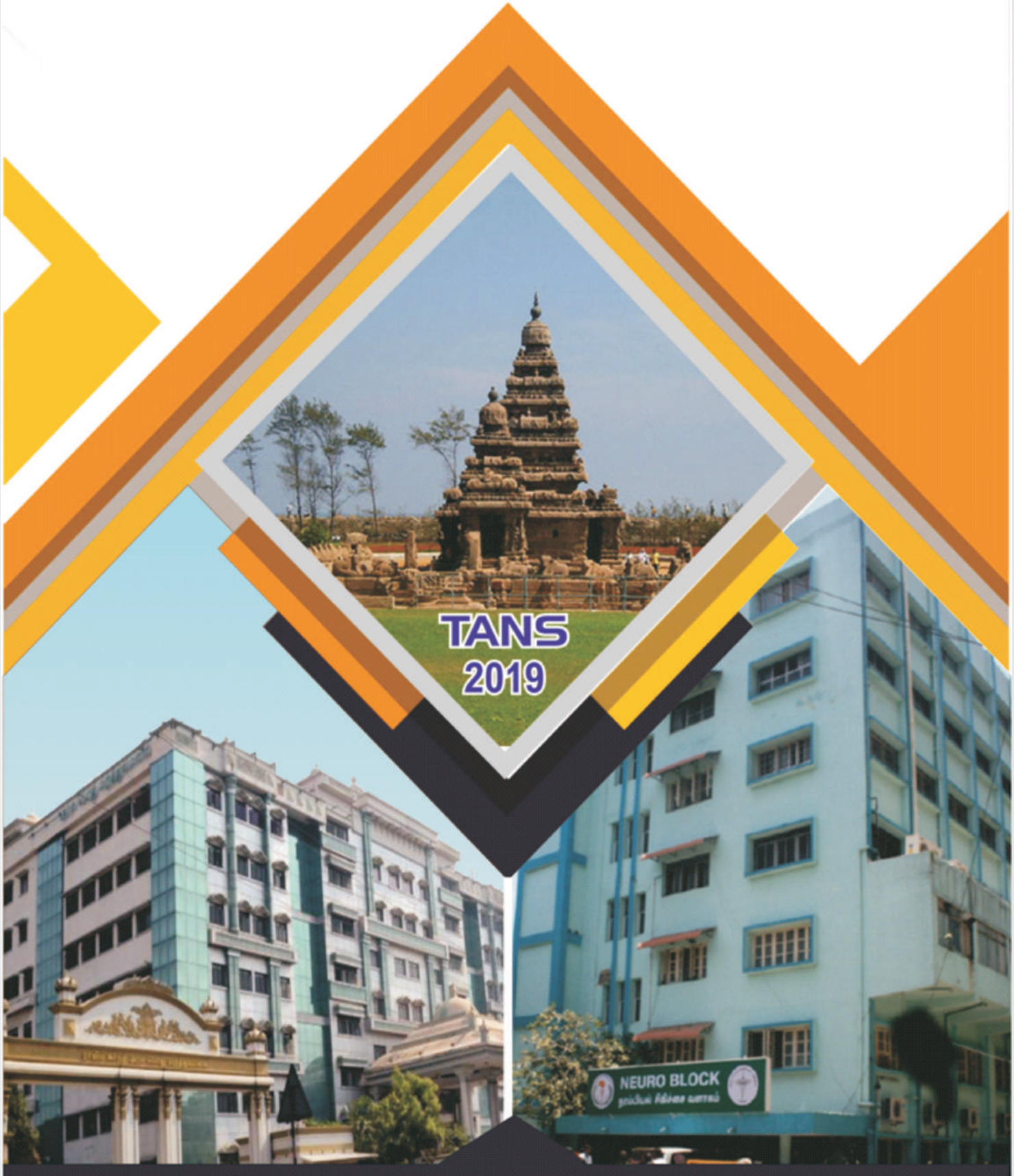
Annals of the Tamilnadu Association of Neurological Surgeons - 2019

INAUGURAL ISSUE



Institute of Neurosurgery, Madras Medical College, Chennai

ANNALS OF

TAMILNADU ASSOCIATION OF NEUROLOGICAL SURGEONS

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(FOR PRIVATE CIRCULATION ONLY)

Tamilnadu Association of Neurological Surgeons

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Annals
Of
Tamilnadu Association of Neurological Surgeons

Inaugural issue - 2019

(From the Institute of Neurosurgery, Madras Medical College)

Message from Editorial Committee

We would like to extend our heartfelt thanks to the organizing committee of TANS 2019 for entrusting us with the job of reviewing and organizing the inaugural issue of the *Annals of TANS – 2019.*

We were able to complete the daunting task with able help and motivation from our senior colleagues at the Institute of Neurosurgery, Madras Medical College.

We have made a sincere effort to edit the manuscripts and present them in a neat manner, although possible errors might have crept in. We hope that our effort and that of the contributors will be appreciated.

We extend our gratitude to all the contributors for the annals.

Editorial Board

TANS 2019 - Organizing Committee

Standing L to R: Devanand Senthil Kumar S, Balamurugan S
Sitting L to R: Raghavendran R, Thiruvalluvan A, Balasubramanian D

TANS 2019 – Annals Editorial Committee

Left to Right: Magesh P, Raghavendran R, Devanand Senthil Kumar S, Thiruvalluvan A, Balasubramanian D, Balamurugan S, Prabhuraman K

Message from the Organizing Chairman

Prof. A. Thiruvalluvan MS., MCh.,
Director,
Institute of Neurosurgery,
Madras Medical College,
Chennai – 600 003

Dear TANS members,

It gives me immense pleasure as the Organizing Chairman of TANS 2019, to thank the TANS office bearers for entrusting our team to conduct the 2nd Annual conference of the Tamil Nadu Association of Neurological Surgeons, at RadissonBlu, Mamallapuram.

தொட்டனைத் தூறு மணற்கேணி மாந்தர்க்குக்
கற்றனைத் தூறும் அறிவு

As an initiative and suggestion from our senior members, I feel proud to bring the Inaugural issue of the **'Annals of Tamil Nadu Association of Neurological surgeons**, which is released now during **TANS 2019.** Also, I wish that it should become the Journal of our body with periodical publications in due course. This inaugural issue was prepared in a short time with limited submissions. In the future, either as Annals or Journal, this is going to be on par with international standards and I am sure that this will happen.

I take this opportunity to thank all members of the organizing team – TANS 2019 for their untiring efforts and support to make this event successful.

Prof. Thiruvalluvan A

Message from the Organizing Vice-Chairman

Prof. Balasubramanian DMCh.,
Professor,
Institute of Neurosurgery,
Madras Medical College,
Chennai – 600 003

Dear TANS members,

It is with pride that we bring forth this inaugural issue of the 'Annals of Tamil Nadu Association of Neurosurgeons'. A first step towards establishing a periodic publication of our esteemed association. As the president of TANS and an Organising vice- chairman of 'TANS 2019', it is my hope and belief that this will lead to a full-fledged publication that will represent our organization both at a national and international level.

This initiative is aimed as a first step into establishing a veritable collection of neurosurgical information that shall strive to enhance the frontiers of neurosurgery and research in our ever-expanding field.

At this juncture, I would like to thank everyone who strived hard and tirelessly to ensure that this endeavour succeeded and was transformed from an idea to reality.

Prof. Balasubramanian D

Message from the Organising Secretary

Prof. Raghavendran R, MCh.,
Professor,
Institute of Neurosurgery,
Madras Medical College,
Chennai – 600 003

Respected Teachers and dear friends,

I write this message with immense satisfaction and gratitude on being the Organising Secretary for the Annual conference of TANS-2019. It is a pleasurable privilege to be part of the Organising Team of TANS 2019.

I can see that, TANS 2019 has blossomed into a successful conference. As I pen this message, the total registration so far is 215(251 including accompanying persons) and will further increase, without doubt, as we are still processing lots more registrations. I thank each and every Neurosurgeon of Tamilnadu and Puducherry personally and on behalf of the Institute of Neurosurgery, Madras Medical College, Chennai, for showering us with your love, affection. I am overwhelmed and moved beyond words about this Grandstand finish to TANS 2019.

As a member of the Founding Executive Committee and on behalf of our Institute of Neurosurgery, I had submitted the registration form and got our association registered under the Societies act in September 2017. In a short span of less than 2 years we have seen phenomenal growth of our association into a big organisation. The decision to start our own Annals of TANS is a welcome move and is an essential part of our growth curve. TANS will continue to grow in leaps and bounds and will surely attain the status to Pioneer and guide the art of neurosurgery in this part of the world.

I am indeed honoured to be part of the Editorial Board for the INAUGURAL ISSUE OF THE ANNALS OF THE TAMILNADU ASSOCIATION OF NEUROLOGICAL SURGEONS. As the Organising Secretary of TANS 2019, I am happy with the trust you all have on me and also happy that the inaugural issue of the ANNALS will be released in TANS-2019 conference. I am glad about my involvement in the preparation, publication and release of the inaugural issue of

Annals of TANS in TANS -2019. I personally witnessed the Annals committee put in long hours of work in collecting, editing, correcting and meticulously working to create the Annals to its present state. It indeed is a good platform to start with and can be modified to suit our future needs. The annals inaugural issue has come out very well and will be good to read, due to the utmost sincerity and hard work put in by the annals committee. My prayers for our Annals to become a journal of global repute soon.

I wish to quote Sir Isaac Newton here. Taking over the Prestigious Chair at Trinity College, London on February 15th, 1676, He said

"I HAVE SEEN FURTHER THAN OTHERS, IT IS BY STANDING UPON THE SHOULDER OF GIANTS"

The mother of this quote is the phrase

"Nanos Gigantum Humeris Insidentis"

from a book authored by John of Salisbury on Bernard of Chartres in the year 1159. It means

"we dwarves see more and farther than our predecessors, not because we have keener vision or greater height, but because we are lifted up and borne aloft on their gigantic stature."

Indeed, every one of us has seen and will continue to see further, riding on the shoulders of our Giant Teachers. I personally feel our Inaugural issue of ANNALS of TANS is a dedication to our Teachers as a mark of our Love, Admiration, Gratitude and Respect, we have for them.

I extend my heartfelt thanks to each and every member of TANS and their family and the Neurosurgical community of Tamilnadu and Puducherry for giving me an opportunity to be a part of this wonderful journey of TANS and TANS - 2019.

God bless us all

Thanks and Regards

Prof. Raghavendran R

Message from the Chairman – Academic Committee

Prof. Devanand Senthil Kumar S MCh.,
Professor,
Institute of Neurosurgery,
Madras Medical College,
Chennai – 600 003

Warm greetings!

The long-cherished dream of having a separate organization for the neurosurgical fraternity of Tamil Nadu was realised in 2017, overcoming many false starts. Now, one longer pending necessity of the neurosurgeons of Tamil Nadu has come to fruition, namely the launch of the official publication of the Tamilnadu Association of Neurological Surgeons titled “Annals of TANS". This will go a long way in helping the neurosurgeons of Tamil Nadu to have a platform to publish their original scientific and research work. It is indeed an honour for me to be the Chair of the Academic Committee of TANS 2019 on the occasion of which this inaugural edition of “Annals of TANS” is being published and released.

The articles in this inaugural edition have been sourced with much effort and adequate diligence has gone into the selection and content so that the inaugural edition will come out well in spite of the time and other constraints.

I am sure the annals will, in the near future, lead to the formation and publication of an indexed journal of TANS.

Happy reading. Thank you.

Prof. Devanand Senthil Kumar S

Message from TANS Secretary

Dr. Srisaravanan J MS., MCh.,
Professor,
Institute of Neurosurgery,
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Madurai

It gives me immense pleasure to share with you all the release of Annals of Neurosurgery by TANS during its second year of tenure.

It is indeed quite inspiring to know that we are providing excellent quality care for neurosurgical patients on par with international standards of treatment to the ailing people in our part of country. Quality International Standard of Care is not only restricted to the capital city of Tamilnadu, but evenly distributed all across Tamilnadu up to Kanyakumari.

Neurosurgeons of Tamilnadu bring laurels to TANS through their contributions in various activities like academics and research. We as a fraternity have to contribute more towards research in neurosurgery in future to help mankind and excel in the society of world neurosurgeons.

This journal is a historical treatise to record the achievement of neurosurgeons of Tamilnadu and embodiment of (tell-tale evidence) our work in the field of neurosurgery.

Prof. Thiruvalluvan A, Prof. Raghavendran R and their team have done enormous work to bring out this journal in a fruitful way. I take this opportunity to thank them and congratulate them for their meticulous work which is reflected in the pages of this journal.

Prof. Srisaravanan J

CONTENTS

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FOREWORD

Prof. S. Kalyanaraman MS., FRCS., PhD.,
Former Head of the Department,
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Chennai – 600 003

It is a great honour and privilege to write a foreword to this academic journal. When there are already a number of national and international journals catering to the needs of neurosurgeons, there is still a need for a regional journal. It is very important to highlight the special problems we face and to record how we have solved them successfully despite limitations in advanced equipment, infrastructure and trained paramedical personnel.

It is also very necessary to publish our rare complications and occasional failures so that the younger generation will realize that sailing in the neurosurgical seas is not always smooth and safe. We have a number of highly dedicated capable and enthusiastic members in our association and I am confident that this journal will help them to raise the standards of neurosurgery to greater heights of glory

Prof. Kalyanaraman S

1. A Case Series of Occipital AVMs operated over Duration of One Year - An Institutional Study in a Single Unit.

Raghavendran R, Nihal Ahemad

Abstract

Background: *Arteriovenous malformation (AVM) in the occipital lobe has been known to cause visual symptoms, headaches and seizures. The majority of patients initially manifest with intracranial haemorrhage, while others manifest symptoms of visual field defects, headaches and other progressive neurological deficits.* ***Materials and Methods:*** *We reviewed a series of cases of occipital AVMs operated micro surgically in a single unit of our institute over a period of 1 year, with focus on their presentations, various factors influencing their management, treatment outcomes and complications. A total of 6 cases of occipital AVMs admitted in our unit from February 2018 to February 2019 were included in this series. Various factors such as clinical presentations and AVM characteristics were considered while deciding surgical intervention and their postoperative outcomes were analyzed.* ***Results:*** *About half of the patients presented with intracranial haemorrhage while the rest presented with visual disturbances. All patients had surface lesions grade two, three and four AVMs with relatively preserved GCS. All six patients underwent microsurgical excision of the lesion with no major postoperative deficits. Three patients had homonymous hemianopia, two of whom had field defects preoperatively while one developed postoperatively.* ***Complication:*** *The annual haemorrhage rate of 2 to 4 % of AVMs combined with a mortality rate of about 10% warrants microsurgical excision of the AVMs, especially in young age group and in lower grade AVMs. Despite concern of hemorrhagic risk, patients with occipital AVMs are at significant risk for visual disturbances after treatment which can be debilitating. We thus aim to characterize the haemorrhage risk and visual disturbance in occipital AVMs patients from our experience and literature review and aim to compare the complication rate with other modalities of treatment available.*

Introduction

Patients with arteriovenous malformation (AVM) of the occipital lobe commonly present with headaches and visual disturbances that seem similar to, but are usually distinguishable from, the symptoms caused by migraine[1]. If untreated, these AVMs can cause seizures or intracranial haemorrhages.

Although various therapeutic modalities are intended to prevent permanent neurologic disability and death in patients with occipital AVMs, no study has evaluated the long-term visual and neurologic outcome in treated patients. For example, it is frequently assumed that surgical evacuation of hematoma is necessary to reverse the homonymous field defect caused by occipital lobe haemorrhage[2]. However, surgical excision of these AVMs, although easier after a bleed, worsens or causes new visual field loss in 56% of patients or fails to improve the existing field defect in 33%[3]. Similarly, the clinical results of newer modalities of treatment, including intra-arterial percutaneous embolization and radio surgery have not been specifically evaluated for the outcome of treatment of AVMs in this location. We describe the presenting symptoms and findings and the impact of surgical therapy on the visual and neurologic dysfunction in patients with occipital AVMs.

Methods

We reviewed a series of cases of occipital AVMs operated micro surgically in our unit over a period of 1 year, with focus on their presentations, various factors influencing their management, treatment outcomes and complications. A total of 6 cases of occipital AVMs admitted in our unit from February 2018 to February 2019 were included in this series. Various factors such as clinical presentations and AVM characteristics were considered while deciding surgical intervention and their postoperative outcomes were analyzed. All patients underwent a complete neuro-ophthalmologic evaluation, including visual field testing (using tangent or automated threshold perimetry) of the central 30 degrees. Cerebral angiography was performed in all patients to assess the vascularity and feeders of the AVM.

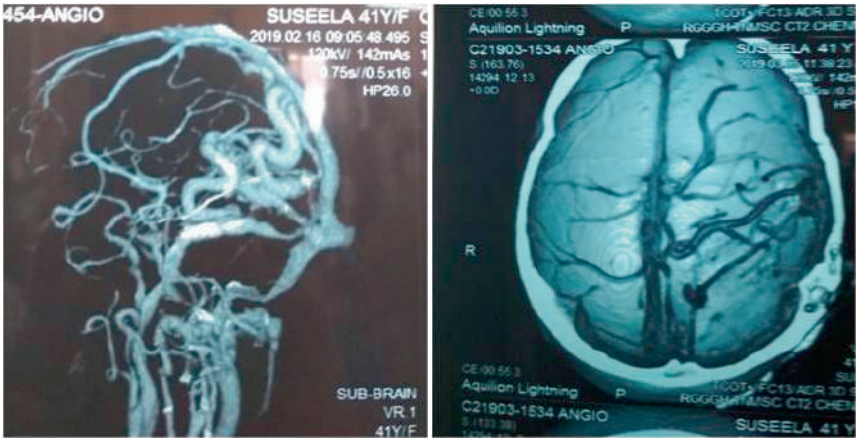
The goal of surgical therapy was the eradication or significant reduction of the AVM nidus and arterial feeders while preserving the normal circulation and brain function. The method of treatment selected was individualized after discussion with neuroradiologists and neuro-ophthalmologists.

Multiple factors such as the extent and permanency of clinical dysfunction, age, general medical condition, location and angio-architecture of each AVM were considered. Follow-up neuro-ophthalmologic evaluations were performed in the treated patients upto twelve months after surgery.

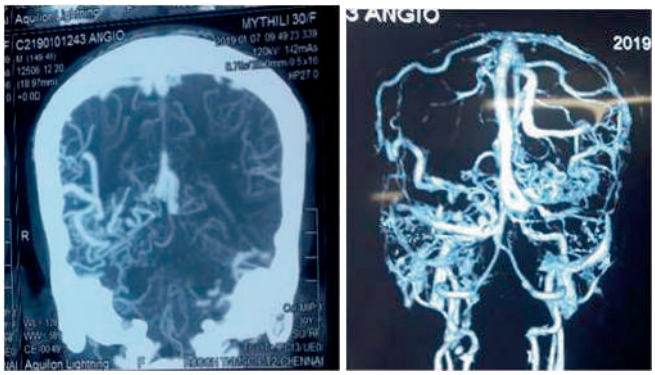
Results

A 40 yr old previously normal female presented with complaints of bumping into objects while looking to the right side. Examination revealed a right homonymous hemianopia. CT angiogram (CTA) revealed a left occipital AVM (4.8X2.8X2cms) Spetzler Martin grade 3 with

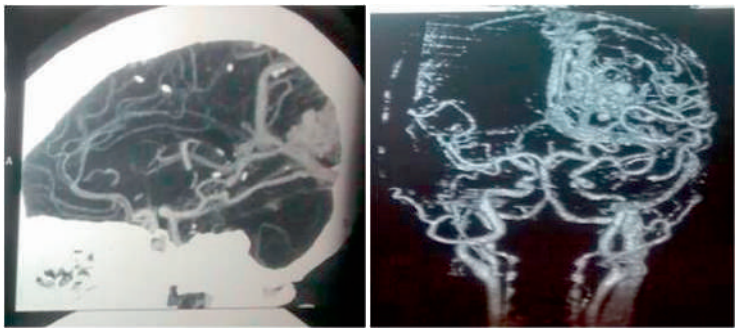
arterial feeders from P3 and P4 segments of Posterior Cerebral Artery (PCA).Venous drainage was into superior sagittal sinus and straight sinus. Patient underwent left parieto-occipital craniotomy and complete excision of AVM. However, post operatively her visual symptoms did not improve but there was no deterioration as well.



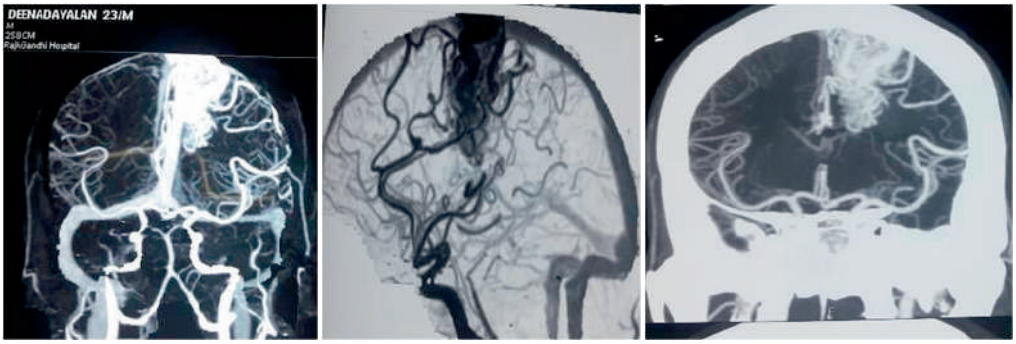
Another 30 yrs female presented with headache and obscuration of vision and ringing sensation in the right ear for 2 months. Examination revealed a left homonymous hemianopia. CTA revealed a 5.5 X 2 cm size AVM in the right occipital region with feeders from PCA and draining into superior sagittal sinus (Grade 3). Craniotomy and complete excision of AVM was done. Visual symptoms persisted postoperatively but tinnitus and headache resolved.



Another 60 year old male presented with sudden onset tonic clonic movements of left side of body associated with severe headache and loss of consciousness. CTA revealed a 4x3 cm right occipital AVM with haemorrhage. Patient was initially stabilized and monitored closely. He underwent craniotomy and excision of AVM 1 week later, but postoperatively developed a left homonymous hemianopia.



Apart from these 3 more patients presented with symptoms of severe headache and loss of consciousness with no visual disturbances. All these three patients were found to have parieto-occiptal AVMs and underwent craniotomy and microsurgical excision. They did not develop any visual symptoms or any other deficit postoperatively.



Discussion

Homonymous visual field loss is the most common neurologic deficit in patients with occipital AVMs followed by tonic clonic seizures. Field defects occurred in 67% of ruptured AVMs compared with 25% in unruptured AVMs[3]. In our series of six cases four presented with haemorrhage and two with visual disturbances. One ruptured AVM patient presented with seizures and LOC. The frequency of headache for patients with AVMs in all locations is approximately 3%[4] to 40%[5]. Throbbing headaches, with or without fortification images, similar to migraine occurred particularly when the occipital lobe was involved with the AVM[6,7]. Hence, when the headache and/or visual symptoms are restricted to one side of the head or field (even if the visual field examination is normal), a neuroimaging study of the brain should be performed, and migraine should be a diagnosis of exclusion. Almost all the patients presenting with visual symptoms presented with headache at some point of time.

