none	2	9
none	1	14
none	1	11
none	1	8
none	1	14
none	1	14
transient third cranial nerve palsy	1	5
CSF leak	1	24
none	1	9
none	1	12
none	1	14
none	1	12
3rd cranial nerve palsy	1	12
none	1	12
recurrent csf leak, meningitis	15	90
none	1	12
none	1	9
CSF leak	3	20
None	1	12
none	1	9
none	1	9
none	1	9

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