The occipital lobe is a common location for AVMs and is the predominant lobe involved in 15%[5] to more than 20%[4,8,9] of parenchymal AVMs. In two reports concerning occipital AVMs,

haemorrhage was the reason for presentation in 46%[2] and 75%[3] of patients. In our series more than half of them presented due to haemorrhage.

All patients in our series had surface lesions of SM grade II, III, and IV, and hence amenable to microsurgical excision. Most of these patients were young with no co-morbidities and were able to tolerate surgery well. The annual haemorrhage rate of 2 to 4 % of AVMs combined with a mortality rate of about 10% warrants microsurgical excision of the AVMs especially in young age group and in lower grade AVMs[10]. In addition to hemorrhagic risk, patients with occipital AVMs are at significant risk of developing debilitating visual disturbances after treatment. Hence other modalities of treatment like embolization and radiosurgery should also be considered either as standalone therapy or in combination with surgical excision.

Conclusion

The surgical treatment of an AVM is continually being updated. Surgery is considered to be the gold standard for treatment of low grade AVMs. In the wake of advent of newer modalities, extensive long term studies need to be carried out to prove the benefit of one modality over the other especially in the case of occipital AVMs affecting vision.

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2. Novel modification of FOUR score: Comparative analysis with GCS in poly trauma patients

Ashirwad Karigoudar, Thiruvalluvan A, Sudhakar Kasinathan

Abstract

Overview: *Head injuries are among the leading cause of morbidity and mortality across the world. Adequate, expeditious assessment and early intervention is of utmost importance for favorable outcome in patients with head injury. Glasgow Coma Scale (GCS) and Full Outline of UnResponsiveness (FOUR) score are the widely accepted tools to quickly assess the severity in head injury patients and prognosticate, albeit with limitations. The objective of this study was to test the adequacy of FOUR-P score, as an alternative tool, to assess the severity and prognosticate the patients with head injury in poly trauma patients.* ***Methods and Materials:*** *This was a comparative study, conducted on 100 patients of poly trauma admitted to the trauma ward of Madras Medical College, Chennai. For all these patients, FOUR, FOUR-P and GCS scores were calculated at the time of presentation and at first hour, sixth hour, 24th hour. The predictive value of FOUR-P score and its correlation with FOUR and GCS scores were studied.* ***Results:*** *A statistically significant assessment and prognostication could be made using FOUR-P score when compared to FOUR score and GCS. Also FOUR-P was able to furnish better details about the neurological status of poly trauma patients. Conclusion: As per the results, it can be concluded that the FOUR-P score can be applied as an ideal tool for initial evaluation and prognostication in patients with poly trauma. It can be used as the ideal replacement for FOUR score and GCS. Further studies are needed.*

Key words: FOUR score, FOUR-P score, GCS, Head injury, Poly trauma

Introduction

Traumatic brain injury (TBI) is one of the serious causes of mortality and disability worldwide[1]. In India, it is estimated that nearly one million people get injured, 200,000 people die and another one million require rehabilitation services every year due to TBI[2]. GCS score is being widely used to assess patients with head injury across the world. With no serious challenges raised in the last 15 years, it has certainly withstood the test of time. It was in 2005 that Wijdicks and his associates published a new coma scale, the FOUR score[3]. FOUR score

appears to be an easier tool to use and it provides a more comprehensive neurological assessment[4].

Aims and Objectives

To evaluate the effectiveness of assessment of trauma patients by addition of associated other injuries to the FOUR score in the form of P, making it a FOUR-P score. To assess if FOUR- P score is comparable to and has an advantage over FOUR score and GCS

Study Design

It is a prospective study with a sample size of 100, involving patients aged 14-70 years. All poly trauma patients with associated head injury were included in the study. Study population included TBI with poly trauma patients arriving at Madras Medical College trauma ward. Patients with non-traumatic insults to the brain, alcoholics and pediatric population were excluded from the study.

On admission, patients were managed according to the Advanced Trauma Life Support (ATLS) protocol, later the detailed history was noted and data collected using a proforma. At the time of admission, the patients were assessed and their GCS, FOUR and Four P scores were charted. This was done by the same person to reduce observer variation and a standard scheme of testing was followed.

FOUR and FOUR-P score and GCS were calculated at the time of presentation and at first, sixth and 24th hours. The level of statistical significance was set at $p < 0.05$. Data was statistically analyzed by applying Pearson coefficient correlation.

P in FOUR-P score stands for poly trauma which includes other associated injuries which are graded from 0-4 based on the severity.

After admission, X-rays, CT brain and USG were done as per requirement. Appropriate treatment protocols were followed during the study.

Surgical management or conservative treatment options were considered based on patients' clinical and radiological findings. Adequate ventilator support, neuro-critical care and appropriate management of other associated injuries were done after taking opinion from concerned specialists.

FOUR –P scoring system

Component Tested	Score
Eye Response	
Eye lids open or opened, tracking or blinking to command	4
Eye lids open but not tracking	3
Eye lids closed but open to loud voice	2
Eye lids closed but open to pain	1
Eye lids remain closed to pain	0
Motor Response	
Thumbs up or fist or peace sign	4
Localizing to pain	3
Flexion response to pain	2
Extension response to pain	1
No response or generalized myoclonus status	0
Brainstem Reflexes	
Pupil and corneal reflexes present	4
One pupil wide and fixed	3
Pupil or corneal reflexes absent	2
Pupil and corneal reflexes absent	1
Absent pupil, corneal and cough reflex	0
Respiration	
Not intubated regular breathing patterns	4
Not intubated Cheyne-stokes breathing pattern	3
Not intubated, irregular breathing	2
Breathes above ventilator rate	1
Breathes at ventilator rate or apnea	0
Poly-trauma	
No associated injuries	4
All injuries requiring conservative treatment	3
Extremity injuries requiring intervention or thoracic injuries requiring ICD insertion without hypotension	2
Abdomen, thoracic or vascular injuries leading to hypotension	1
Patient on inotropes at admission	0

Results

The collected data was analyzed with IBM.SPSS statistics software 23.0 version. Frequency analysis was used to describe descriptive statistics, percentage analysis was used for categorical variables and the mean and standard deviation were used for continuous variables. Pearson's Correlation was used to assess the relationship between the variables. To predict the agreement of comparability between the tools the Bland Altman plot was used. In all the above statistical tools the probability value 0.05 is considered as significant level.

Correlations		
		GCS AD
FS A	Pearson Correlation	.980**
	Sig. (2-tailed)	0.001
	N	100
FSP A	Pearson Correlation	.964**
	Sig. (2-tailed)	0.001
	N	100
**. Correlation is significant at the 0.01		

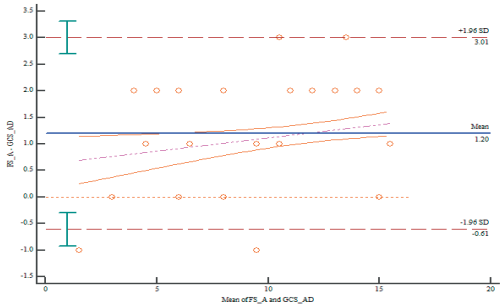
Correlations		
		GCS 1ST
FS 1	Pearson Correlation	.974**
	Sig. (2-tailed)	0.001
	N	100
FSP 1	Pearson Correlation	.958**
	Sig. (2-tailed)	0.001
	N	100
**. Correlation is significant at the 0.01		

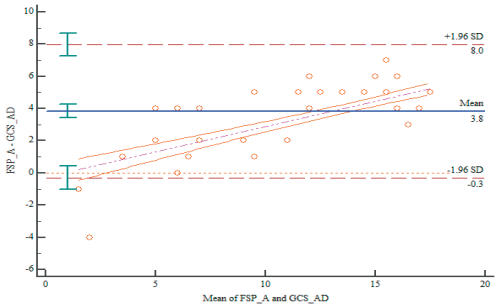
Correlations		
		GCS 6TH
FS 6	Pearson Correlation	.988**
	Sig. (2-tailed)	0.001
	N	100
FSP 6	Pearson Correlation	.980**
	Sig. (2-tailed)	0.001
	N	100
**. Correlation is significant at the 0.01		

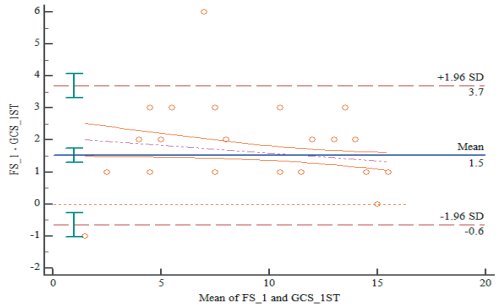
Correlations		
		GCS
FS 24	Pearson Correlation	.989**
	Sig. (2-tailed)	0.001
	N	100
FSP 24	Pearson Correlation	.983**
	Sig. (2-tailed)	0.001
	N	100
**. Correlation is significant at the 0.01		

The Bland-Altman plot (Bland & Altman, 1986 and 1999), or difference plot, is a graphical method to compare two measurement techniques. In this graphical method the differences (or alternatively the ratios) between the two techniques are plotted against the averages of the two techniques.

The presentation of the 95% limits of agreement is for visual judgment of how well two methods of measurement agree. The smaller the range between these two limits the better the agreement is.


+1.96 SD
3.01
Mean
1.20
-1.96 SD
-0.61
FS_A - GCS_AD
Mean of FS_A and GCS_AD


+1.96 SD
8.0
Mean
3.8
-1.96 SD
-0.3
FSP_A - GCS_AD
Mean of FSP_A and GCS_AD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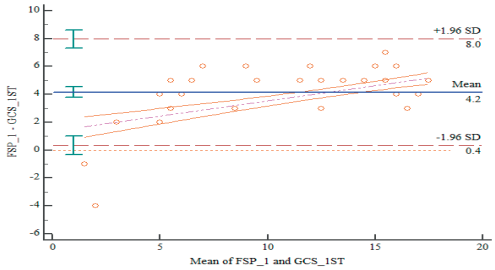
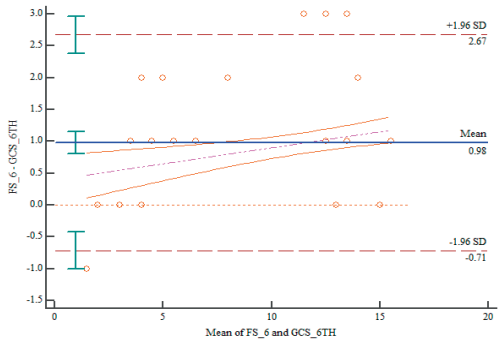
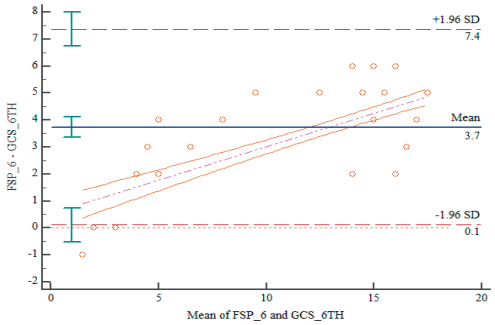
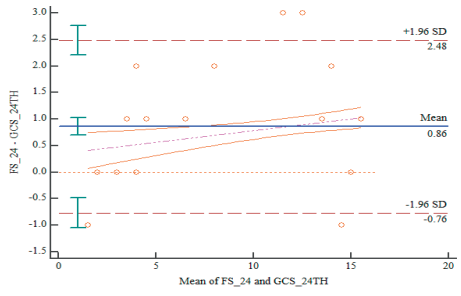
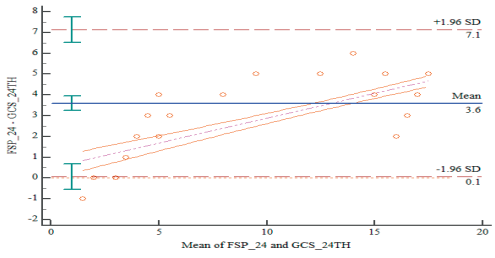
Mean
1.5
-1.96 SD
-0.6
FS_1 - GCS_1ST
Mean of FS_1 and GCS_1ST


+1.96 SD
8.0
Mean
4.2
-1.96 SD
0.4
FSP_1 - GCS_1ST
Mean of FSP_1 and GCS_1ST


+1.96 SD
2.67
Mean
0.98
-1.96 SD
-0.71
FS_6 - GCS_6TH
Mean of FS_6 and GCS_6TH


+1.96 SD
7.4
Mean
3.7
-1.96 SD
0.1
FSP_6 - GCS_6TH
Mean of FSP_6 and GCS_6TH


+1.96 SD
2.48
Mean
0.86
-1.96 SD
-0.76
FS_24 - GCS_24TH
Mean of FS_24 and GCS_24TH


+1.96 SD
7.1
Mean
3.6
-1.96 SD
0.1
FSP_24 - GCS_24TH
Mean of FSP_24 and GCS_24TH

Discussion

GCS and FOUR score are already established scoring systems to assess the level of consciousness in TBI patients5. Several studies have showed FOUR score to be more comprehensive than GCS in assessing TBI patients. We sensed the importance of adequate management of associated systemic and general injuries in TBI patients. This was a descriptive study undertaken to find whether FOUR-P score can be an effective tool in assessing head injury patients with associated polytrauma.

Most common age group was 20-50 years and mode of injury in most cases was motor vehicle accidents. Most common associated injuries were lung and thorax injuries followed by abdominal and long bone injuries. The FOUR score hovered around the maximum of 16 in many of the studied patients and so was corresponding FOUR-P score to 20. When the GCS score improved over a period of time, a similar improvement in FOUR score was also noted but FOUR-P score varied depending upon the associated injuries. It was quite evident that the FOUR score could furnish out more details about the neurological status of the patients.

Our results concurred with the findings from similar studies which compared FOUR score with GCS. A research conducted in 2014 on head injury patients, revealed that FOUR score is an applicable tool with high predictive power of outcomes at the time of discharge in patients with TBI6. The authors suggested that FOUR score could be used in the first 24 hours of admission of patients with TBI. By including associated injuries along with FOUR score it was easy to categorize the patients and prioritize the treatment plans.

The Pearson correlation coefficient between FOUR, FOUR-P and GCS scores were calculated to be (0.980 & 0.964), (0.974 & 0.958), (0.988 & 0.980) and (0.989 & 0.983) respectively at the time of presentation, after 1 hour and after 6 hours and at 24 hours. As derived from the graphs, there is excellent correlation between the two. In all cases the p values were calculated to be less than 0.05, which shows that the correlation is not due to chance, but is of statistical significance.

As per the results of our study, FOUR and FOUR-P scores show comparable results with GCS in the assessment of patients with Traumatic Brain Injury, with added advantage of including polytrauma patients in FOUR-P score. There is excellent statistical correlation between the scoring systems. Additionally, FOUR score furnishes better details regarding the neurological status of the patient, so does the FOUR-P score by being more comprehensive in giving information about associated injuries

Study Limitations

Sample size was small. Associated facial injuries which are common have not been categorized in the score. Patients with extremes of age excluded from the study. Study was of short duration. Study did not include treatment protocols.

Conclusion

The FOUR-P score can be applied as an effective reference to evaluate consciousness status and associated injuries in management of TBI with polytrauma patients. It can be a good guide for the clinician in detecting and stratifying patients with TBI with polytrauma in trauma ward.

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3. Analysis of Neurologic Outcome in Cervical Spine Injuries

Devanand Senthil Kumar S, Bharanidharan

Abstract

Background: *Traumatic spinal cord injury is one of the leading causes of morbidity, mortality and permanent disability. Cervical Spine Injuries account for 50% of all spinal cord injuries and occurs in 2-6% of all adult trauma patients. While prevention on the whole is not possible, minimizing or prevention of secondary injuries can have significant effect on outcome. Goal of treatment is to stabilize the spine and decompress when necessary in order to promote optimal environment for recovery. Aim: The purpose of this study was to describe the clinical presentation, functional recovery and outcome of patients with cervical spine injuries in a tertiary care center.* ***Settings & Design:*** *The present study was conducted at Institute of Neurosurgery, MMC & RGGGH, Chennai for a period of 2 ½ years from Nov 2015 to June 2018. This was a prospective analytical study involving 162 patients with cervical spine injuries.* ***Materials & Methods:*** *Patients above 12 years of age admitted in trauma ward of RGGGH were included in the study. Patients were evaluated in terms of mode of injury, time interval between injury and surgical intervention, vertebral levels involved, neurological status on admission and at the time of discharge and also at three months of follow-up. The neurological disability was graded using the American Spinal Injury Association Scale. The institution based nature of this study may limit the scope of the results.* ***Statistical Analysis:*** *The data was analyzed using IBM-SPSS (Version 17.0). There was statistically significant association between time of presentation (p=0.001), neurological status at presentation (p=0.001) and outcome. Operated cases have better outcome and lower mortality (10%) than conservatively managed (mortality=30.64%).* ***Interpretation and Conclusion:*** *Our data suggest that early presentation of cervical spine injury patients to tertiary centers followed by early intervention results in improvement of neurologic status in significant number of patients. Neurologic status at the time of presentation is an important predictor of outcome. There is an urgent need to strengthen pre-hospital care and promote early transportation of cervical spine injury patients to tertiary care centers. This will go a long way in improving neurological outcome in such patients.*

Key words: Cervical Spine Injury, Spine injury outcome, Traumatic spinal cord injury

Introduction

Spinal trauma is one of the leading causes of morbidity, mortality and permanent disability. Cervical spine remains the most common level for spinal cord injury (SCI), representing 55% of all SCIs[1]. Indeed, it is a fact that all patients who have had significant trauma should be suspected of having a cervical spine injury.

Cervical spine is injured in 2.4% of blunt trauma victims[2]. The annual incidence rate is 64/100,000 with two peaks, one in the second and third decade of the male population and another in elderly females[3]. Risk of cervical spine injuries increases with age and male gender, and mortality may reach 20% in elderly population[4].

Improvements in trauma protocols, pre hospital support and transport, surgical management and spinal rehabilitation have resulted in improving outcomes after cervical spine trauma.

While prevention of injuries on the whole is not feasible, minimizing or prevention of secondary injury can have a significant effect on the outcome of cervical spine injuries. To achieve this end, a systematic protocol for the management of a multiply injured patient, early diagnosis of spine injury, preservation of spinal cord, restoration of spinal alignment and stability are absolutely essential.

With recent advances in cervical spine instrumentation and surgical techniques, surgery is now commonly advised. Conservative treatment may lead to post traumatic instability and chronic pain which can be a constant source of disability[5].

In this study, we have endeavored to study the clinical presentation and functional outcomes in patients with cervical spine injuries in a tertiary care centre.

Aim of the Study

The purpose of this study was to describe the epidemiological factors, clinical presentation, functional recovery and outcome of patients with cervical spine injuries in a tertiary care center.

Material and Methods

This study was carried out at The Institute of Neurosurgery, Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai, India for a period of two and a half years from November 2015 to June 2018.

This study is a prospective analytical study involving 162 patients with cervical spine injuries which account for about 30% of spine injuries. The total number of trauma cases admitted per year is around 18000 at an average of 50 cases per day with spine injuries accounting for about 5%.

All patients above 12 years of age with radiologically proven cervical spine injuries were included. Patients below 12 years of age, patients with other associated injuries (Poly trauma, Head injury, Solid organ injury, Long bone fractures), patients who were lost to follow-up and those with previous cervical spine surgery were excluded from the study.

Patients were evaluated in terms of mode of injury, type of injury, time of presentation, vertebral levels involved, neurological status on admission, at the time of discharge and also at three months of follow-up.

All patients were initially stabilized according to ATLS protocol. After stabilization of the patient, detailed history was obtained and complete neurologic examination was done. The neurological disability was graded using the American Spinal Injury Association Scale.

American Spinal Injury Association Scale		
A	Complete	No sensory or motor function is preserved in sacral segments. S4-S5
B	Incomplete	Sensory but not motor function is preserved below the neurological level and extends through sacral segments S4-S5
C	Incomplete	Motor function is preserved below the neurologic level, and most key muscles below the neurologic level have a muscle grade of less than 3
D	Incomplete	Motor function is preserved below the neurologic level, and most key muscles below the neurologic level have a muscle grade that is greater than or equal to 3
E	Normal	Sensory and motor functions are normal

Based on the time of presentation at our hospital, the patients were divided into two groups, namely: Early presentation – Those who presented within 24 hours of injury and Late presentation – Those who presented after 24 hours of injury.

The management was either surgical or conservative. Surgical options included anterior cervical discectomy and fusion or vertebral corpectomy with fusion with titanium implants. Conservative management by immobilization with cervical orthoses was done for stable cervical injuries with no neurological deficits.

The functional recovery was assessed after 3 months of discharge. Both early and late presentation groups were assessed in terms of neurologic deficit at presentation, namely complete injury (ASIA–A), incomplete injury (ASIA- B, C, D), and no neurologic deficit (ASIA-E). The above assessment was done for both operated and conservatively managed patients. The functional recovery was assessed based on the progression of neurological state in the ASIA scale. The data was collated and analyzed using IBM-SPSS (Version 17.0). Statistical significance was set at $P<0.05$ and > 2SD for all analyses. The Chi-square test was used to assess the relationship between neurologic outcome and other parameters under study.

Results and Discussion

Cervical spine fractures are the most common fractures of spine and most often associated with underlying spinal cord injury.

Majority of the patients were young to middle aged adults (Figure-1). Our study showed the age group 21 to 40 years to be most susceptible to cervical spine injuries as it constitutes the active period of everyone's lives. In other studies the mean age of patients with SCI varied from 30.9 - 38.9 years[6,14].

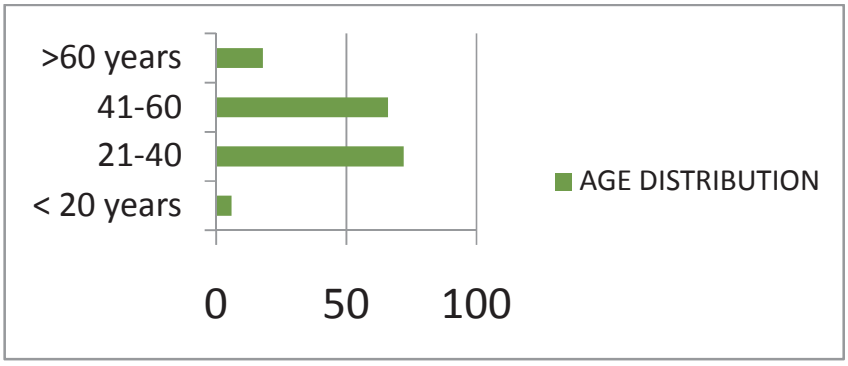

Figure-1

92.6% (150) of patients were males, whereas 7.4% (12) were females (Figure-2). Males were found more prone to cervical spine injuries as reported from India and also other developing countries[7]. In our study, Male: Female ratio was 12.5:1.This highlights devastating

effect of spinal cord injuries on economy due to loss of productivity following disability/death of the young productive sector of population(males< 40 years).

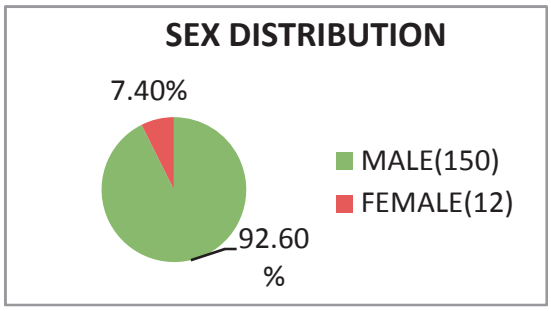

Figure-2

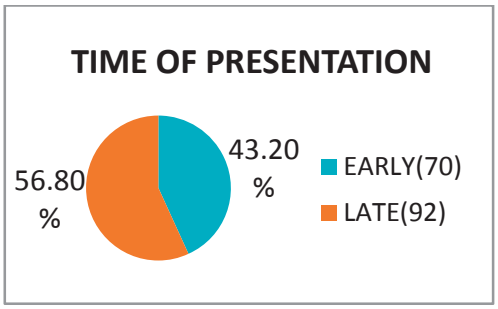

Figure-3

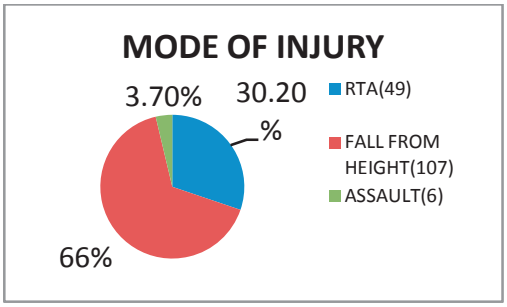

Figure-4

Only 43.2% (70) of patients presented early (< 24 hours) highlighting the need for early referral (Figure-3). Fall from height was the predominant mode of injury accounting for 66% (107) of the cases followed by RTA and assault (Figure-4). In some studies RTA was most common[8,9,10].

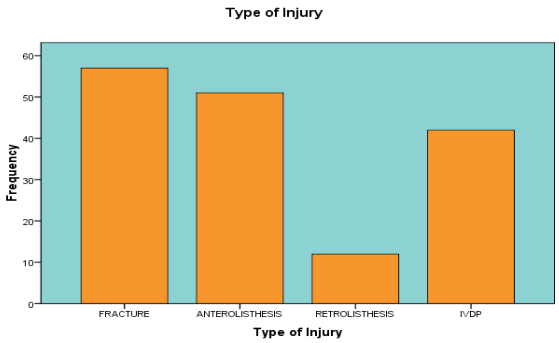

Figure-5

Fracture was the predominant type of injury accounting for 35.2% (57) of cases followed by anterior subluxation (51), IVDP (42), retrolisthesis (12) (Figure-5).

In our study, C5-C6 vertebral motion segment was the predominant motion segment involved in each mode of injury (Table-1)**.** In another study, which is the largest multi-center trial to date, overall the most common site of injury was the atlanto-axial region, with the most commonly injured levels in the subaxial cervical spine being C6 and C7[11].

Vertical Motion Segment Involved			
	Fall	**RTA**	**Assault**
C1-C2	5.80%	7.20%	
C2-C3	11.80%	13.30%	
C3-C4	20.60%	13.30%	
C4-C5	14.70%	13%	5%
C5-C6	25.6%%	33.30%	50%
C6-C7	21.50%	19.90%	45%

Table-1: shows vertebral motion segments involved in each mode of injury

In both early and late presenting cases incomplete injuries were predominant 72.8% (n=118) (Figure-6). In our study, out of 162 patients, 100 patients (61.7%) were operated and 62 patients (38.3%) were managed conservatively (Figure-7).

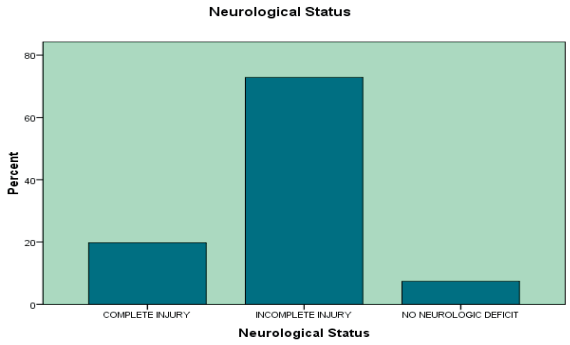

Figure-6

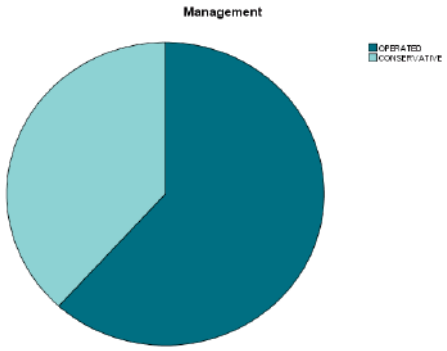

Figure-7

55.7% of patients who presented early showed improved outcome (p=0.001) whereas only 30.7% of patients who presented late showed improved outcome (Figure-8). Neurologic status of the patient at the time of presentation is a statistically significant predictor of outcome (Table-2). 46.6% of patients with incomplete cord injury showed improved outcome

when compared to only 18.8% of patients with complete cord injury (p=0.001). Also the mortality rates were much higher in complete cord injury (53.1%) compared to incomplete injury (10.2%). Majority of patients who were operated showed improved outcome (57%) whereas in majority of conservatively managed patients outcome was static (p=0.000) (Figure-9).

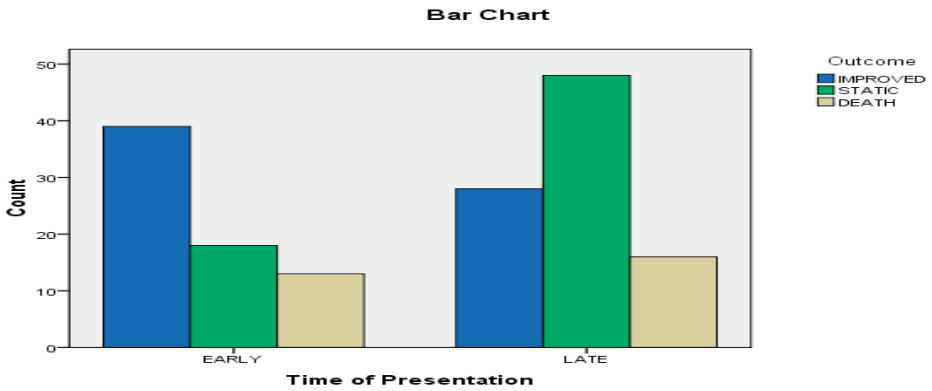

*Figure-8 (Time of presentation * Neurologic Outcome)*

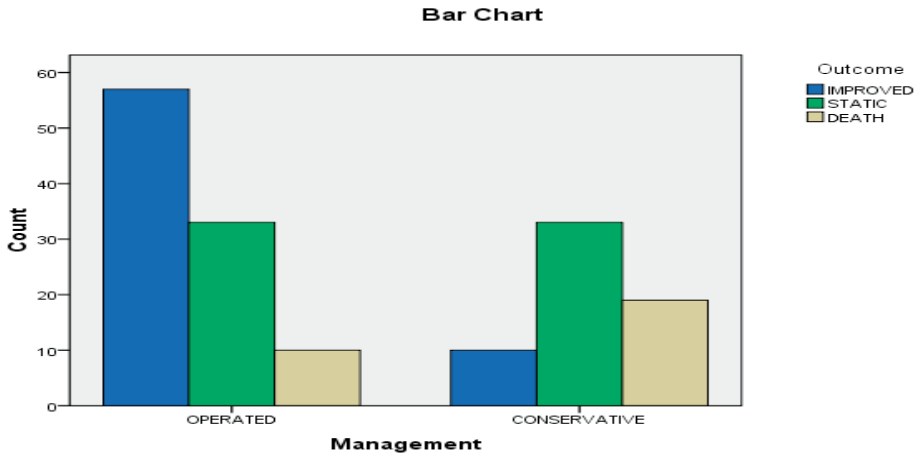

*Figure-9 (Management * Outcome)*

		Outcome				
		Improved	Static	Death	Total	P-Value
Neurological Status	Complete	6	9	17	32	0
	Incomplete	55	51	12	118	0.001
	No Deficit	6	6	0	12	0.001
		67	66	29	162	

*Table-2: Neurologic status at the time of presentation * Outcome*

Regardless of treatment modality, any delay in treatment can leave the patient with lifelong morbidity and mortality in some. Timely surgical decompression of the cord may lead to neurological improvement. Even a single grade neurological improvement can save patient from lifelong disability[12].

In the present study we found mortality rate of 17.9% (n=29). Chen et al. reported a mortality of 10.1%[13]. Only few studies have been published from India on trauma related mortality and none on mortality profile of patients with spinal injuries.

Respiratory failure was the leading cause of mortality. Our mortality was higher because we included only cervical injuries and majority of them presented late.

Limitations

This is a single institution study which may limit the scope of the results. Functional recovery was assessed only at 3 months after discharge. Neurologic status may continue to improve well beyond this time. Long term follow up data were not available. Timing of surgery as a factor improving neurologic outcome could not be studied as early surgery group is very small.

Conclusion

Our data suggest that early presentation of cervical spine injury patients to tertiary centers followed by early intervention results in improvement of neurologic status in significant number of patients. Neurologic status at the time of presentation is an important predictor of outcome. There is an urgent need to strengthen pre-hospital care and promote early transportation of cervical spine injury patients to tertiary care centers. All centers dealing with trauma patients in small towns and districts should be primed about the need for early referral of spinal injury patients to tertiary care hospitals where definitive management can be done. This will go a long way in improving neurological outcome in such patients. This will lessen the morbidity and economic burden of the family and the nation as a whole.

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4. Utility of Corticobulbar Facial Nerve Motor Evoked Potential in Vestibular Schwannoma Surgery

Anand Govindaraj, Nishanth Sampath, Agnes Philomina, Suresh Bapu K R

Abstract

In vestibular schwannoma surgeries, we have been using conventional neuro-monitoring techniques like raw EMG and triggered EMG and it has improved the surgical outcome to a certain extent. To monitor the entire facial motor pathway, we established a novel technique called corticobulbar MEP (CBMEP). In this paper, we retrospectively analyzed and compared the facial nerve outcome of 81 vestibular schwannoma surgeries between conventional neuromonitoring (raw EMG and triggered EMG monitoring) and corticobulbar MEP inclusive neuromonitoring. The facial nerve outcome was divided into Excellent, Good, Satisfactory, Poor and Worst categories based on the House-Brackmann grade compared between day 1 after surgery and a year later. The group of cases that included CBMEP monitoring had better outcome when compared to the group done without CBMEP monitoring. The percentage of "Excellent" category cases under CBMEP monitoring group was higher (73%) compared to the conventional monitoring group (67.3%). Similarly, "Good" outcome cases in CBMEP monitoring group was slightly higher (7.7%) than non-CBMEP monitored cases (7.3%). No "Poor" and "Worst" outcomes were recorded when CBMEP was monitored. Thus, our preliminary observation is that the addition of CBMEP to conventional neuromonitoring armamentarium has proved to be a valuable adjunct in improving the outcome of vestibular schwannoma surgeries.

Introduction

In Institutional studies, CP angle tumors account for about 5-10 % of intracranial tumors out of which 85 % are vestibular schwannomas [(1)]. Facial nerve preservation has been one of the key aspects of CP angle tumor surgery. Facial nerve has 4 parts: 1) intra-axial part from Facial Nucleus to Root Exit Zone 2) Cisternal part from REZ to IAC fundus 3) intra-temporal part and 4) extracranial part. Major function of the Facial nerve is motor innervation to the muscles of the face. The extracranial part has 5 terminal branches: 1) temporal 2) zygomatic 3) buccal 4) mandibular & 5) cervical. Thus, muscle sampling is done such that at least 1 muscle is sampled from each of the branches. Other functions of Facial Nerve namely general sensation to small part of the ear, taste sensation to anterior two thirds of the tongue,

motor parasympathetic innervations of the salivary, lacrimal and nasal glands and nerve to stapedius are not monitored during CP angle surgery.

Triggered EMG and raw EMG monitoring have shown to improve the surgical outcome of CP angle tumor surgeries. However, in cases where the proximal end of the facial nerve is inaccessible, triggered EMG monitoring becomes less efficient, especially prior to identification of facial nerve during tumor resection. Monitoring neurotonic discharges also has limitation since even slightest maneuver of the facial nerve produces instant firing of neurotonic discharges in raw EMG thereby rendering unreliable predictions of facial nerve injury. At times, even complete transection of nerve shows no discharges in the facial nerve innervated muscles. Intraoperative continuous facial nerve monitoring (ICFN) is also a valuable tool to monitor the facial nerve during CP angle surgeries wherein a ball type stimulating electrode and continuous direct electrical current is stimulated on root entry zone of the nerve [(2)]. Unfortunately, this method cannot be done for all CP angle surgeries since for many large tumors the root entry zone cannot be exposed. After the advent of motor evoked potential (MEP) monitoring to monitor the descending motor pathway, corticobulbar MEP (CBMEP)/facial MEP (fMEP) monitoring became possible. Controversies still exist that CBMEP monitoring is unreliable since many recordings showed false positives due to inadvertent excitation of peripheral facial nerve by current spread during MEP stimulation. In this paper, we will be sharing our preliminary experience of CBMEP monitoring and the impact it has had on the surgical outcome when used adjunct to the conventional raw EMG and triggered EMG monitoring.

Subjects and Methods

We retrospectively analyzed a total of 81 vestibular schwannoma cases from 2014 to 2018 who had underwent retro-sigmoid craniotomy and tumor excision under neuro-monitoring. Out of the 81 patients, CBMEP was done in 26 patients along with raw EMG and triggered EMG monitoring. In the rest 55 patients, only triggered EMG and raw EMG were monitored. The machine used for monitoring was either a Medtronic NIM version 3, 8 channel system or a Medtronic NIM Eclipse, 16 channel system with software version 4.2.422. The IONM machine used for surgery was dependent on the availability of the NIM Eclipse system, availability of experienced neurophysiologist and the need for monitoring fMEP in that surgery. Every patient for facial nerve monitoring undergoes preoperative assessment of House-Brackmann grading (HB 1-6). Bipolar EMG needle electrodes were used for recording muscle responses. The common muscles sampled for monitoring VII CN were ipsilateral frontalis, orbicularis oculi, zygomaticus, orbicularis oris and mentalis. For monitoring of V CN, ipsilateral masseter muscle was sampled. 10-20 system was used for electrode placement on the scalp. EEG cork screw electrodes were placed at Cz and Fz points to monitor the depth of anesthesia.

Similar cork screw electrodes were also used for fMEP stimulation. Contralateral hemispheric stimulation corresponding to face area on the scalp was done for fMEP. Two single needle electrodes were placed on the chest, one for ground and the other used as reference during monopolar triggered EMG stimulation. fMEP was checked quasi-continuously whereas EEG and raw EMG were monitored continuously. The alarm criteria used for fMEP was more than 50% drop from baseline. At the end of surgery, the proximal stimulation threshold of the nerve stimulated was tested using constant current monopolar stimulation to check the nerve continuity. The findings of fMEP recordings were correlated with immediate postop facial nerve assessment.

The timeframe considered for analysis are day one after surgery and one year later. Table 1 defines the facial nerve outcome categories. The patients who had HB 1-3 on day one and HB 1-2 at year one were categorized “Excellent”. Patients who had immediate post-op deficit of HB 4-6 on day one and improved to HB 1-2 at year one were categorized as “Good”, those who improved to HB 3 at year one as “Satisfactory”, patients who had mild improvement to HB 4-6 as “Poor”. Those who had HB 6 on day one and did not show any signs of improvement and had HB 6at year one as well were classified as “Worst”. A comparison was done between cases that were monitored under conventional method and CBMEP monitoring.

Results

The group of cases that included CBMEP monitoring (Fig 1) had better outcome when compared to the group done without CBMEP monitoring (Fig 2).The percentage of “Excellent” category cases under CBMEP monitoring group was higher (73%) compared to the conventional monitoring group (67.3%). Similarly, “Good” outcome cases in CBMEP monitoring group was higher (7.7%) than non-CBMEP monitored cases (7.3%). No “Poor” and “Worst” outcomes were recorded when CBMEP was monitored. Thus, CBMEP has proved to be a valuable tool and has improved the outcome of vestibular schwannoma surgeries, though the results did not reach statistical significance.

Discussion

We happened to come across an unusual scenario of a 54-year-old male with peripheral polycystic vestibular schwannoma with HB 1. The surgery was done under conventional technique where only raw EMG and triggered EMG were monitored using Medtronic NIM 3 system. Towards the end of the surgery, the nerve was stimulated at the root entry zone and responses were obtained at a low threshold of 0.1 mA thereby indicating intact facial nerve. But postoperatively the patient had severe facial nerve palsy and ended up with HB 6 and

postop scans showed possible insult at the brainstem. This motivated us to establish CBMEP in our institute. Triggered EMG monitoring is limited to the nerve structure distal to the brainstem. To monitor the entire facial motor pathway, CBMEP monitoring was required.

For all CP angle surgeries done under neuromonitoring, TIVA was used. To avoid bite injury during fMEP stimulation, a soft bite block was placed. Very short acting muscle relaxants like succinylcholine was given only during intubation. At all other stages of the surgery, no inhalational agents nor any muscle relaxants were used. To maintain the depth of anesthesia, propofol/fentanyl or propofol/ketamine infusion was used. EEG was monitored throughout the procedure and the anesthetist was informed of changes in the depth of anesthesia and appropriate corrective measures were taken. Communication with the anesthetist is key for neuromonitoring. Parameters like blood pressure, core body temperature etc. have a direct impact on MEP signal monitorability. Any change in anesthesia and its parameters were immediately informed to the neuromonitoring team and the events were noted in the neuromonitoring system.

EEG was continuously monitored throughout the surgery. The infusion rate of the anesthetic agents was altered such that EEG was not under burst suppression and the spectral edge frequency (SEF 90) was maintained around 20 Hz. SEF 95 is the frequency below which 95 percent of the total power of the EEG signal lies. Under higher doses of propofol, EEG becomes burst suppressed and fMEP becomes non-monitorable. EEG burst suppression pattern is also marker for low BP and hypothermia. Any slowing and significant change in EEG pattern was immediately informed to the anesthetist for corrective actions and noted in the neuromonitoring system.

Raw EMG monitoring has been one of the key tools in not only determining the proximity of the facial nerve during tumor excision but also ongoing facial nerve damage. Raw EMG monitoring acts as an online feedback system to the surgeon. Sudden onset of spontaneous discharges from facial nerve innervated muscles can be an indicator that the nerve is being handled by the surgeon. These discharges are called neurotonics. Neurotonic discharges are of several patterns and many of them do not possess any predictive value. Even a small disturbance like minor bipolar heat and drilling vibrations to the nerve can produce instantaneous neurotonic discharge. Such discharge potentials caused due to the disturbances were ignored and not alerted to the surgeon.

Neurotonic alerts were given to the surgeon only for the following patterns 1) spikes 2) burst and 3) train. Spike and burst pattern alerts indicate the presence of the facial nerve in close proximity and helps the surgeon to re-evaluate the ongoing surgical maneuver and

reassess his approach for further excision of tumor. Train discharges are spontaneous continuous discharges that last for several seconds. Train potentials are further classified into A Train, B Train and C Train out of which the occurrence of A train could be correlated with postoperative worsening of facial nerve status[3]. During the occurrence of train neurotonics, the corrective steps taken were 1) the surgeon stopped resection 2) warm saline was irrigated 3) time was given for the neurotonics to subside and 4) the procedure was resumed after it wears off.

Triggered EMG was done using a monopolar handheld stimulator. Constant current with a maximum threshold of 4 mA, 200 μs pulse duration and at the rate of 3 Hz were the stimulation parameters used. Triggered EMG was used for differentiation between the nerve and tumor and for searching of the nerve. A monopolar single needle electrode was placed on the chest which served as a reference. During searching of the nerve, the current thresholds were kept at a higher value (>1 mA). For dissection of tumor around the nerve, a significantly lower threshold (~0.1 mA) was used. Current thresholds as low as 0.01 mA can produce muscle response if stimulated directly on the nerve.

Triggered EMG can also be used to examine the integrity of the facial nerve by stimulating at the distal and proximal most points of the exposed nerve. Towards the end of the surgery, the proximal most end of the nerve was stimulated and checked for response at the lowest possible threshold. Response at thresholds of less than 0.2 mA indicates that the facial nerve is intact. Higher thresholds or absent response can indicate nerve injury. However, the proximal end of the nerve may not always be accessible such as in cases of large tumors. fMEP can overcome this shortcoming of triggered EMG. fMEP elicited by transcranial electrical stimulation was first reported by Merton and Morton in 1980[4].

fMEP was evoked using high frequency constant current multipulse train stimuli[5]. The first train of stimuli was to elicit fMEP and the next stimulus was a single pulse to rule out peripheral stimulation of facial nerve. Those recordings in which responses were obtained exclusively from the train stimuli and not from the single pulse were considered true fMEP. This stimulation protocol proved that the fMEP obtained was a true motor evoked potential and the responses obtained were not because of peripheral facial nerve activation due to current spread during fMEP stimulation. The sensitivity of fMEP can be explained using table 3 and figures 3,4,5 and 6. The status of fMEP at closure was compared with the facial nerve outcome. A higher percentage of facial nerve outcomes was “Good” and “Satisfactory” when the fMEP was >50% and <50% of baseline, respectively, at closure. Patients who had intact fMEP, the facial nerve outcome was mostly “Excellent” and some patients had “Good” outcome as well. In one case where the fMEP became flat, the facial nerve outcome was “Worst” and never improved

even after one year. Thus, there is a strong correlation between the facial nerve outcome and fMEP status at the end of surgery. The 50% cut off is an arbitrary value for alarm; Bhimrao et al[6] in their study found Final-to-baseline fMEP ratio of 60% or greater with satisfactory FN function. Akagami et al[7] considered 50% reduction in amplitude as an indicator for predicting facial nerve damage. Some authors (Hongmei Song et al[8], Bozinow[9]) propose increase in stimulus threshold – Delta FNMEP – of > 20mA for eliciting the FNMEP for predicting impaired facial nerve function.

Conclusion

Addition of CBMEP to conventional neuromonitoring armamentarium is found to be a valuable adjunct in improving the outcome of vestibular schwannoma surgeries. In large tumors where identification of facial nerve at REZ may be difficult and delayed, CBMEP is the only mode to ascertain the integrity of entire cisternal part of the facial nerve. Though a good response with direct stimulation of facial nerve at REZ with 0.2 mA threshold is strongly suggestive of nerve integrity, it will be false positive when there is an associated minor insult to the intrapontine part of the nerve. CBMEP is the only mode which can monitor the entire course of nerve.

Tables

Classification	HB Day one	HB year one
Excellent	HB 1-2 or HB 3	HB 1-2
Good	HB 4-6	HB 1-2
Satisfactory	HB 4-6	HB 3
Bad	HB 4-6	HB 4-5
Worst	HB 6	HB 6

Table 1: Classification of Facial nerve outcome

Facial nerve outcome		Tri EMG alone		TriEMG+CBMEP		P-value
		N=55	%	N=26	%	
Grading of facial nerve outcome	Excellent	37	67.3	19	73.1	0.824
	Good	4	7.3	2	7.7	
	Satisfactory	11	20.0	5	19.2	
	Poor	1	1.8	-	-	
	Worst	2	3.6	-	-	

Table 2: Facial nerve outcome comparison between conventional and CBMEP monitoring

CBMEP (Trig EMG with CBMEP)(N=19)		Flat		<50%		>50%		Same as baseline	
		N=1	%	N=6	%	N=3	%	N=9	%
Grading of Facial N Outcome	Excellent	-	-	1	16.7	1	33.3	5	55.6
	Good	-	-	-	-	2	66.7	4	44.4
	Satisfactory	-	-	5	83.3	-	-	-	-
	Poor	-	-	-	-	-	-	-	-
	Worst	1	100.0	-	-	-	-	-	-

Table 3: Facial nerve outcome compared with CBMEP at closure

Figures

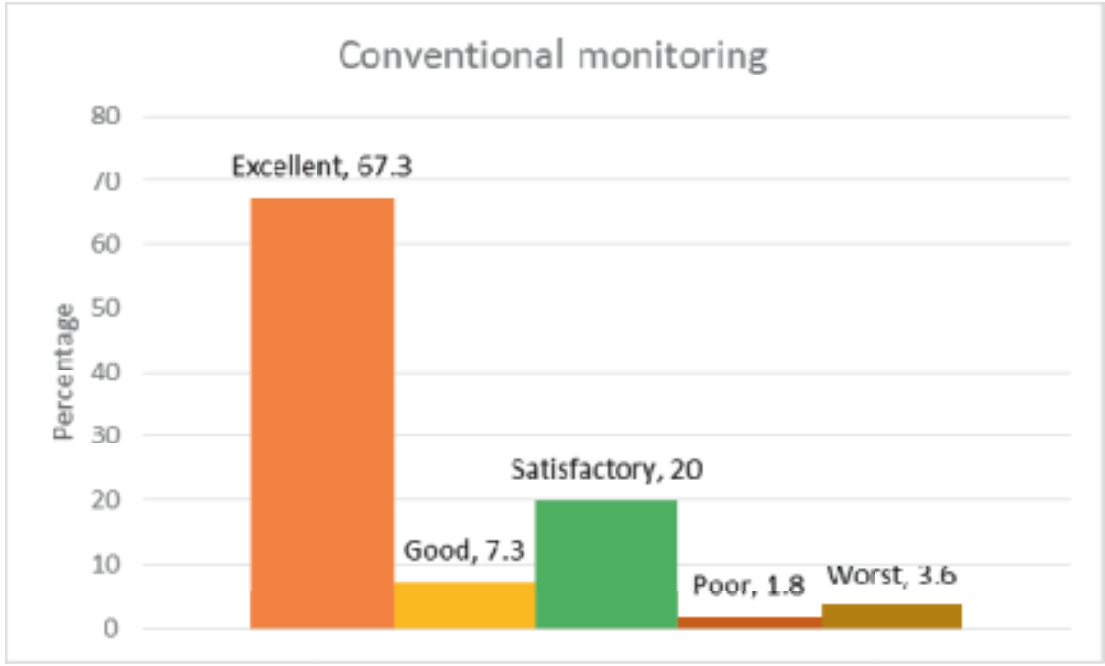

Figure 1: Facial nerve outcome with conventional triggered EMG and raw EMG monitoring

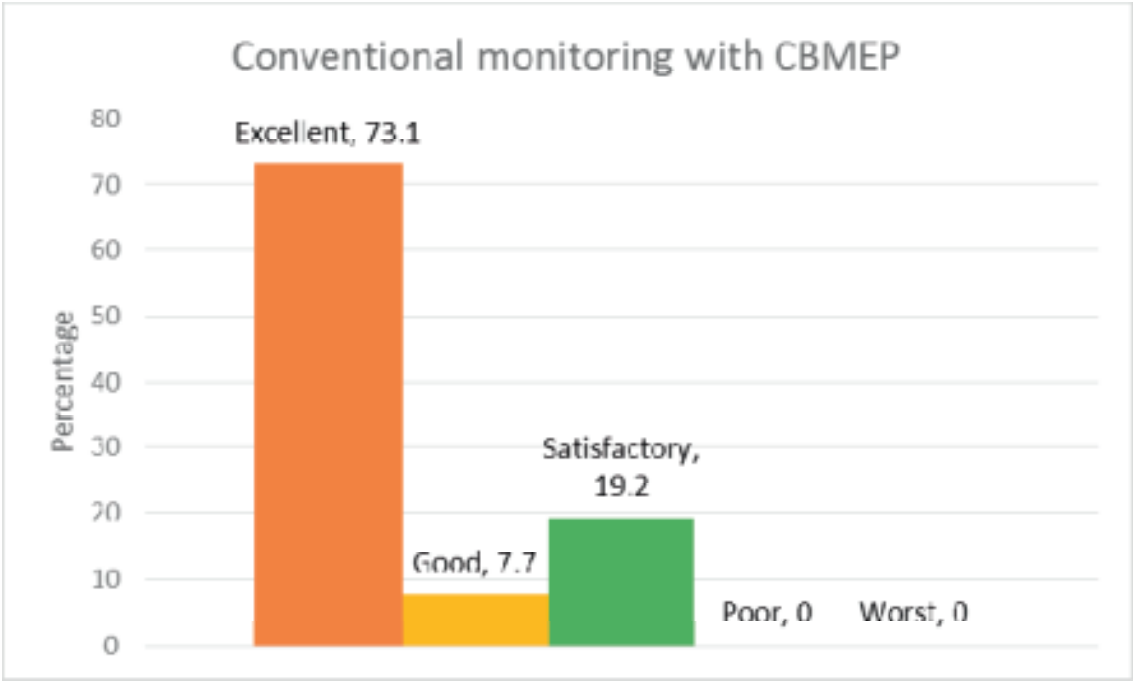

Figure 2: Facial nerve outcome with conventional triggered EMG, raw EMG and CBMEP monitoring

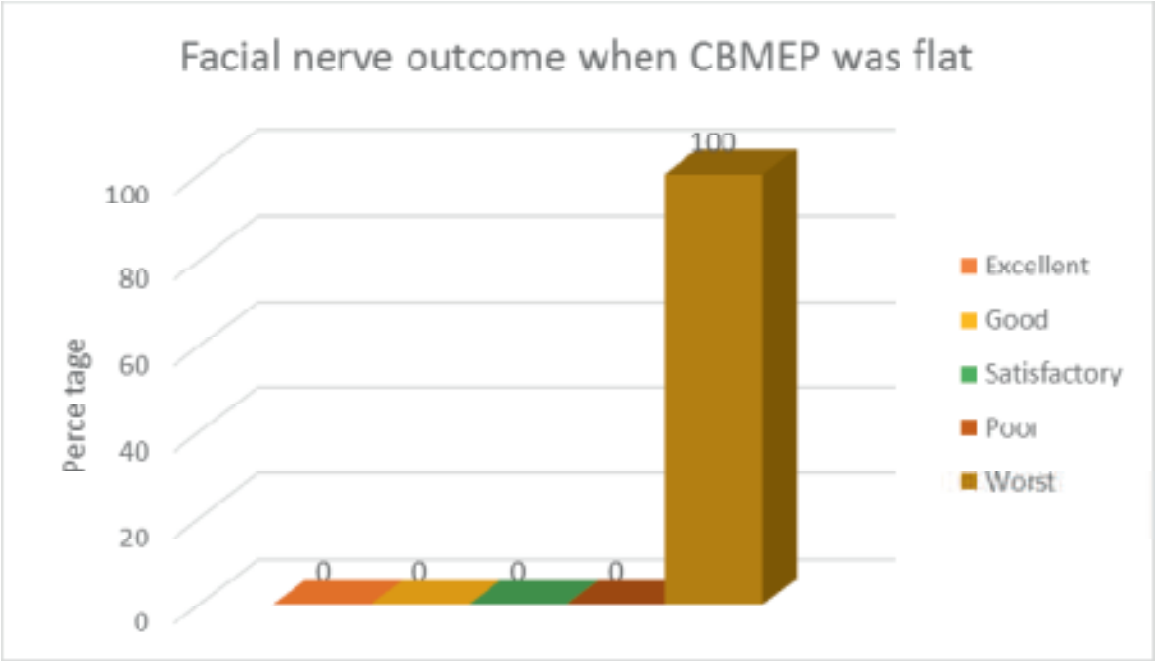

Figure 3: Facial nerve outcome when CBMEP was flat at closure

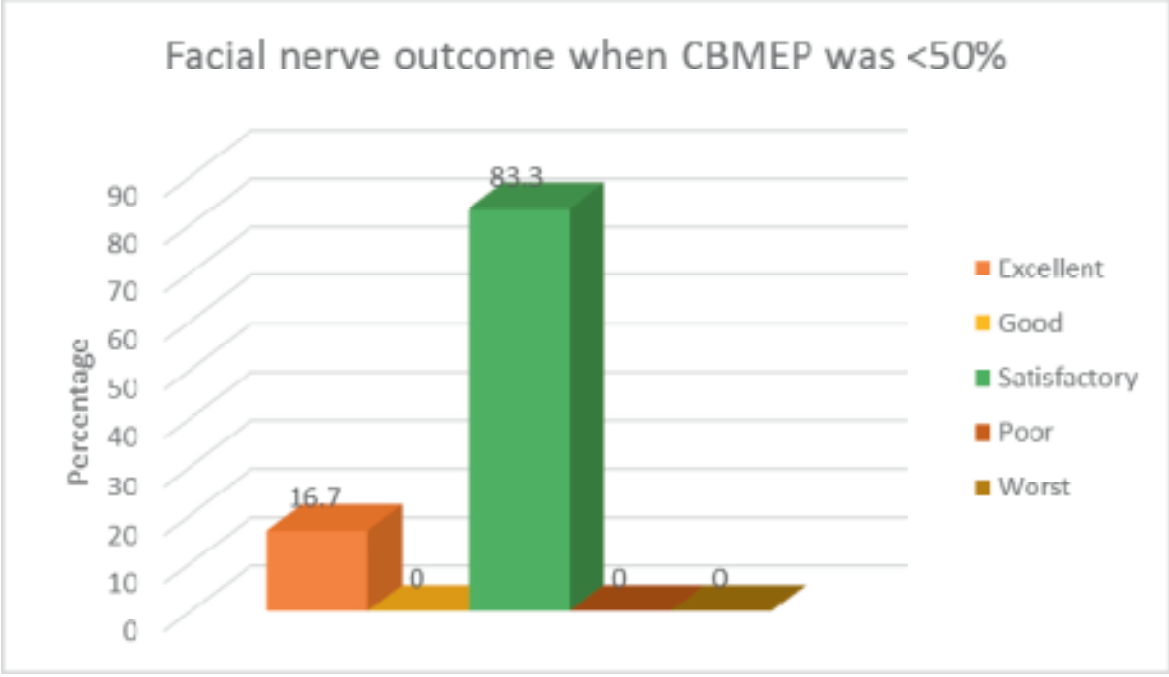

Figure 4: Facial nerve outcome when CBMEP was <50% as baseline at closure

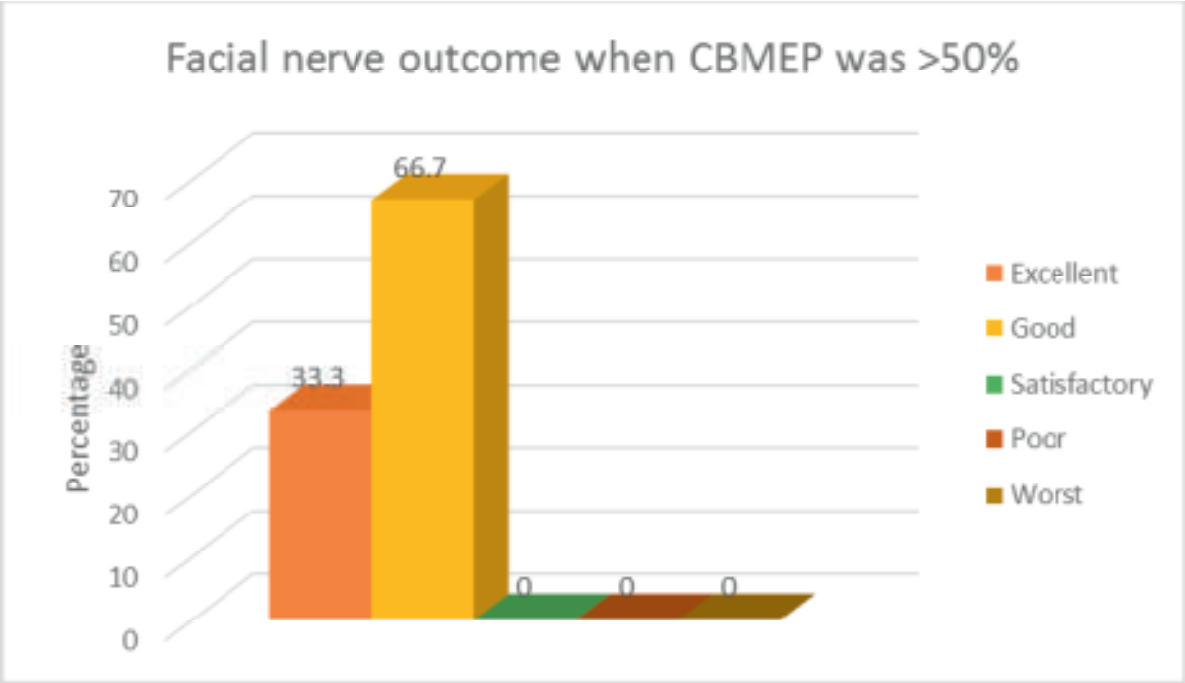

Figure 5: Facial nerve outcome when CBMEP was >50% as baseline at closure

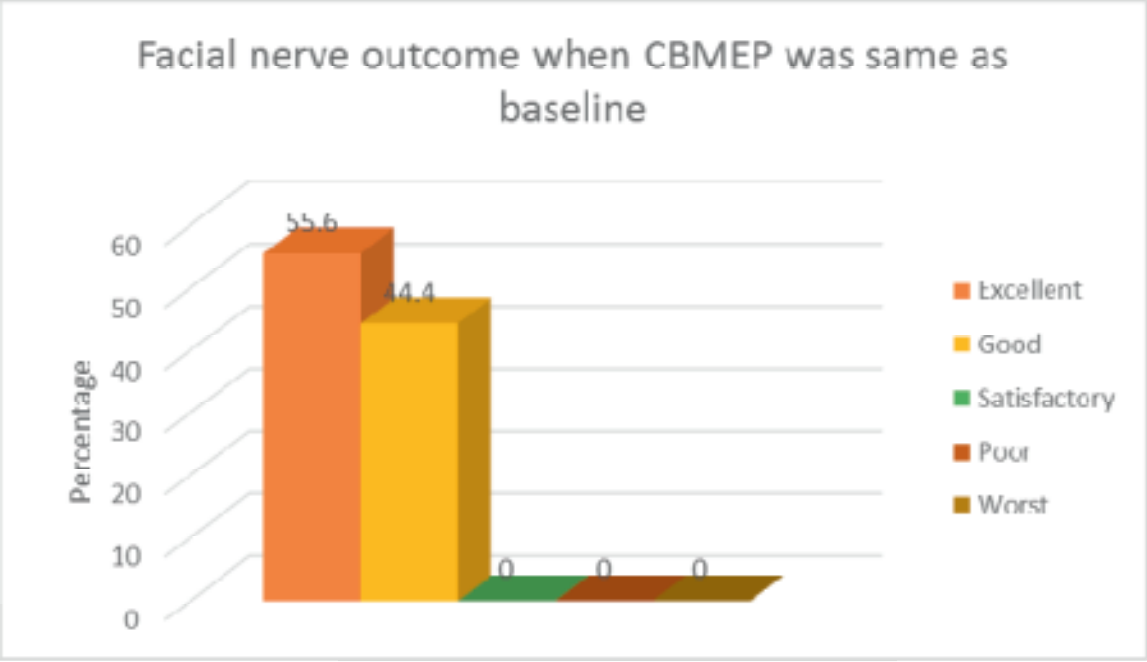

Figure 6: Facial nerve outcome when CBMEP was same as baseline at closure

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5. Experience with AVMs in a Peripheral Tertiary Care Centre

Ramasamy C

Abstract

Objectives: *Surgical management of arteriovenous malformations (AVMs) is challenging but plays a definite and time-tested role in its treatment. Due to non-availability of procedures like embolization, radiosurgery and limited resources in a peripheral set up, we rely on microsurgical management. We present a series of cases operated over a one year period and their follow-up.* ***Materials and Methods:*** *A total of 7 cases of AVMs managed in our medical college from August 2017 to August 2018 were analyzed. The diagnosis of AVM was confirmed by DSA (digital subtraction angiogram) and they underwent microsurgical excision.* ***Results:*** *There were 5 males and 2 female patients between the age groups of 38-60 years. Presentation included intracranial bleed in 5(71%), headache and seizures in 2(29%) patients. Four AVMs involved the right hemisphere and three involved the left hemisphere. Two cases involved frontal lobe, two involved temporal lobe, one parietal, one occipital and one multi-lobar with an associated aneurysm. On DSA five patients had less than 5cm nidus and two had more than 5cm. As per Spetzler and Martin: one was grade I, three were grade II and three were grade III. All the 7 patients underwent microsurgical excision and clipping as required. Complete surgical removal of the AVM was achieved as evidenced by follow up DSA in 6 patients, with significant symptomatic and clinical improvement. One patient deteriorated in the post operative period and follow up DSA was not done.* ***Conclusion:*** *The microsurgical excision of AVMs is fraught with challenges. However, if the patients are carefully selected, prepared and meticulous surgery is executed; it offers a single stage complete treatment with acceptable mortality and morbidity, especially in a resource crunched environment like ours.*

Key words: Arteriovenous malformations, AVMs in periphery Tertiary care centre

Introduction

Arteriovenous malformations (AVMs) are abnormalities of intracranial vessels that constitute a fistulous connection between the arterial and venous systems and that lack a normal intervening capillary bed. Typically, these lesions are triangular, with the base toward the meninges and the apex toward the ventricular system. AVMs appear as serpiginous isodense or slightly hyperdense vessels that strongly enhance following contrast administration

on computed tomographic scanning. Calcification is identified in 25 to 30% of cases. On magnetic resonance imaging (MRI), the typical AVM appears as a tightly packed “honeycomb” of flow voids on T1 and T2 weighted images, caused by high flow velocity signal loss. Phase contrast magnetic resonance angiography (MRA) can be useful in the depiction of flow, but complete definition of complex lesions and their internal angio-architecture requires a cerebral angiogram. On cerebral angiography, parenchymal AVMs appear as tightly packed masses of enlarged feeding arteries and dilated tortuous veins with little or no intervening parenchyma within the nidus. Arteriovenous shunting with abnormal early filling of veins that drain the lesion is characteristic of AVM.

AVMs are the most frequently detected symptomatic vascular malformation, accounting for 2% of all strokes and 38% of all intracerebral hemorrhages in patients between 15 and 45 years. AVMs are one seventh as common as aneurysms, and the prevalence has been estimated at 0.2% to 0.8% of the general population.

The treatment of arteriovenous malformations (AVMs) has undergone a wide change in the last two decades with the emergence of minimally invasive procedures of endovascular neuro-radiological treatment and the non-invasive method of treatment by radiosurgery. Despite this, the well-established surgical method of treatment constitutes the principal form of treatment. Whilst a small proportion of cases can be primarily treated by embolization alone, this mode of therapy has been seen as an adjunct to surgery. The long-term outcome of radiosurgery and its effects and effectiveness is yet to be assessed.

As the tertiary care center for neurosurgery covering 8 districts in the southern delta region, with a catchment area comprised with a population of 42 lakh people, this study is being undertaken with the goal of providing epidemiological and clinical data on the presentation and management of arteriovenous malformations in an emergency situation in our hospital.

Due to time and financial constraints, surgery plays a vital role in the treatment of these AVMs in the absence of endovascular intervention procedures in centers like ours. Surgical resection of AVMs is a time proven method for cure from the pathology of AVM. Apart from technical skills necessary to surgically treat AVMs, experience in treating these cases is crucially important.

Methods

The patients who were referred or admitted to Thanjavur medical college hospital from August 2017 to August 2018 were included in the study. The data were obtained from review of

medical records and imaging studies were available. The information included demographic characteristics, presentation, involved lobe, angiographic characteristics and nidus size, Spetzler-Martin grade, the surgical outcomes, complications and death. Modified Rankin score (mRS) was used to assess new neurological outcomes due to treatment and was recorded as follows: mRS score of 1 (minor deficits not interfering with lifestyle), mRS score of 2 (minor disability but capable of self-care in all aspects of life), mRS score of 3 (moderate disability requiring some help with self-care), mRS score of 4 (moderately severe disability preventing independence but not requiring constant attention) and mRS score of 5 (severe disability requiring constant attention). Outcome was measured according to downgrade of neurological function due to surgery. Downgrade was defined as new permanent neurological deficit after surgery. Significant morbidity was defined as a decrease in mRS score >1 from baseline. Spetzler-Martin grade was based on an aggregate on the basis of lesion size, location in eloquent area and pattern of venous drainage. One point was assigned to small (<3 cm) AVM, one point each for adjacent to eloquent brain and deep venous drainage. Grade VI referred to extremely large and diffuse AVM, dispersed through critical area.

Results

There were 7 patients admitted or referred to the hospital from August 2017 to August 2018 with an admitting impression of AVM. The mean age of patients was 42.8 years, with a range of 38 to 60 years. There was a male predominance (5, 65%) compared to females (2, 35%). The mean length of hospital stay was 25.2 days (range of 7 to 59 days).

Clinical presentation:

The presenting symptoms are listed in Table 1. As shown, majority of patients presented with headache (42.8%). The second most frequent presentation was seizure (28.6%). Uncommon presenting signs included focal weakness, dizziness and loss of consciousness. The average duration of symptoms was 2-3 months. No patient had a family history of AVM.

Clinical Presentation	No. of Patients
Headache	3
Seizure	2
Focal Weakness	1
Loss Of Consciousness	1

Incidence of hemorrhage:

4 patients had CT scan evidence of intracranial hemorrhage on admission. All patients had cortical hemorrhage with one patient having intraventricular hemorrhage. Thus hemorrhage occurred in 57% of patients

Angiographic characteristics:

All patients underwent CT angiogram and majority (4, 57%) had feeders from anterior circulation, 2 patients had feeders from posterior circulation, 1 patient had feeders from both anterior and posterior circulation.

Deep venous drainage was noted in 3 patients. One had both superficial and deep venous drainage and the rest of the patients had superficial venous drainage. There were 2 associated aneurysms documented on angiography and both were intra-nidal.

Spetzler-Martin grade:

5 patients had less than 5cm nidus and 2 had more than 5cm. 4 AVMs were found to involve the right hemisphere and 3 involved the left hemisphere. 2 cases involved frontal lobe, 2 temporal lobe, 1 parietal, 1 occipital and 1 multilobar with an associated aneurysm. As per Spetzler and Martin: 1 was grade I, 3 were grade II and 3 were grade III.

Treatment and outcome:

All the 7 patients underwent microsurgical excision and clipping as required. Complete surgical removal of the AVM was achieved as evidenced by follow up DSA in 6 patients, with significant symptomatic and clinical improvement. One patient deteriorated in the post op period and follow up DSA was not done.

There was no complication encountered with the patient who was operated with Spetzler Martin grade I. He was discharged with no neurologic deficits. Of the 3 patients with a Spetzler-Martin grade 2, one was discharged with a MRS score of 0. One patient had seizures post-operatively which was controlled with medications. One patient had a homonymous hemianopia after excision of his occipital AVM. There was no surgical mortality. Two of the three patients with Spetzler-Martin grade 3 who underwent excision had some neurologic deficits post-operatively, with a MRS score of 1. Both had Medical Research Council (MRC) Grade 4 to 4+/5 weakness of unilateral extremities after excision of their AVM. The percentage of patients with Spetzler-Martin grade 3 who had neurologic downgrades was 66.7%. The third patient had a MRC Grade 2/5 weakness of his left extremities on admission; he had a right

thalamic bleed secondary to his Grade 3 posterior temporal AVM, which had some perforator-type feeders. He was admitted with a poor GCS of 6(E1V1M4) Post-excision, his weakness had improved to MRC Grade 3. His MRS score was 4. His post-operative period was stormy, with pneumonia and surgical site infection. He was not subjected to post op angiogram. For Spetzler-Martin Grade 3 patients, the surgical morbidity was 6.3% and there was no surgical mortality.

Discussion

There has been an increase in the number of patients with AVM admitted in our institution. The mean age of patients in this series was 42.8 years. These probably reflect improving diagnostic facilities and early referral to tertiary care centers.

The most common clinical presentation in this series was headache, whereas it was subarachnoid hemorrhage in the majority of other studies. The incidence of hemorrhage in the present study was 57% with no incidence of mortality. This was lower than the estimated mortality rate of 10-29% associated with AVM hemorrhage in a major study. The improved mortality rate may have been partly due to timely evacuation of hematoma.

The mortality rate for Spetzler-Martin Grade 1 to 3 AVMs in this series was 0%, which was in agreement with the report of Hamilton & Spetzler. This was a major improvement when compared with many series reported in literature. The low surgical morbidity rate for Spetzler-Martin Grade 1 AVMs of 0% is also in agreement with the series of Hamilton & Spetzler.

For patients with Spetzler-Martin Grade 2 AVMs, one patient had homonymous hemianopsia. Two other patients had a downgrade of MRS score from 0 to 1 with homonymous hemianopsia. For Spetzler-Martin Grade 3 AVM patients, the low morbidity rate of 6.3% was also concurrent with that in the report by Hamilton and Spetzler. It has been shown that Spetzler-Martin Grade 3 AVMs with deep perforating arteries have a similar complication rate to that of Grade 4 to 5 AVMs. Two of the three patients with Spetzler-Martin Grade 3 AVM in the present series had a downgrade of MRC scores from 0 to 1 with mild limb weakness after excision of AVM. These morbidities were not clinically significant. The third patient had MRS score of 4 from residual limb weakness. However, the muscle weakness preceded the surgical excision and improved marginally after the operation.

In conclusion, the risks of surgery for patients with Spetzler-Martin grade 1 & 2 AVMs are low. As surgery immediately negates the risk of hemorrhage from the lesion after excision, we believe these low-grade AVMs are best treated with microsurgical resection. Patients with Spetzler-Martin grade 3 AVMs may undergo microsurgical resection, as surgical morbidity &

mortality rates are also low. The microsurgical excision of AVMs is fraught with challenges. However, if the patients are carefully selected, prepared and meticulous surgery is executed, it offers a single stage complete treatment with acceptable mortality and morbidity, especially in a resource crunched environment like ours.

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6. Neuro-endoscopic Excision of Third Ventricular Colloid Cyst - Our Institutional Experience

Pallavan P, Dhiraj Patil, Mannar Mannan P, Rajkumar S, Sankar M M

Abstract

Objective: *Colloid cyst of the third ventricle is a rare intracranial benign tumour. Though micro neurosurgical technique is preferred to total resection, subtotal resections and higher post operative morbidity occur even with best surgical hands. Neuro-endoscopy is emerging as an effective alternative to microsurgical procedures. We present our experience with neuro endoscopic removal of third ventricular colloid cyst.* ***Material and Methods:*** *Fifteen patients with colloid cyst of third ventricle underwent endoscopic excision over a period of 4 years. All patients were operated by precoronal uniportal transventricular technique using a rigid neuro-endoscope of 2.7 mm diameter, and gross total resection was attempted.* ***Results:*** *Complete excision was possible in 12 cases. The operative time ranged between 50 minutes and 90 minutes. The inpatient stay time ranged from 5-10 days. The mean follow-up was two years. Pre operative symptoms and signs improved in all patients. There was no mortality.* ***Conclusion:*** *Neuro-endoscopy is a safe and effective alternative to the well established approaches of craniotomy with microsurgical excision and stereotactic aspiration with a short recovery time, hospital stay and low or negligible direct surgical morbidity.*

Key words: Colloid Cysts, Microneurosurgery, Neuroendoscopic Excision

Introduction

Colloid cyst is a slow growing benign, congenital, epithelium lined, endodermal cyst, almost always arising in the antero-superior third ventricle, near the foramina of Monro. Colloid cyst of the third ventricle constitutes 0.5-1 % of intracranial tumors and 15-20% of intra-ventricular lesions[1,2,3,4]. It is the most common type of neuro-epithelial cyst and the most common tumor in the third ventricle[5,6]. It is responsible for acute obstructive hydrocephalus because of the location and sudden deaths have been reported in literature[7,8]. It is commonly diagnosed as an incidental finding during brain imaging. The recommended neurosurgical options are transcallosal or transcortical-transventricular approach[9,10,11]. Ventriculo-peritoneal shunt used to be an alternative to the direct approach in olden days. Less invasive techniques have been developed over the years, including simple puncture, stereotactic aspiration and

endoscopic aspiration of the cyst. Neuro endoscopy is emerging as an effective alternative to treat third ventricular colloid cyst[12]. We report our institutional experience with neuro-endoscopic excision of third ventricular colloid cyst in 15 patients.

Materials and Methods

Fifteen patients (Male-10, Female-5) with colloid cyst of third ventricle underwent endoscopic excision over a period of 4 years from August 2014 to July 2018. The age group of the patients ranged from 22 to 44 years. The presenting symptoms were: headache (15 patients), vomiting (5 patients), altered mentation (2 patients), drop attacks (3 patients), and symptomatology of normal pressure hydrocephalus in 1 patient. (Table1). On CT Imaging there was evidence of hyperdense lesion in all patients. On Magnetic Resonance Imaging the lesion was hyperintense in 11 patients, isointense in 3 patients and hypointense in 1 patient. Five of the patients had asymmetric hydrocephalus. The size of the cyst ranged from 12mm to 18mm in maximum diameter (Table1). All patients were clinically examined and evaluated with routine blood investigations and imaging. Right or Left precoronal uniportal transventricular technique was employed in all according to the cyst site and ventricular size. Operative time, length of hospital stay, intraoperative and post operative complications were documented and analyzed.

Surgical technique

Under general anesthesia, IV Ceftriaxone was given as prophylactic antibiotic at induction and continued for 48 hours postoperatively. Patients were put in the supine position, head elevated to 30° with ring cushion head support, infiltration of scalp incision site was done with 2% lignocaine with adrenaline. After a vertical cutaneous incision of about three cm, a burr hole was made two cm anterior to the coronal suture and 12 cm to nasal bridge or root and 2.5 cm to midline[12]. After ventricular catheterization, the neuro-endoscope was connected to the camera with cold light source and introduced into the lateral ventricle. The irrigation system was set up immediately. Intra ventricular anatomical route was visualized and the neuro-endoscope passed ahead of choroid plexus to the foramen of Monro. The colloid cyst site obstructing foramen of Monro was identified. The cyst wall was carefully cauterized, allowing retraction and a puncture was made in the cyst wall to decrease its volume as well as the intra-cystic pressure to facilitate its removal. A French no.3 fogarty catheter was then inserted through the puncture site to dilate and to evacuate the remaining cyst contents under steroid IV coverage and copious amount of irrigation. The cyst wall was grasped with grasping forceps introduced through the endoscope instrument port and rotated until the cyst wall separated from the attachment. The endoscope was withdrawn along with the grasping forceps after

visually confirming the cyst removal status and haemostasis. The burr hole was plugged with appropriate size gelfoam. Scalp was closed in layers.

Results

All patients were operated by trans-foraminal approach. One patient required trans-septal approach. Complete excision was possible in 12 cases, while in three patients a small part of cyst was left behind to avoid venous injury. The operative time ranged between 30 and 45 minutes (Table 1). Two patients developed postoperative chemical meningitis and was managed with steroids.

Postoperative transient memory disturbance was observed in 3 patients. One patient had a postoperative CSF leak requiring shunt surgery. Temporary placement of an external ventricular drain was required for managing one patient who developed signs of raised intracranial tension postoperatively. One patient with incomplete excision was re-operated endoscopically after three days on the basis of residual lesion on post operative scan. Total hospital stay of these patients ranged from 5 days to 10 days. The average follow-up period was 24 months.

S.No	Age/Sex	Signs and Symptoms	Cyst size in mm in Imaging	Surgical procedure time in minutes	Excision status	In patient stay period in days
1	34/M	Headache, vomiting	12	35	Total	5
2	35/F	Headache	14	40	Total	5
3	40/M	Headache, Vomiting	18	45	Partial	
4	22/F	Headache, Altered mentation	14	35	Total	5
5	35/M	Headache, Vomiting	15	40	Partial	7
6	40/M	Head ache	17		Total	5
7	44/M	Headache, NPH triad	15	35	Total	
8	32/F	Headache, Altered mentation	18	45	Partial	7
9	40/M	Headache, Drop attack	14	36	Total	5
10	27/F	Head ache	14	30	Total	5
11	40/M	Headache, Vomiting	16	30	Total	10
12	34/M	Headache, Drop attack	15		Total	5
13	23/F	Head ache	13	35	Total	5
14	35/M	Headache ,Vomiting	16	35	Total	5
15	42/F	Headache, Drop attack	18	30	Total	5

M- Male; F- Female; mm- Millimeter; + Present

Table.1. Master chart of patient demographics, clinical presentation and imaging characteristics and surgical out come

Discussion

Colloid cyst was described by Wallman in 1858[11].It is composed of an outer fibrous layer and an inner epithelium of ciliated or mucin producing cells. Nearly 60% of these mucinous cysts are incidental findings during brain imaging and mostly asymptomatic. The size of colloid cyst reported in literature is 5 - 25 mm[14,15,16]. In our study the size ranged from 12-18mm.The clinical manifestations of colloid cysts are nonspecific. However, the positional paroxysmal headache is the most common symptom and is rather specific. Commonly, the disease is manifested also as intracranial hypertension due to acute obstructive hydrocephalus. Two patients showed intracranial hypertension with severe disturbance of consciousness (Glasgow coma score 6/15). Other clinical signs are visual disturbances, decreased visual acuity, optic disc swelling, nausea, vomiting, dizziness, motor deficits and seizures. The risk of sudden death as a complication of colloid cysts mandates surgical management of symptomatic cases and regular monitoring of cysts with a few symptoms or cases of incidental diagnosis. Another rare complication of colloid cyst is the intra-cystic haemorrhage, abruptly increasing the volume of the cyst and accounting for a rapid severe rise in intracranial pressure.

The advantage of neuroendocopy is minimal invasiveness, short procedure time, short patient recovery time, minimal post operative complications and double benefit of management of both the lesion and hydrocephalus in one procedure.

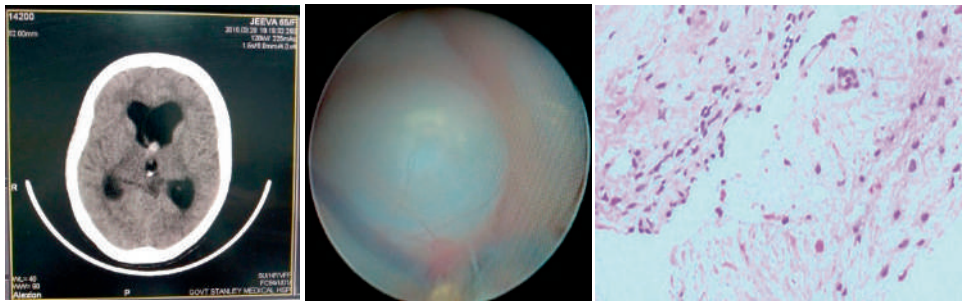
The disadvantage is the cost of instruments and their maintenance. Partial excision, recurrence and vessel injury are a possibility with endoscopic technique, and additional open procedures are mandatory in case of severe bleeding or failure.

Conclusion

Our single centre study shows good results for endoscopic colloid cyst excision. Since we achieved total excision in most of the cases with short procedure time, minimal post operative morbidity and no post operative mortality, we consider the endoscopic technique of colloid cyst excision is a viable alternative to more invasive craniotomy and excision procedures. Small sample size and single centre study are the two major limitations of this study.

Conflict of interest

The authors have no conflict of interest to declare.



(1) (2) (3)

Figure 1 *Third ventricular colloid cyst with hydrocephalus in CT scan*

Figure 2 *Neuro endoscopic view of Third ventricular colloid cyst*

Figure 3 *Eosin and Haematoxylin stain of Third ventricular colloid cyst*

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7. Economic factors in Coiling and Clipping- Analysis of 86 patients

Gopikrishnan R, Roopesh Kumar V R, Rithesh Nair, Suresh Bapu K R

Abstract

With the advances in endovascular techniques, it's role in the management of intracranial aneurysms has been steadily increasing in the last few decades. However, the economic burden of such procedure on patients in a developing country like India have not been studied. We proposed to analyze the cost effectiveness of craniotomy and clipping when compared to endovascular procedures. ***Materials and Methods:*** *We retrospectively reviewed 86 patients who had undergone treatment for intracranial aneurysms in our institute between 2014 and 2018.We studied the outcome (mRS at 6 months), the length of hospital stay and total hospital cost for each of these patients.* ***Results:*** *The aneurysm obliteration rate was 98% (50/51) for the clipping group, 92.9% (26/28) for the coiling group and 85.7% (6/7) for the flow diverter group.88% of patients in the clipping group had good (mRS<1,2) or moderate (mRS=3) outcome as opposed to 74% in the endovascular group. The length of hospital stay was short for the endovascular group. Aneurysm obliteration rate was higher in the clipping group. The total hospital cost for craniotomy and clipping was less than that for coiling or flow diverter stenting.* ***Conclusion:*** *In the Indian scenario, clipping seems to be more cost-effective than endovascular treatment when both options are available*

Introduction

Out of the estimated 135 Crore Indian population, only around 52 crores make up India's working population. Less than one crore people earn over Rs 50000 per month and around 30 crore people earn less than 2500 rupees per month. The average monthly salary of a junior doctor or an IT professional is around Rs 50000 and that of an unskilled worker is around Rs 9000. As the public health coverage is not adequate, private health care providers play a major role in India. As the cost of coiling or clipping can vary between 2 lakhs to 15 lakhs, the economic burden of such a procedure on a middleclass family can be overwhelming. Cost becomes an important factor in decision making between Coiling and Clipping in the private sector. Every human life is invaluable and one cannot assign a cost to an individual human. However, because of financial constraints patients may be forced to choose one modality over the other. Hence we want to analyze the cost effectiveness of clipping versus coiling in a private setup in India.

Materials and Methods

We retrospectively analyzed 86 patients who underwent clipping and coiling in our institute between 2014 and 2018.We recorded the type of treatment (clipping, coiling, flow diverters), recurrence at 6 months, mRS at 6 months, complications, mortality and the total cost incurred. The clinical end points of effectiveness that we used were mRS at 6 months, aneurysm obliteration rate on the day of the procedure, residue or recurrence at 6 months. Rather than analyzing the cost benefit ratio which can be arbitrary and subjective, we analyzed the cost effectiveness of each modality of treatment. The parameters that were used to calculate the cost of treatment included total hospital cost, cost break up, length of stay in ICU, total length of stay in the hospital.

Results

Out of the 86 patients, 51 (59.3%) underwent clipping, 28 (32.6%) underwent coiling and 7 (8.1%) underwent flow diverter stenting (Table 1).

Out of the 51 patients who underwent clipping, the reasons for not coiling were financial issues (n=18), unfavorable location and configuration (n=28), associated large intracranial hematoma (n=1), giant aneurysm with mass effect (n=2), non-availability of neuroradiologist (n=3) (Table 2)

The aneurysm obliteration rate was 98% (50/51) for the clipping group, 92.9% (26/28) for the coiling group and 85.7% (6/7) for the flow diverter stenting group (Table 3).

46 of the 51 patients in the clipping group and 26 of the 35 patients in the endovascular group underwent check angiogram at 6 months. Residue or recurrence detected at 6 months was 2.2% (1/46) in the clipping group and 11.5% (3/26) in the endovascular group (Figure 1).

All patients were followed up for atleast 6 months and 88% of patients in the clipping group had good (mRS<1,2) or moderate (mRS=3) outcome as opposed to 74% in the endovascular group.12% of the clipping group had poor outcome (mRS 4,5,6) as opposed to 36% in the endovascular group(Figure 2).

There were 3 mortalities in the surgical group (procedural complication =1, Vasospasm=1, Sepsis=1) and 7 mortalities in the endovascular group (Procedural complications=2, Poor grade=3, Vasospasm=1, Sepsis=1) (Table 4).

The length of stay in the clipping group was 13.7 days, in the coiling group it was 7.8 days and in the flow diverter group it was 5.4 days (Table 5).

The cost break-up was analyzed as total hospital cost, Physician fees, Industry cost and pharmacy costs (Table 6). The cost of clipping was less than 5 lakhs in 74.5% of the patients in the clipping group, and in 21.4% of the coiling group. The cost exceeded 7.5 lakhs rupees in 11.8% of the clipping group, in 21.4% of the coiling group and in 100% of the flow diverter group (Table 7) (Figure 4).

The mode of payment was either by the cash (self-paying) (76.7%), insurance (18.6%) or a combination of both (4.7%) (Table 8). When patients pay through cash, the source of such payment can be from their savings, loan from employer, family and friends or from banks, sale of inherited property. However, no reliable data could be collected as most patients were unwilling to reveal the source of the money.

Discussion

Universal health coverage and fully developed public health facilities in Western countries may obviate the question of cost effectiveness in the treatment of intracranial aneurysms. In developing countries like India, cost becomes a very important factor in choosing the modality of treatment, especially in the private sector.

Zhang et al[1] in their meta-analysis have found that hospital costs were region specific. The total hospital cost for both craniotomy and clipping were similar in the United States. While in South Korea[2] and China[3], coiling is costlier than clipping.

When subset of patients from different countries who were enrolled in the ISAT trial were analyzed comparing the cost of clipping and coiling, the results varied according to each country [4], i.e. there was no significant difference between the two groups in the United Kingdom[5] and Canada[6], but coiling proved to be cheaper in Perth, Western Australia[7]. In a single center study in the United States by Hoh et al [4], it was found that coiling was associated with shorter hospital stays but higher costs compared to clipping, for both ruptured and unruptured aneurysms. The difference was attributed to the higher cost of coils when compared to the clips.

In developing countries, Tahir et al [8] in their single institution analysis of 55 patients found that coiling was 62% more expensive than clipping and there was no significant difference in morbidity and outcome. Even though the bed charges, pharmacy and investigation charges were more for the clipping group, and the duration of hospital stay was

significantly more in the clipping group, the high cost of coils and Flow Divertors made endovascular therapy the more expensive of the two. Tahir, in order to optimize cost effectiveness, has proposed Risk Score considering age, location and complexity of aneurysm and Hunt-Hess grade and applied to aneurysms with sizes < 5mm and > 5 mm. This scoring system needs to be validated. Logically, with increasing size of aneurysm, the number of coils increase/or Flow diverter indicated and the cost gets escalated accordingly[9,10].

When the anatomical configuration of the aneurysm is favorable and when there are no contraindications for coiling, we offer both treatment options to the patient explaining the cost of both modalities. Coiling is invariably preferred by the patients as it is perceived to be less invasive, avoiding a surgical pain and the scar. However financial constraint remained the main reason for opting to clipping over coiling in 18 out of the 51 clipped patients.

Even though the total hospital stay and ICU stay were significantly less in the endovascular group than the clipping group, this did not offset the total hospital cost because of the high cost of consumables.

In this study we have found that the aneurysm obliteration rate was better with clipping; mortality rate and the recurrence rates were less in the clipping group than in the endovascular group. The reason for slightly higher mortality rate in the coiling group was due to the difference in the selection of patients between the two groups. Clipping was done only if the patient had M6 or M5 motor response while Coiling was done even in patients with M4 response.

Limitations

The analysis includes both ruptured and unruptured aneurysms. It would be expected that patients with ruptured aneurysms will need longer hospitalization and more post-operative care. Readmission rates, rehabilitation costs were not included in the analysis and these can widen or narrow the gap between the treating costs of these two modalities.

Conclusion

In the Indian scenario, clipping seems to be more cost-effective than endovascular treatment when both options are available. Considering the low exchange value of Indian currency, importing Coils, Flow Diverters and the infrastructure for endovascular therapy is a major reason for the high cost of endovascular therapy. Indigenous manufacturing of quality coils, catheters and flow diverters will contribute significantly in bringing down the cost of endovascular treatment.

Table

Modality	No of Patients (n)	Percentage (%)
Clipping	51	59.3
Coiling	28	32.6
FD Stent	7	8.1
Total	86	100

Table 1: Modality of Treatment

Reason for not choosing coiling	n
Location & Configuration	28
Associated large ICH	1
Giant Aneurysm with mass effect	2
Non availability of NeurRadiologist	3
Financial Issues	18

Table 2: Reasons for not choosing coiling

Modality	Aneurysm Obliteration Achieved	
	Yes	No
Clipping	50 (98%)	1 (2%)
Coiling	26 (92.9%)	2 (7.1%)
FD Stent	6 (85.7%)	1 (14.3%)

Table 3: Aneurysm obliteration Rate

	Clipping (3/51)	Endovascular (7/35)
Procedural Complications	1	2
Poor Grade	0	3
Vasospasm	1	1
Sepsis	1	1

Table 4: Mortality- Causes

Length of Stay	Clipping Mean (days)	Coiling Mean (days)	FD Stent Mean (days)
Total Hospital	13.7	7.8	5.4
Total ICU	6.019	4.035	1.71

Table 5: Length of Stay

	Clipping (Rupees)(Mean)	Coiling (Rupees)(Mean)	FD Stent (Rupees)(Mean)
Total Hospital Cost	474218	643996	1390065
Physician Cost	81145.8	57532.1	49285.7
Industry Cost	27328.5	138273	566678
Pharmacy Cost	162382	408120	1095930

Table 6: Cost break-up

Modality	<5Lakhs	5 -7.5Lakhs	>10Lakhs	Total
Clipping	38 (74.5%)	7 (13.7%)	6 (11.8%)	51 (100%)
Coiling	6 (21.4%)	16 (57.1%)	6 (21.4%)	28 (100%)
FD Stent	0	0	7 (100%)	7 (100%)

Table 7: Total Hospital Cost

Modality	Cash	Insurance	Both	Total
Clipping	38(74.5%)	9(17.6%)	4(7.8%)	51(100%)
Coiling	23(82.1%)	5(17.9%)	0	28(100%)
FD Stent	5(71.4%)	2(28.6%)	0	7(100%)

Table 8: Mode of Payment

Figures

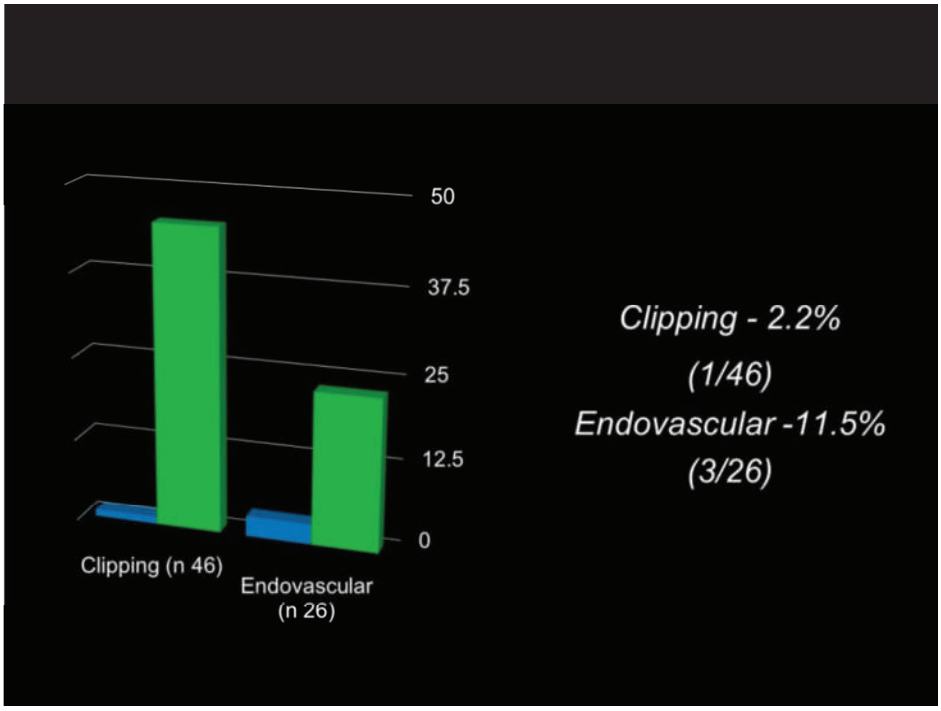

Figure 1: Residue/ Recurrence at 6 months

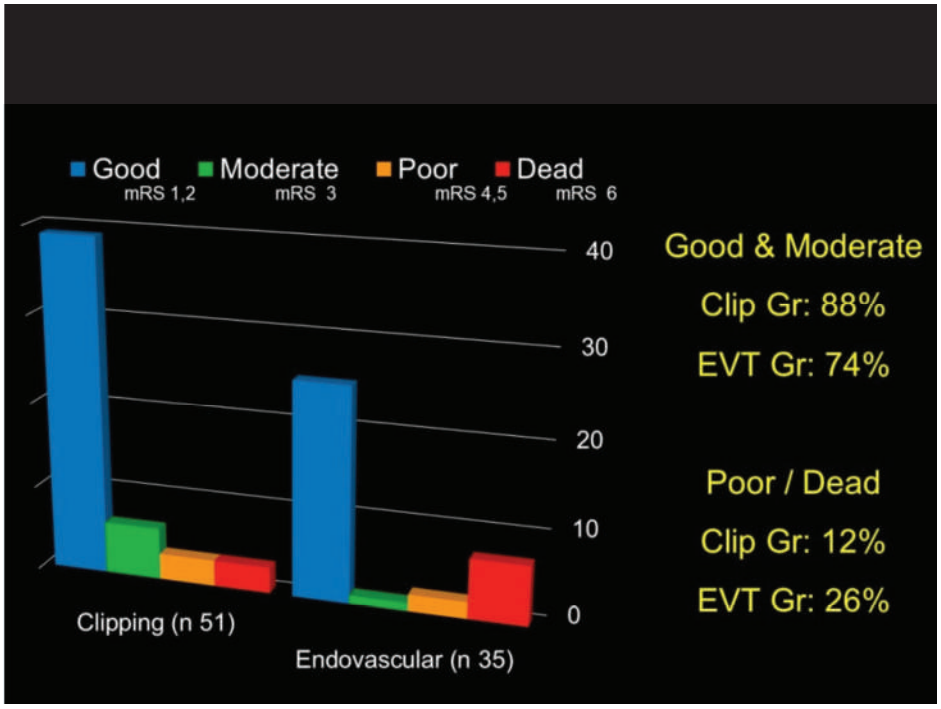

Figure 2: mRS at 6 months follow-up

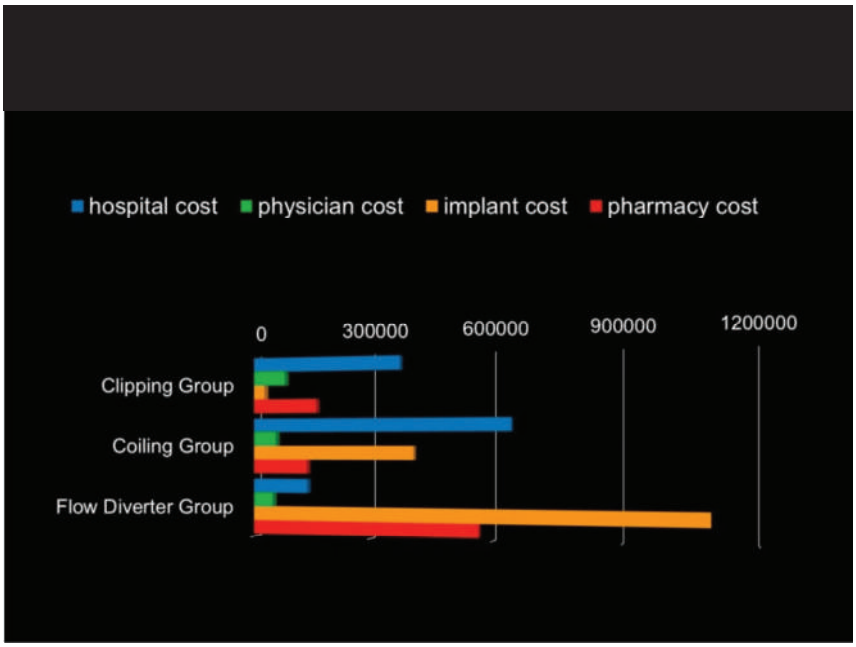

Figure 3: Cost break up

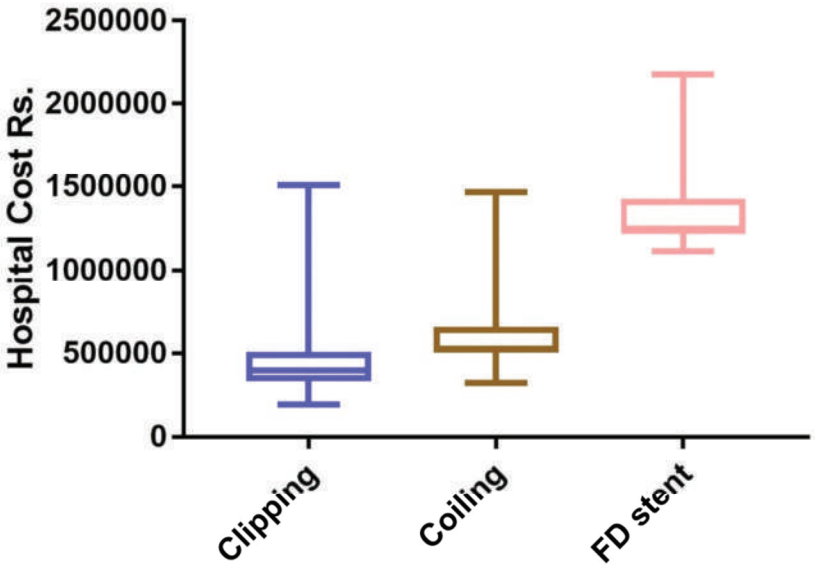

Figure 4: Total Hospital cost

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8. Awake Craniotomy: An Institutional Experience in a Single Unit.

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Abstract

Introduction: *Awake Craniotomy is a neurosurgical procedure that allows a surgeon to operate on brain tumour while the patient is awake, in order to preserve eloquent cerebral cortex. Surgery is done in the same way as conventional craniotomy. This procedure is done with the aid of intra operative monitoring. This procedure is done for the patients who have space occupying lesions in the eloquent areas, mostly commonly speech and motor area.* ***Materials and methods:*** *This study was done in a single unit at The Institute of Neurosurgery, Rajiv Gandhi Government General Hospital and Madras Medical College, Chennai, on a group of patients who had tumours in the temporal and frontal lobes. All these patients were intra-operatively monitored during the procedure.* ***Conclusion:*** *The outcome of these patients re-emphasised the efficacy of this procedure in preventing significant morbidity due to the involvement of the eloquent cortex. This study helps us to prove that, awake craniotomy with intra operative monitoring is helpful in patients with tumour in eloquent areas. It reduces post-operative morbidity in patients.*

Key words: Awake, Craniotomy, Eloquent, Frontal lobe, Temporal lobe

Introduction

Awake craniotomy is a novel procedure that has reduced the morbidity of the patients. The space occupying lesions in the frontal and temporal lobes cause motor inactivity and speech disturbance and this leads to significant disability. This study was done to assess the reduction in disability for the patients treated with awake craniotomy over conventional procedures.

Materials and Method

This prospective descriptive study was conducted in a single unit at the Institute of Neurosurgery, Rajiv Gandhi Government General Hospital and Madras Medical College, Chennai, in which 20 consecutive patients underwent awake craniotomy for lesions within the eloquent cortex, who did not have altered level of consciousness at presentation and tolerated the procedure well (physically and psychologically).

Inclusion Criteria

1) Age 20 to 50 yrs.
2) Patients with intraparenchymal space occupying lesion in Frontal and Temporal lobes
3) Patients who are able to communicate

Exclusion Criteria

1) Age >50 years
2) Multiple lesions
3) GCS <12 / altered sensorium
4) Patients who were operated earlier
5) Hemodynamic instability
6) Patients with anxiety disorders, schizophrenia, claustrophobia
7) Patients with low pain tolerance and
8) Patients who developed seizure during the procedure were excluded from the study.

The decision regarding awake craniotomy was made by both the anaesthetist and surgeon[1-10]. Patient planned for awake craniotomy underwent thorough pre-operative clinical assessment and risk evaluation of surgical intervention under awake anaesthesia[15, 53]. The details of the surgery and theatre environment including instruments and staff were shown and explained to the patients[12-17].

Procedure

Before proceeding with awake craniotomy, anxiolytic medications were given to the patients preoperatively[2, 3]. As soon as the patient arrived in the operating theatre, two wide bore intravenous cannulae were inserted for fluid and medications and standard monitoring was applied[21]. Sedation was started using Dexmedetomidine[33-38]

Patients were then placed supine and the head of the patient was fixed with Mayfield frame [52]. Patient was supported with soft pillows to provide maximal intra-operative comfort. Draping was done in such a way that eye contact could be maintained with the patient for assessment and for the airway if emergency airway management was needed[22-28]. A set of laryngeal mask airway was prepared to be used if airway obstruction developed intra-operatively[40,41,42]. Oxygen was supplemented through a nasal cannula and a urinary catheter was inserted.

Skin and bone flap were made accordingly[18,51] by blocking supraorbital, supratrochlear, auriculotemporal, zygomaticotemporal, posterior auricular branches of greater auricular nerve, greater, lesser and third occipital nerves[48,49]. Bupivacaine was selected as most of the candidates were elderly and with cardiovascular diseases. Following elevation of bone flap, saline and 2% of lignocaine soaked cotton pledgets were placed over the durotomy surface to ensure dural anaesthesia. Durotomy[11,46,47] was performed and intravenous sedation was then tailored down to facilitate functional assessment[18,19,23-25,50].

Surgery was performed by the principle of maximal safe resection with constant clinical monitoring. When the patient shows signs of transient deficits in speech or motor function, the resection was stopped and switched over to another area that was deemed non eloquent/ non-functional[5]. The tumour was resected slowly. During resection the patient was encouraged to continue speaking as well as to move his/her limbs and this clinical status of the patient was constantly monitored[43,44,45]. A sluggish response or an alteration of response was judged to be due involvement of eloquent cortex and resection was stopped. In this way most of the tumour is resected and the tissue was sent for histopathological examination to check the grade of the tumour. Sedation was restarted upon closure of duramater and terminated at the end of skin closure. After histopathological examination of the tumour, patient was subjected to radiotherapy for completion of the treatment[18-21].

The collected data were analyzed with IBM.SPSS statistics software 23.0 Version. To describe about the data descriptive statistics frequency analysis, percentage analysis were used. To find the significance in categorical data Chi-Square test was used. In the used statistical tool the probability value .05 is considered as significant level.

Results and analysis:

Patient demographics:

Age (yrs)	Male	Female
20 - 30	4	4
30 - 40	4	3
40 - 50	3	2

Table 1: Patient demographics

Patient demographics are as those depicted in table 1, there was no predilection for age or sex

Post-operative deficit:

	No. of patients with Hemi paresis (% of total)	No. of patients with Aphasia (% of total)
POD 1	8 (40%)	9 (45%)
POD 3	5 (25%)	3 (15%)
POD 5	2 (10%)	3 (15%)
POD 7	2 (10%)	1 (5%)

Table 2: Post-operative deficit

Statistical Analysis

Age * Gender Cross tabulation				
		Gender		Total
		Female	Male	
Age	20 – 30	4	4	8
	30 - 40	3	4	7
	40 – 50	2	3	5
Total		9	11	20

Chi-Square Tests			
	Value	df	Asymptomatic. Sig. (2-sided)
Pearson Chi-Square	.144a	2	0.93
Likelihood Ratio	0.144	2	0.93
N of Valid Cases	20		
a. 6 cells (100.0%) have expected count less than 5. The minimum expected count is 2.25.			

POD * Outcome Cross tabulation				
		Outcome		Total
		Aphasia	Hemi paresis	
POD	POD 1	9	8	17
	POD 3	3	5	8
	POD 5	3	2	5
	POD 7	1	2	3
Total		16	17	33

Chi-Square Tests			
	Value	df	Asymptomatic. Sig. (2-sided)
Pearson Chi-Square	1.063a	3	0.786
Likelihood Ratio	1.075	3	0.783
N of Valid Cases	33		
a. 6 cells (75.0%) have expected count less than 5. The minimum expected count is 1.45.			

P -Value = No Significance at P >.050

1. The patients who underwent craniotomy for eloquent cortex lesions by this method had a favourable post-operative morbidity profile in terms of fixed neurological deficit (motor and language) compared to conventional case series of patients undergoing craniotomy for the same . As described in table 2 , the number of patients with hemiparesis was 8 (around 40 % of patients) however, by POD 7 only 2 patients had hemiparesis, whereas around 9 patients (45%) had post-operative aphasia , this aphasia subsequently improved in 8 patients and by POD 7 only 1 patient had documented aphasia .
2. The general complications for craniotomy were comparable to those patients undergoing conventional craniotomy.

Discussion

Awake craniotomy requires an adequate level of sedation during the opening and closure of bone flap without producing respiratory depression, full consciousness during tumour removal stage, with maximum comfort to patient throughout the procedure. The common target for all techniques is to facilitate maximum possible tumour resection while sparing normal brain functions. Specific data analysis of patients revealed a significantly better neurological outcome and quality of resection in the awake craniotomy group than the group who underwent conventional surgery to lesions in eloquent areas. Craniotomy and resection of space occupying lesion usually takes more than 5 hours. Such lengthy operation time mandates a degree of sedation that should be titrated in such a way that the patient remains comfortable, motionless, alert and cooperative during resection of space occupying lesion and for neurological assessment.

Although the operation time was not in favour of an awake patient to stay motionless and comfortable throughout the procedure, adherence to details of the ideal awake craniotomy technique helped to prevent these events. Skin incision and craniotomy are the most painful phases of this operation. A rapid control and modulation of sedation and analgesia is absolutely mandatory to manage painful surgical stimuli.

The success of surgery largely depends on adequate scalp block; otherwise patients become restless and uncooperative, requiring higher doses of analgesics or sedatives which can interfere with functional assessment and airway patency. Bupivacaine 0.5% may be used to carry out the block.

After tumour removal, all haemostasis secured and duramater is closed with sutures. Bone flap is replaced with three titanium, mini-plates and screws. Scalp is closed in layers. Skin is then closed with staples and wound is dressed and a head bandage is applied.

Post-operative recovery is usually much quicker than with a conventional craniotomy. Patient is advised to take oral diet and mobilized as soon as possible. Patient could be discharged earlier compared to conventional craniotomy.

Risk of awake craniotomy for a brain tumour is the same as those for conventional craniotomy. There is a small risk of seizures during surgery and in such cases it is required to convert into general anaesthesia. But overall complications following awake craniotomy are uncommon and the degree of risk depends on a number of factors such as the age, co-morbidities, size, location and type of the tumour.

Following are the some of the expected complications of awake craniotomy but not exclusive in all patients.

1. Neurological deficit such as paralysis of limbs or aphasia
2. Haematoma in the tumour bed
3. Brain oedema
4. Brain abscess and wound infection
5. Development of seizures
6. CSF leak from the wound site

Conclusion

Though 8 patients had transient motor weakness and 9 patients had transient speech disturbances on the first post-operative day, subsequently all of them recovered well. Only 2 patients had persistent motor weakness and one had aphasia on 7th postoperative day. Hence we conclude that awake craniotomy is a safe procedure in patients with tumours involving eloquent areas of the brain.

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9. Idiopathic Intracranial Hypertension or Pseudotumour Cerebri? The Conundrum of Nomenclature in the Presence of Normal CSF Pressures.

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Abstract

Idiopathic Intracranial Hypertension (IIH), also known as Pseudotumour cerebri (PTC), is a condition in which the patient presents with signs and symptoms of increased intracranial pressure, with no demonstrable organic cause in the brain imaging including venous sinus thrombosis, and with normal cerebrospinal fluid (CSF) composition. Atypical cases of IIH have been reported periodically, and important subsets of these patients have normal CSF Opening pressure (OP) on lumbar puncture (LP). Application of strict criteria for diagnosing such patients needs reconsideration.

We present 7 cases of IIH with normal CSF Opening pressures, out of 30 consecutive patients of suspected IIH admitted to the neurosurgery ward of a tertiary care hospital over a period of 2 years, kindling interest in nomenclature and diagnostic dilemma if strict criteria are adhered to.

Key words: Idiopathic Intracranial Hypertension (IIH), lumbar puncture, Normal CSF pressures. Opening pressure, Pseudotumour cerebri (PTC)

Introduction

Idiopathic Intracranial Hypertension (IIH), also known as Pseudotumour cerebri (PTC), is a condition in which the patient presents with signs and symptoms of increased intracranial pressure (ICP), with no demonstrable organic cause in the brain imaging including venous sinus thrombosis, and with normal cerebrospinal fluid (CSF) composition. Dandy was the first to methodically describe the symptoms of raised ICP, document CSF pressures and composition and rule out the possibility of brain tumours with ventriculography in his description of this condition in a set of 22 patients in 1937[1].

The Dandy criteria for the diagnosis of IIH/PTC, modified by Smith et al., in 1985, are: (a) signs and symptoms of increased intracranial pressure; (b) absence of localized findings on neurologic examination; (c) normal neuroradiologic studies; (d) awake and alert patient; (e) no

other cause of increased intracranial pressure present and are being widely followed as modified Dandy criteria[2].

The classical features of IIH headache described by the International Headache Society (ICHD III) are: New headache, or a significant worsening of a pre-existing headache, caused by and accompanied by other symptoms and/or clinical and/or neuro-imaging signs of IIH, with typical features suggestive of IIH[3]. Diagnostic criteria:

A. New headache, or a significant worsening of a pre-existing headache, fulfilling criterion C
B. Both of the following:
    1. IIH has been diagnosed
    2. CSF pressure exceeds 250mm CSF (or 280 mm CSF in obese children)
C. Either or both of the following:
    1. Headache has developed or significantly worsened in temporal relation to the IIH, or led to its discovery
    2. Headache is accompanied by either or both of the following:
        a) Pulsatile tinnitus
        b) Papilloedema

There are reports of atypical cases of IIH, and include those with headaches that are not classical for ICP and those without visual disturbances. Some patients have had symptoms suggestive of IIH, without papilloedema, but have demonstrable increase in CSF opening pressure, responding to pressure reducing agents, and have since been designated as IIH without papilloedema[4].

Johnston et al. called attention to some cases that bear a close resemblance to PTC but fail to comply with one or more of the accepted diagnostic criteria[5]. These authors proposed that the concept of PTC be broadened to include other atypical forms. One of these atypical forms was that of "normal pressure pseudotumor syndrome", and is being reported periodically.

Objective

To draw attention to the paradox in nomenclature of patients presenting with typical signs and symptoms of raised ICP with *normal* Lumbar CSF opening pressures – to name them IIH even when there is no measured evidence of *hypertension* or simply *normal pressure* PTC?, and to record the therapeutic effect of a single LP.

Materials and Methods

This study was conducted on 30 consecutive cases of suspected IIH/PTC admitted in the neurosurgery department at the Institute of Neurosurgery, Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai, between 2008 and 2010 with a clinical diagnosis of IIH, as suggested by the 'Modified Dandy criteria'. The approval of the Institutional Ethics Committee was obtained.

All patients had headache of varying severity, persistent and constant for few weeks prior to admission, necessitating medical advice. The temporal profile of headache was suggestive of raised intracranial pressure in all of them. All patients had bilateral papilloedema clinically, and were confirmed by the Neuro-ophthalmologist of the Institute, and visual field charting was done with Goldmann perimetry. None had any focal neurological deficit after a thorough neurological examination, other than lateral rectus palsy in a few. None had history of chronic medications. All patients were alert and co-operative. All had CT brain and MRI Brain and MRV done to rule out venous sinus thrombosis and there was no evidence of hydrocephalus, mass or structural or vascular lesions in any of them.

All patients were explained in detail about the procedure and written informed consent was obtained for performing lumbar puncture under local anaesthesia. Each patient was positioned in the right lateral decubitus position and under sterile aseptic precaution, lumbar puncture was performed with 20G spinal needle under local anaesthesia. The needle was connected to a saline manometer without letting out any CSF. The patient was allowed to relax, extend lower limbs and neck, lying comfortably in the right lateral position, and the opening pressure was noted in centimeters of water (CSF) after the saline column stabilized.

About 20 to 25 ml of guarded therapeutic drainage of CSF was done in each case. Cytological and biochemical analysis of the CSF samples were found to be normal in all cases. The procedure was uneventful in all cases, and the patients tolerated well.

Results

There were 8 males and 22 females in all, with age ranging from 15 to 49 years. The mean CSF OP was 36.1 cmH_2O ranging from 14 to 83 cmH_2O. Seven patients, 3 males and 4 females, had OP below 25 cmH_2O, ranging from 14 to 21 cmH_2O, and did not meet the typical modified Dandy criteria for a diagnosis of IIH/PTC. Of these, five patients had OP less than 20 cmH_2O and two had 21 cmH_2O.The observations and clinical features of these seven patients are summarized in table.1. All patients were advised complete bed rest for 24 hours following LP, and were started on T.Acetazolamide 1 gm/day in divided doses. They were encouraged to

take plenty of oral fluids. Dietary advice was given to prevent hypokalemia secondary to the drug.

All patients reported subjective improvement on the day following LP, and headache and visual blurring were the first symptoms to be relieved. None reported new headache suggestive of low tension.

All patients with OP below 25cmH_2O were given the option of repeat LP and OP estimation in the next two days, but they refused, apparently due to the significant subjective improvement in symptoms. All but one patient did well with conservative management.

One patient had transient improvement for about a week following LP, but had persistent papilloedema and enlargement of blind spot on field charting. She also reported recurrence of double vision and headache. Second LP done on her was also below 20cmH_2O. She underwent lumbo-peritoneal shunt, and improved.

Discussion

Demonstration of raised ICP

The diagnosis of IIH or PTC, by definition and convention requires proof of increased ICP. The study by Lenfeldt et al., demonstrated the accuracy of the lumbar puncture technique to determine ICP in both absolute and relative terms[7]. In the absence of any pathological obstruction in the CSF pathway, the measurement of LP OP reflects ICP.

Modified Dandy criteria require presence of LP OP of more than 25 cmH_2O to confirm a diagnosis of PTC. ICHD III criteria mandate CSF pressures in adults to be more than 25cmH2O and in obese children to be more than 28cmH_2O.

Our series had 7 patients with OP below the criteria of 25cmH_2O, but had all other symptoms and signs of raised ICP. They responded favourably after a therapeutic drainage of CSF, and Acetazolamide, confirming the presence of IIH/PTC.

***Single or repeat LP*:**

Normal pressure PTC has been reported periodically and perhaps the first such description was by Johnston[5]. A series of six such patients was reported by Abdelfatah[8]. Such cases have also been reported by Green, Biousse, and SouYounSuh[6,9, 10].

Johnston et al., reported a series of atypical IIH patients, one of which was a 13 year old boy with disc edema and visual field defects that resolved following lumbo-peritoneal shunt insertion even though his CSF pressures were normal on single LP and with continuous ICP monitoring later[5]. Green et al., reported the case of an 18 year old woman IIH patient with normal pressures measured on three occasions, with documented improvement in symptoms following LP and ultimately benefitted with optic nerve sheath fenestration[6].

Biousse described a 31 year old woman with papilloedema and clinical profile fitting IIH, but with normal LP OP, who improved following LP and continued to do better with conservative management[9]. Soh YS reported two female patients with clinical findings of IIH but with pressures below 25 cmH_2O, demonstrated twice in one, and both patients did well after LP and were managed conservatively[10]. The study by Abdelfatah describes 6 obese anaemic female patients, two of whom were pregnant, and four had history of excess vitamin A intake and or on hormonal contraceptive. All patients had papilloedema, underwent LP twice, with mean OP recorded to be 11 cmH_2O, falling to 7.3 cm H2O respectively and all had responded favourably to medical management[8].

A repeat LP or continuous monitoring of ICP for 24 hours may be required in appropriate clinical settings for confirmation of IIH as recommended by Friedman and Jacobson, but all but one of our patients refused a second tap[11].

Therapeutic advantage of single LP:

The explanation for the observed subjective and satisfactory relief of symptoms following a single LP in these patients is given by Simone et al.[12]. As the CSF production rate allows its complete turnover up to four times in 24 hours, the longstanding changes observed cannot be easily considered a long term effect of fluid removal. Actually, a single lumbar puncture could act as a switch between two different balance states - venous and CSF pressures. Although secondary to CSF hypertension, venous sinuses may have an important role in hypertensive status maintenance. They go on to hypothesize that, at least in IIH patients with a history of longstanding remissions after a single or a few serial lumbar punctures, a cryptogenetic transient increase of CSF pressure can induce a sinus compression.

The treatment of raised ICP itself begins with the diagnostic lumbar puncture, which is often effective in transiently improving symptoms and signs. Interestingly, it is not uncommon to observe a lasting clinical remission following a single lumbar puncture in some IIH patients, obviating the need for further medical or surgical treatment. This phenomenon cannot be

simply explained by the amount of CSF drained, or by the hole made in the dura by the needle used for the lumbar puncture.

Interaction of various factors, such as CSF formation, compliance, cerebral blood flow, and outflow resistance, leading to multiple stable and unstable equilibrium levels of ICP in IIH is the explanation proposed by Mathematical models of CSF hydraulics[13]. If a single lumbar puncture lowers the CSF pressure beyond the threshold level of an unstable equilibrium, the ICP must settle into a lower stable pressure state until other factors cause the pressure to exceed that threshold. This observation emphasizes the importance of the initial lumbar puncture as a therapeutic procedure in IIH in addition to its diagnostic importance. It also explains why some patients dramatically improve after two or three lumbar punctures or require episodic lumbar punctures to remain asymptomatic[14].

In majority of patients, as in our series, diagnostic LP proves to be therapeutic, and medical management for a variable period of time, as per clinical response are often sufficient for a remission. All patients in our series had shown improvement with a single LP, establishing its definitive therapeutic role. All but one patient in the normal pressure group continued to do well following LP and medical management. We believe that the dural hole made by the 20G needle is kept patent by the relatively higher pressure on the other side of the dura, and, in effect it functions technically as a shunt, diverting the CSF from the subarachnoid space to the extradural space till the pressures equilibrate.

Mechanisms / Pathophysiology:

Johnston et al. proposed two possible explanations for the presence of papilloedema in the absence of measured elevated ICP[5]. Firstly, it was proposed that the situation could be likened to normal-pressure hydrocephalus, in which there is a definite abnormality of CSF circulation and volume relieved by drainage, without a demonstrable abnormality of CSF pressure. Secondly, it was hypothesized that local abnormalities in the region of the optic nerve sheath are responsible for the development of papilloedema, with relatively normal ICP allowing a local build up of pressure that is not reflected in the pressure measurement elsewhere in the subarachnoid space.

Another possible explanation by Suh SY suggests that some patients may have optic discs that are more susceptible to lower ICP than others[10].

As has been observed by Abdulfetah et al., the cause of the normal CSF pressure at LP in patients with normal pressure PTC despite the symptoms and signs suggestive of increased

ICP is obscure. The presence of papilloedema in these patients indicates increased ICP, which due to a certain cause failed to be transmitted to the spinal subarachnoid space[8].

Are low pressures and PTC mutually exclusive? Or can it still be PTC?

Corbett has observed that the diagnosis of PTC should not be made under any circumstances without finding elevated spinal fluid pressure[15]. Normal intracranial pressure has been defined as 136 mm H_20 (SD ± 37.6) in patients of normal weight, and 167 mm H_2O (SD ±36.46) in obese patients. Johnston and Paterson have observed wide fluctuations of CSF pressures[16]. It has also been noted that OP may vary in the same individual when measured at different times.

Mollan et al., have observed that despite optimizing the conditions for lumbar puncture, OP is still a one-off reading[17]. It is, however, useful retrospectively to ask the patient if their symptoms of visual obscuration's, headache, etc., improved for a few days after the lumbar puncture. Improvement supports the presence of raised intracranial pressure.

Tibussek et al., have concluded that OP measured during an LP is a snapshot of a highly dynamic process and that the results of opening pressure measurement must be correlated with caution and in the overall context of the patient's clinical history, symptoms and clinical signs[18].

Nevertheless, repeat LP and 24-hour monitoring of ICP and reassessment of OP may not be possible in all situations due to patient preference and logistic limitations.

Nomenclature – What's in a name?

The diagnostic criteria for pseudotumor cerebri syndrome (PTCS) have been revised recently by Friedman et al[19]. The authors mention "probable PTCS" as a subgroup of PTCS for patients with an OP even below 20 cm H_2O but with clinical signs and symptoms suggestive of PTCS.

While demonstration of raised CSF pressure is clearly an important component of the diagnosis of PTCS and can, in most instances be satisfactorily achieved by manometry via lumbar puncture, there will be cases with genuine PTCS in whom a single manometric pressure measurement on one or more occasions will be normal. This will be due either to the measurement being carried out during a trough in the ICP level (most instances) or to genuine 'normal-pressure' PTCS in a small but unknown proportion of cases. In these revised criteria, documentation of an elevated CSF opening pressure is required for the diagnosis of definite

PTCS, but the diagnosis of probable PTCS may still be made in an otherwise typical patient if bilateral papilloedema is present and the measured opening pressure is not elevated. Distelmaier et al. have proposed the concept of "probable IIH", and suggest adding 1) CSF OP may be less than 20 cmH_2O and 2) clear clinical response to initial pressure release and/or treatment to the diagnostic criteria[20].

It has been suggested that ICHD criteria need reconsideration in view of the fact that among a cohort of patients with headache secondary to IIH, no patient showed the elevated levels of opening CSF pressure established as a criteria for the disorder[21].ICHD 3 recognizes that "Relief of the headache after CSF removal is supportive of the diagnosis but not on its own diagnostic", but is still far from approving it as a significant criterion[3]. Hence, irrespective of the term used for diagnosis, it is prudent to recognize the fact that cases of IIH with normal pressures or Normal pressure PTC do occur, and early identification goes to save the patient of morbidity and avoidable complications

Conclusion

Strict reliance on criteria on OP in patients with papilloedema and other symptoms and signs of raised ICP may lead to avoidable delays in diagnosis and initiation of treatment. As papilloedema is reversible with appropriate treatment in IIH patients, and untreated papilloedema can result in progressive and irreversible visual loss, a broader approach ends diagnostic dilemma.

With many atypical cases being reported, patients with normal CSF OP may be categorized as "Atypical IIH or Normal pressure PTC or Probable PTC", and the diagnostic criteria may be modified to accommodate such cases. A single diagnostic LP, while recording the OP, doubles up as therapy in a significant proportion of IIH/PTC patients.

Table – 1

S.No.	Age	Sex	OP	Visual Field	6th CN Palsy	Papilloedema	Obesity	Management
1	28	F	21	BS↑	—	+	—	Cons.
2	40	F	18	BS↑	—	+	+	Cons.
3	37	F	19	BS↑	+	+	+	LP Shunt
4	36	M	16	BS↑	—	+	—	Cons.
5	45	M	14	BS↑	—	+	—	Cons.
6	49	M	21	BS↑	—	+	—	Cons.
7	15	F	19.5	—	—	+	—	Cons.
OP - Opening Pressure								
BS↑ - Blind Spot Enlargement								

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10. An Analytical Study on Posterior Fossa Meningioma – An Institutional Experience

Shankar D R, Suresh Babu T

Abstract

Background*: Posterior fossa meningiomas constitute about 15 to 20% of all types of intracranial meningiomas. They usually become large before they start producing clinical symptoms, because of their slow and indolent growth. Even though microsurgical excision is the mainstay of treatment, the tumors' location, encroachment of adjacent neurovascular structures and invasive behavior, makes surgical excision a challenging task.* ***Material and Methods****: This is a prospective clinical study of about 32 cases of posterior fossa meningiomas operated at The Institute of Neurosurgery, Rajiv Gandhi Government General Hospital & Madras Medical College, Chennai-3. The incidence, various surgical procedures, post operative complications and outcome are analyzed.* ***Results:*** *Gross total resection was done in 72% of the cases. Subtotal excision was done in petroclival and jugular foramen tumors with extra cranial extension, tentorial meningiomas with sinus extension and ventrally placed foramen magnum tumors. Post operative complications in the form of CSF leak was found in about 12.5% cases and new onset or aggravation of preexisting neurological deficit in about 33% of cases. We had encountered two recurrent cases over a mean follow up of 1 year.* ***Conclusion:*** *Because of its close proximity to the sinus and adjacent neurovascular structures, posterior fossa meningiomas are difficult to excise. Judicious use of Microscope, CUSA, intra operative nerve monitoring help in preserving vital anatomical substrates.*

Key words: Gross total resection, Meningioma, Posterior fossa

Introduction

Meningiomas are neoplastic lesions of benign nature and they constitute about 15 to 20% of all intracranial tumors. Posterior fossa meningiomas constitute about 85 to 10% of all intracranial meningiomas. They are usually large at the time of presentation since they grow very slowly. Even though microsurgical excision is the treatment of choice of these tumors, the classical characteristics like larger size, invasiveness and adhesion to adjacent neurovascular structures makes surgery challenging.

Aims and Objectives

This is a comprehensive study to analyze the different types of posterior fossa meningiomas and their clinical presentations and to enlighten the technical difficulties encountered during their surgical excision and to discuss their modes of management.

Materials and Methods

This is a prospective study of 32 cases of various types of posterior fossa meningiomas, operated at The Institute of Neurosurgery, Madras Medical College & Rajiv Gandhi Government General Hospital, Chennai - 3 from November 2015 to November 2017. All the patients were investigated with CT Brain, MRI Brain – with contrast, MRA and MRV.

The incidence, gender-wise distribution, different clinical presentation and the various surgical procedures and their post operative complications and post surgical outcome were analyzed.

The tumors were classified based on "Sekhar and Wright" classification as Type I – Cerebellar Convexity/Lateral Tentorial, Type II– Cerebellopontine Angle, Type III – Jugular Foramen, Type IV – Petroclival, Type V – Foramen Magnum, Type VI – Unclassified.

Observation and results

There were 32 cases of posterior fossa meningiomas, out of which 24 (75%) patients were females and 8 patients (25%) were males. The mean age of presentation was 44 years, with an age range from 18 to 70 years. Majority of the patients presented with dysfunction of cranial nerves and otological symptoms were frequent. Other clinical presentations included headache, cerebellar signs and brainstem signs. Some patients presented with signs of increased intracranial pressure.

Hearing loss/ Tinnitus were present in 17 patients (53%). Headache was the commonest presentation in 16 patients (50%). Cerebellar compression syndrome in the form of ataxia was seen in 15 patients (46%). 12 patients (37%) had features of Trigeminal anaesthesia / neuralgia and 10 patients had presented with features of lower cranial nerve palsies in the form of nasal regurgitation, dysphagia and dysphonia. Facial Nerve palsy was present in 4 patients (12%). Diplopia was seen in 3 patients (9%).

Type	Location	Anatomical Extension
I	Cerebellar convexity. Lateral Tentorial	Tentorium, transverse & sigmoid sinus
II	Cerebellopontine angle	Petrous ridge, Internal auditory canal
II	Jugular foramen	Cerebello medullary angle, Internal Jugular vein, Extra cranial
IV	Petro clival	Upper 2/3rdclivus, cavernous sinus, Meckel's cave, Petrous ridge
V	Foramen magnum	Lower 1/3rdclivus,C1C2 area
VI	Unclassified	Entire clivus, mid and lower clivus and other types.

Tumor Location	No. Of Cases	Surgical Approaches	Gross Total Excision	Subtotal Excision
CP Angle meningioma	10(31.2%)	Retromastoid Sub occipital craniectomy	7	3
Petroclival	6(18.8%)	Retromastoid Sub occipital craniectomy – 5 cases, Transpetrous approach – 1 case	4	2
Lateral Tentorial	4(12.5%)	Retromastoid sub occipital craniectomy	2	2
Cerebellar convexity	4(12.5%)	Suboccipital craniectomy	4	-
Jugular foramen	2(6.3)	Retromastoid suboccipital craniectomy	2	2
Foramen magnum	4(12.5)	Midline suboccipital craniectomy – 5 cases, Far Lateral approach – 1 case	3	1
Unclassified	2(6.3)	Retromastoid suboccipital craniectomy	1	1

Clinical Features	No. Of Patients	Percentage
Hearing loss/ Tinnitus	17	53%
Headache	16	50%
Ataxia	15	46%
Trigeminal Neuralgia	12	37%
Lower cranial nerve palsy	5	15%
Facial nerve palsy	4	12%
Diplopia	3	9%

Literature Studies	No. Of Cases	Gross Total Resection (%)	CSF Leak (%)	Overall Complications (%)	Mortality (%)
Roberti et al	161	57	13.6	41	2.5
Saleh et al	40	97	5	54	2.5
Lobato et al	80	62.5	2.5	67.5	6.2
Cudlip et al	52	84	4	54	11
Symon et al	73	78	4	72	9
Our Studies	32	72	12.5	45	3.2

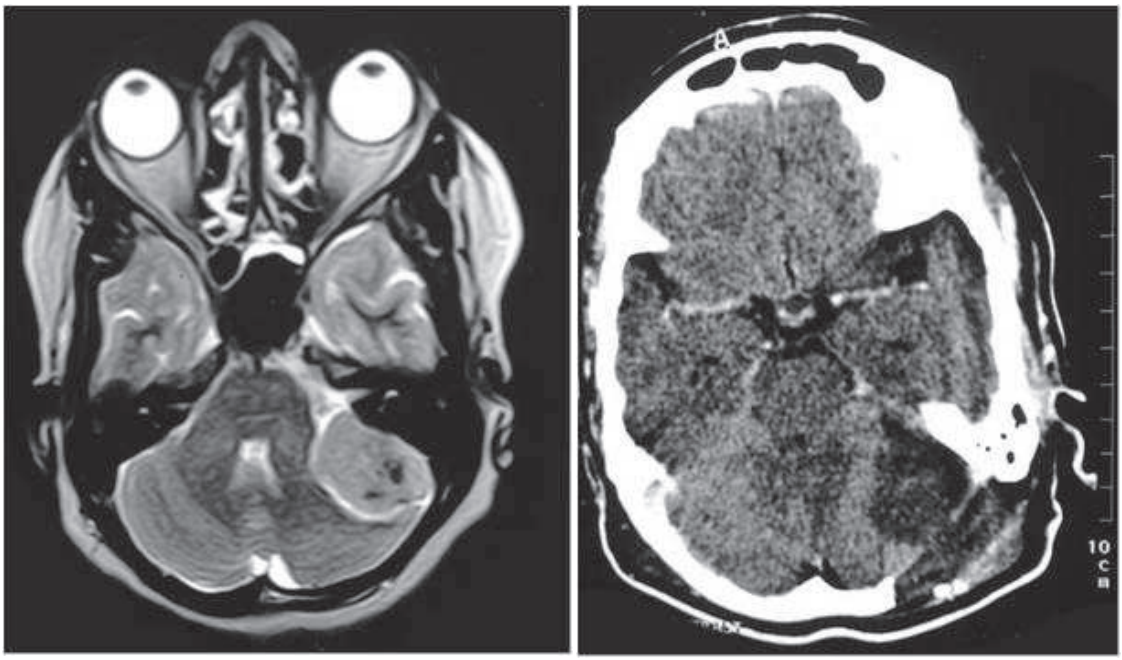

Figure: 1. Left Lateral Petrous meningioma: Pre-operative & Post-operative images.

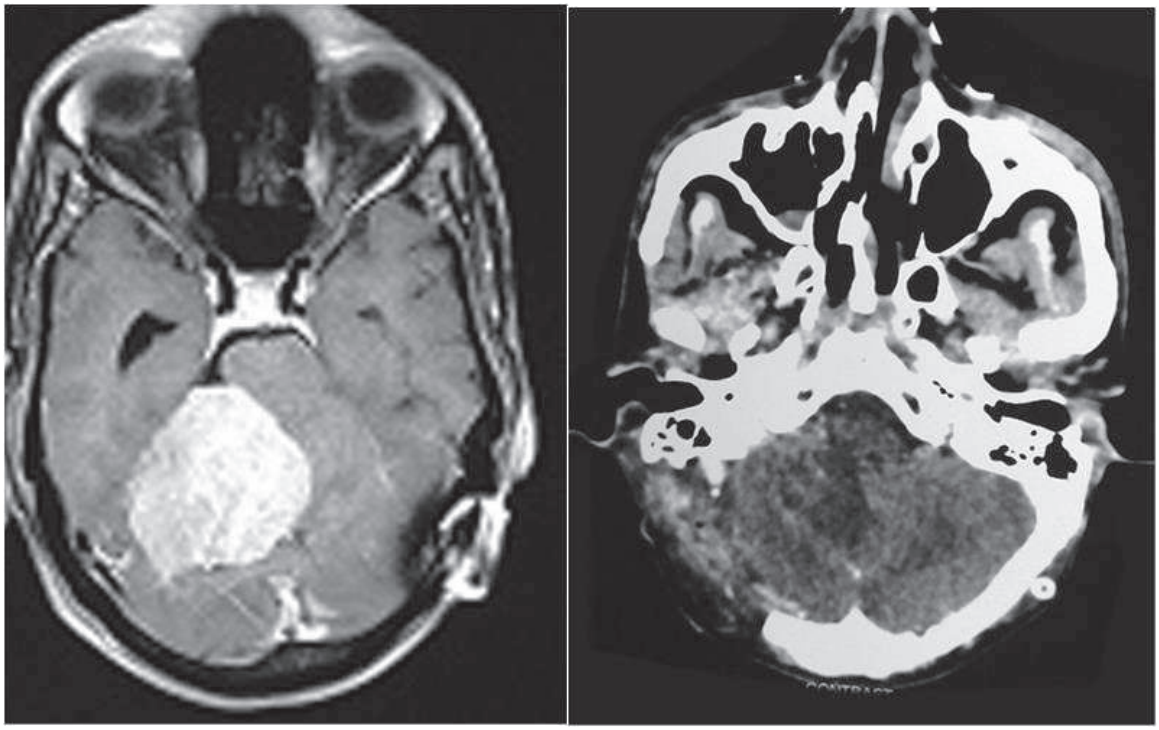

Figure 2: Right cerebellopontine angle meningioma: pre-operative & post-operative images.

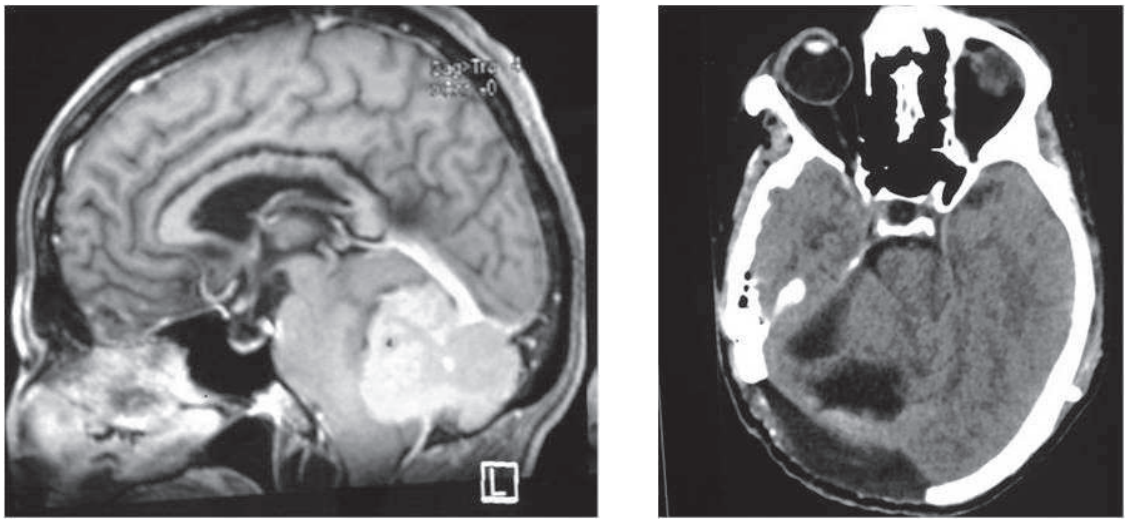

Figure: 3 Right Tentorial Meningioma: Pre-operative and Post-operative images

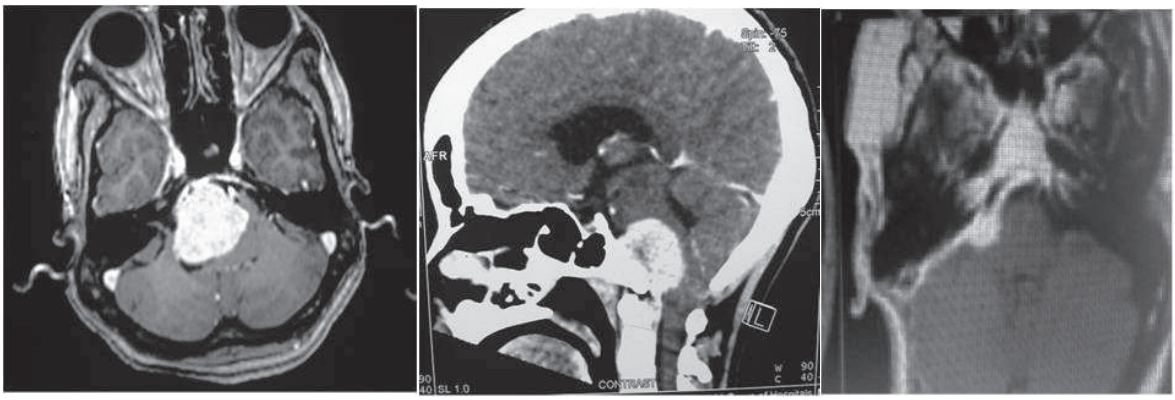

Figure: 4 Ventral Foramen magnum Meningioma: Pre-operative and Post-operative images.

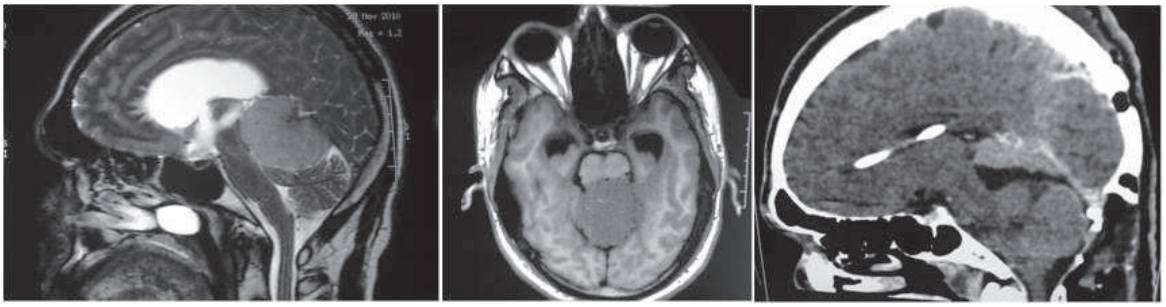

Figure: 5. Tentorial Meningioma: Pre-operative & Post-operative images showing residual lesion

Cerebellopontine angle meningioma was present in 10 patients (31.2%). All these patients underwent retromastoid suboccipital craniectomy. Gross total excision was done in 7 patients and subtotal excision was achieved in 3 patients.

Petroclival meningioma was present in 6 patients (18.8%). 5 patients underwent retromastoid suboccipital craniectomy and one patient underwent transpetrous approach. Total excision was done in 4 patients and subtotal excision was done in 2 patients.

4 patients (12.5%) had lateral tentorial meningiomas. All these patients underwent retromastoid craniectomy. Gross total resection was achieved in 2 patients and subtotal excision was done in 2 patients.

Cerebellar convexity meningiomas were present in 4 patients (12.5%). Suboccipital craniectomy was done in all the cases and total excision was achieved in all patients.

2 patients (6.3%) had jugular foramen meningiomas and both of them underwent retromastoid suboccipital craniectomy. Gross total excision was done in one patient and subtotal excision was done in the other patient.

Foramen magnum meningiomas were present in 4 patients (12.5%). Midline suboccipital craniectomy was done in 3 patients and Far Lateral approach was done in one case. Gross total excision was done in 3 patients and one patient underwent subtotal excision. Two patients had “Unclassified” meningiomas. Both underwent retromastoid, suboccipital craniectomy and gross total resection could be achieved in both cases.

Gross total excision was maximum in cerebellar convexity group and was minimum in Petroclival group. Subtotal excision was done due to tumor adhesiveness to the adjacent neurovascular structures, brain stem and venous sinus extension.

Postoperative complications were in the form of pseudomeningocele, CSF leakage, cranial nerve dysfunction, sinus thrombosis and long tract signs. Post operative cranial nerve dysfunction was found in 7 cases (21%), which was either progression of pre-operative dysfunction or new dysfunction. They were very common in petroclival meningiomas. CSF leakage was found in about 12.5% of patients. Post operative mortality was seen in two cases (3.2%) due to sinus thrombosis in one case and in the other, due to aspiration pneumonitis. We encountered 2 cases of recurrence (one petroclival & one tentorial meningioma) over an average follow up of about 6 months.

Discussion

Treatment of posterior fossa meningioma is individualized based on the size, location, growth rate and clinical presentation.

In our study, cerebellopontine angle meningioma subgroup was the commonest group (31.4%), followed by the lateral tentorial group and cerebellar types, and whereas in the classical series of Yasargil et al, about 30% of posterior meningiomas were located in the cerebellopontine angle and about 20% of meningiomas was located at the petroclival region.

Since these tumors are diagnosed very late due to its slow growth, cranial nerve palsy and the gait disturbances are the most common clinical presentation. Trigeminal nerves and the Vestibulocochlear nerves are commonly affected. Few patients present with signs of increased intracranial pressure due to hydrocephalus.

MRI Brain is the major investigation that helps in pre-operative surgical planning based on its site of origin and anatomical extensions. The involvement of skull bone is better delineated by CT Brain. MR Angiography clearly delineates the tumor extension to the venous sinuses, venous anatomy, jugular bulb size, anatomy of superior and inferior petrosal sinuses and extension of the tumor to the adjacent arteries. None of the tumors were subjected to preoperative embolization.

The posterior fossa meningiomas can be managed by observation, surgery, radiotherapy, or a combination of surgery and radiotherapy.

Periodical observation can be tried with interval MRI scans in small tumors and asymptomatic patients. Surgery remains the main stay of treatment in patients with tumor size larger than 3 cms diameter with neurological symptoms. For successful removal of these types of meningiomas, adequate bony exposure, early eradication of arterial feeders, adequate tumor debulking and maintenance of arachnoid plane are essential.

The retromastoid, retrosigmoid, suboccipital craniectomy was the commonly used surgical approach in our series, as in other series. This is a familiar approach and the surgeon finds the posterior and laterally displaced cranial nerves and the brainstem on the way to the tumor and he has to work through the narrow fissure left between the tentorium and cranial nerves.

Pre-sigmoid approach is an optimal surgical procedure for petroclival and pre-meatal cerebellopontine angle meningiomas, as it allows the surgeon to work approximately 2 cm

closer to the tumor. But, as per the recent literature, radical surgical treatment by pre-sigmoid approach is almost equivalent to the conventional retromastoid, suboccipital craniectomy.

Postoperative complications were relatively higher in patients with petroclival meningiomas. Hakuba et al had reported 17% mortality and new neurological deficit in 83% cases. Mayberg and Symorn had reported 9% mortality with 50% permanent morbidity rates.

Sekhar et al had achieved complete tumor removal in about 73% cases with operative mortality in 4% cases. In our series, the rate of complete excision and post operative neurological deficit were better with cerebellopontine angle meningiomas than petroclival meningiomas. We had achieved gross total resection in 72% of cases with post operative new or aggravation of existing neurological deficit in 33% cases.

Moreover, in our series, subtotal excision was more in petroclival, jugular foramen lesions with extra cranial extension, tentorial meningiomas with sinus extension and anteriorly placed foramen magnum meningiomas. Even though subtotal excision carries lesser complication rates, the chances of recurrent growth are very common. Recently, many centers recommend subtotal resection for old patients or when there are factors defying complete removal.

The rate of recurrence was five to ten times higher in patients with subtotal or partial excision compared with radical excision. In Couldwell et al series, in which gross total excision was in 69% of the patients, 13% had documented recurrence or progression over two year, follow up. In our series, we had two recurrent cases over an average follow up of one year. The recurrent cases were seen in petroclival and tentorial subgroups.

Adjuvant radiotherapy is considered to be the secondary modality of treatment in patients, who underwent subtotal resection, since they have higher chances of tumor recurrence.

Stereotactic Radiosurgery (SRS) provides a highly focused, single fraction radiosurgery, confined to the tumor, thereby reducing the incidence of complications that are associated with fractionated radiotherapy. SRS effectively prevents tumor progression, prolongs the interval to recurrence and improves survival rates.

Taylor et al, had determined a 10 year progression free survival rate in cases of subtotal, gross total and subtotal plus radiosurgery subgroups of meningioma and found that recurrence was very high in subtotal subgroup but was same in gross total and subtotal plus radiosurgery subgroups. In this way, the surgeon can remove the bulk of the tumor and the

residual lesion can be treated with radiosurgery, but the benefit is limited as tumor volume increases.

Conclusions

Posterior fossa meningiomas are very difficult to excise and still remain a challenge to the operating surgeon, because of their close proximity to the adjacent vessels, sinuses and cranial nerves.

The use of microscope, CUSA, helps in gross total or subtotal removal, preserving the surrounding important anatomical substrates.

Despite aggravation of post operative neurological deficits, recovery occurs completely after total removal, thus increasing the recurrence free period and thereby improving the outcome.

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11. Intra Parenchymal Extraventricular Supratentorial Ependymomas - Rare Case Series

Jayakumar Perumal, Thiruvalluvan A

Introduction

Ependymomas are glial tumours that can occur throughout the neural axis, usually in close proximity to the ventricles or central canal. While the fourth ventricle is a common location for ependymoma, we present four rare cases of an entirely intraparenchymal supratentorial tumour, remote from the ventricular surface. The histological features, which remain identical despite the varied morphology of intraventricular versus intraparenchymal tumours, are also considered.

Case Report:

Case 1: A 14-year-old girl presented with progressive symptoms of increased intracranial pressure of one month duration. CT scan revealed a right frontal extra-ventricular space occupying lesion with calcifications. She underwent gross total resection. Histopathological examination was consistent with ependymoma. Patient is asymptomatic at follow up.

Case 2: An 11 year old boy presented with headache, vomiting and seizure for 15 days duration. CT scan revealed a left parietal extra-ventricular inhomogeneous space occupying lesion with solid and cystic components with calcifications. He underwent total resection of the solid component. Histopathological examination was consistent with ependymoma - tumour cells were characteristically organized in perivascular pseudo-rosettes. Eight months later, he presented to us with persistent headache with seizure. MRI brain showed recurrence of the left parietal lesion. The patient underwent surgical revision with total removal of the tumour including the solid component and the cystic one and patient was referred to radiation oncology for adjuvant radiotherapy.

Case 3: A six year old girl presented with headache, vomiting and blurring of vision of 15 days duration. Papilledema was seen on fundus examination. She underwent Right ventriculo-peritoneal shunt in another center for obstructive hydrocephalus. Left temporo parietal craniotomy was done. Through cannula, the parietal cyst was tapped at a depth of 2cms and 15ml fluid was aspirated. Subtotal excision of the lesion was done under microscopic guidance. Lateral wall of ventricle with thin rim of brain parenchyma was intact. Post-operative period

was uneventful. Patient was referred to radiation oncology for adjuvant radiotherapy and is under follow up.

Case 4: 18 year old male presented with complaints of headache of one month duration, two episodes of seizures and right upper and lower limb weakness for fifteen days. MRI brain revealed Left fronto-temporo and peri-insular dural based intra-axial mass lesion with heterogeneous enhancement and perilesional edema. Left fronto-parietal craniotomy was done. Corticotomy was done and red-greyish glistening, highly vascularised and friable solid component was visualised and excised.

Microscopic examination of the resected specimen showed a clear cell tumour with cells predominantly arranged in sheets and nests with areas of perivascular pseudo-rosettes and ependymal rosettes. Individual tumour cells were round to oval with clear cytoplasm, having round hyperchromatic nuclei and inconspicuous nucleoli. Focally, cells showed mild anisonucleosis, nuclear atypia and increased mitosis (4-6/HPF). Areas of reactive gliosis, calcification and endothelial proliferation were also present. IHC showed immune-reactivity for GFAP, strong positivity for vimentin and dot positivity for EMA. This confirmed the diagnosis of intraparenchymal clear cell ependymoma.

Discussion

In 1863, Virchow defined ependymomas as tumours with ependymal cells forming ependymal rosettes and perivascular pseudo-rosettes[1]. Ependymomas are glial derived tumours that can occur throughout the neural axis, usually in close proximity to the ventricles or central canal. Fourth ventricle is a common location for ependymoma.

Extra ventricular ependymomas arise from trapping of embryonic rests of ependymal tissue in the developing cerebral parenchyma. They account for approximately 5% of all neuro-epithelial neoplasms, about 10% of all pediatric brain tumours and up to 33% of brain tumours occurring in those less than 3 years of age.

Pathophysiology

As the name implies, extra-ventricular ependymomas arise outside the walls of the ventricular system. They are postulated to arise from remnant nests of ependymal cells in the frontal lobe anterior and inferior to the normal extent of the frontal horns of the lateral ventricles. These remnants come from an extension toward the frontal lobe bases of the frontal horns, so-called “olfactory ventricle” that collapses and regresses during normal development.

However, random distribution of ependymomas occur around the periventricular region, rather than restriction to the angles of the ventricles [2].

Macroscopic appearance

Macroscopically, ependymomas tend to be well defined lobulated grey or tan coloured soft and frond-like tumours. The supratentorial ependymomas tend to be larger in size than those infratentorial. Armington et al [6] found that 94% of supratentorial tumours manifest with a size larger than 4 cm, while most infratentorial ependymomas are significantly smaller at presentation. Their shape is irregular in the posterior fossa accommodating to shape of ventricle or cisterns; however they are spherical in the cerebral hemisphere. Supratentorial ependymomas often contain a cystic component, while infratentorial ependymomas are often more solid tumours [6, 7]. Signal from ependymal cysts is higher than that from CSF. Calcifications, ranging from small punctuate foci to large masses, are very common in both infra and supratentorial ependymomas (40-80% of cases)[7, 8]. Our patient presented with a tumour larger than 4 cm in size, mainly cystic with calcifications imbedded in the wall and in the solid part.

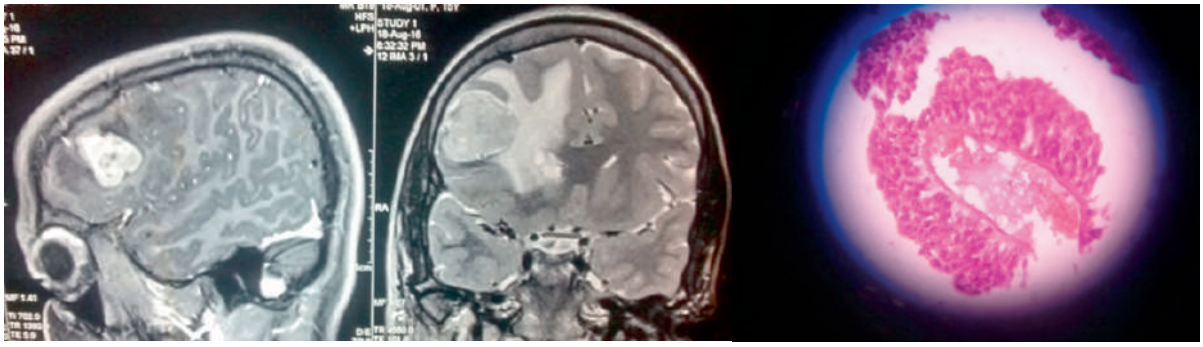
Microscopic appearance

Microscopically, these tumours are characterized by well-differentiated cells. Characteristic features include ependymal rosettes, which are uncommon but pathognomonic and perivascular pseudo-rosettes which are far more common and seen in most of ependymomas [3,4].At histological analysis, ependymomas are moderately cellular tumours with rare mitotic figures. Shuangshoti S et al [8] found that there was no significant relation between histopathology, Ki-67 proliferation index, p53 immuno-labeling, tumour ploidy, and biological behaviour.

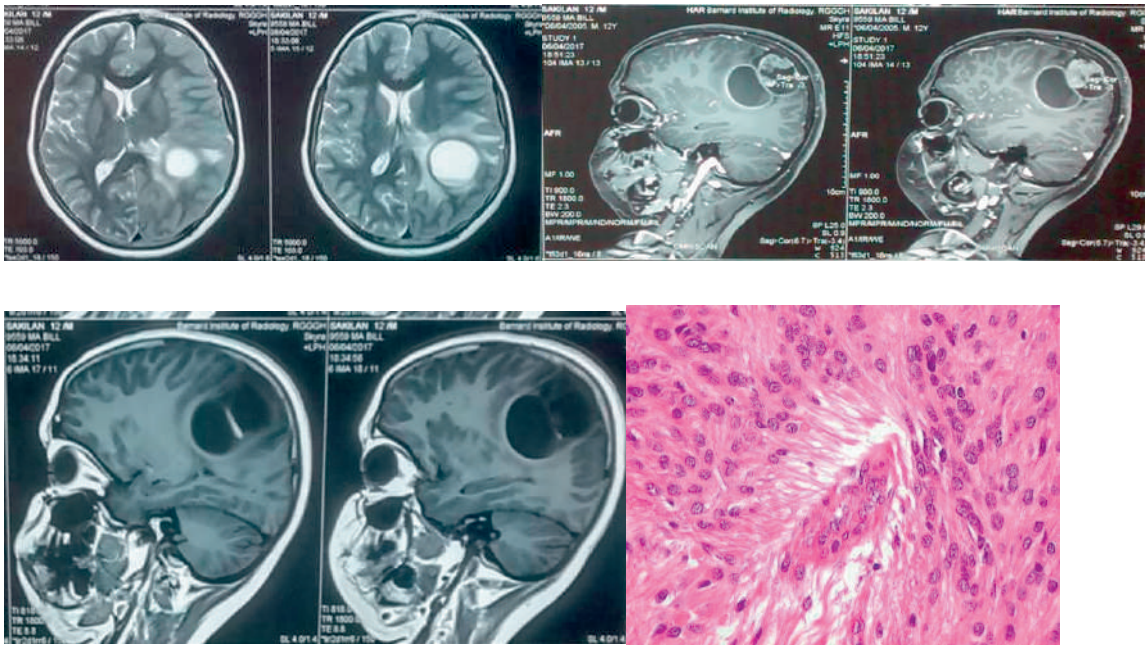
Diagnostic imaging

Ependymomas are typically heterogeneous masses with areas of necrosis, calcification, cystic change and haemorrhage frequently seen. This results in a heterogeneous appearance in all imaging modalities.

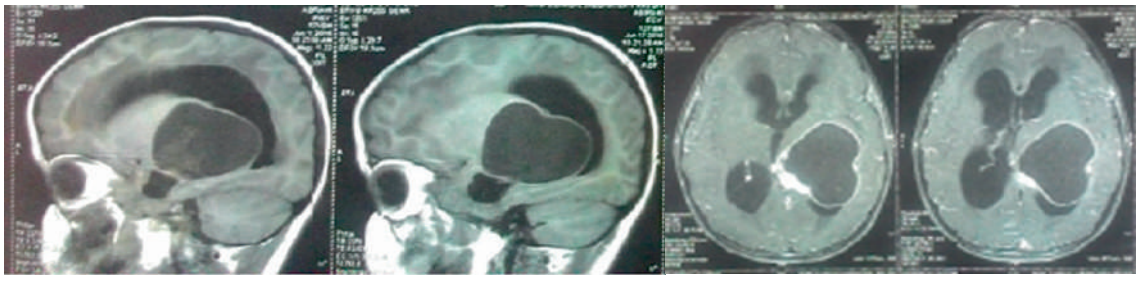
Intra-parenchymal lesions, usually supratentorial, are generally large and variable in appearance, ranging from completely solid, enhancing masses to cysts with a mural nodule, or more heterogeneous masses [5].



Case 1: MRI Contrast study and HPE result of the same lesion



Case 2: MRI T2, Contrast and T1 with HPE of the same lesion



Case 3: MRI Brain T1 plain and contrast

In CT, coarse calcification is common (50%), followed by cystic areas (50%) with solid component iso to hypodense with heterogeneous enhancement and variable areas of haemorrhage.

In MRI, solid portions of ependymoma typically are isointense to hypointense in T1 [5]. T2 weighted images are hyperintense. Susceptibility weighted images show foci of blooming from haemorrhage or calcification. Heterogeneous enhancement with gadolinium is useful in differentiating tumor from adjacent vasogenic edema and normal brain parenchyma. DWI/ADC shows restricted diffusion which may be seen in solid components, especially in anaplastic tumor. Diffusion should be interpreted with caution in masses with significant haemorrhage or calcification. MRS shows Choline peak elevation according to the cellularity of tumor, NAA peak reduction, elevated Cho/Cr ratio and lipid and lactate rise when degeneration occurs. FLAIR sequence better visualizes the border between tumour and ventricular wall.

Careful examination of the entire neuraxis is required to assess for the presence of CSF seeding although it is uncommon when compared to tumours like medulloblastomas,

There is no specific MR image for intra parenchymal ependymomas. They may include calcifications in different patterns, or have heterogeneous enhancement. Differential diagnoses include oligodendroglioma, astrocytoma, germ cell tumours, desmoplastic infantile ganglioglioma, and primitive neuroectodermal tumor.

Treatment

As the tumour is amenable to total radical resection, radical surgery is to be attempted for solid extraventricular tumors located far from clinically eloquent brain areas. Early second-look surgery is proposed to achieve total excision in selected patients with accessible residual tumour detected on postoperative MRI [10].

The need for postoperative adjuvant therapy has been controversial for supratentorial ependymomas. Postoperative radiation therapy must be administered in every case of partially resected ependymomas due to proximity to eloquent areas. So, in general, it is considered safe to observe the patient when postoperative CT or MR shows gross total excision. Supratentorial ependymomas tend to recur in regions amenable to surgery. Therefore, reoperation to attempt complete tumour resection before initiation of radiotherapy should be considered [10,11].

Some authors recommend adjuvant radiotherapy if the tumour is cystic, even after apparently total resection. Adjuvant radiotherapy has also been suggested to be given to

patients with anaplastic ependymomas [9,10]. In our case we considered complementary radiotherapy as the cyst wall was incompletely removed after the first surgical procedure.

Of the different variants of ependymomas, cellular and papillary are most common, while clear cell and tanycytic ependymomas are uncommon. Unlike most ependymomas, clear cell ependymomas (CCE) are associated with an aggressive behaviour and tend to recur early despite gross total resection, and needs vigorous management.

Prophylactic craniospinal irradiation is no longer advocated unless cerebrospinal seeding is evident on imaging or cerebrospinal fluid studies[10]. The benefit of chemotherapeutic agents is questionable. They are used in children for whom radiotherapy is contraindicated or in previously irradiated subjects with an inoperable tumor [9].

Prognosis

Throughout the literature, three major factors were identified determining the outcome. The most important prognostic variable was the presence of radiologic residual disease, seen at postoperative MR imaging or CT. The 5-year-tumor-free survival rate was 75% and 15% for patients with no radiologic evidence of residual tumor and those with residual disease in which progression cannot be stopped, respectively [11].

Poor prognostic factors include a 4th ventricular location, anaplastic variant and incomplete resection. As such, children have a worse prognosis (both 4th ventricular location and anaplastic variant are more common in children). Overall, the 5-year survival rate in children ranges from 50 to 75%. Once recurrence has occurred, the prognosis is very poor, with a mortality rate of 90%(13). When considered together, age at diagnosis along with extent of the surgical resection was better correlated to outcome [14].

The last prognostic variable is the duration of symptoms preceding diagnosis. Patients with symptoms lasting less than one month before diagnosis have a worse outcome than those with a more protracted course[13]. Patients with supratentorial ependymomas have generally a better survival rate than patients with posterior fossa ependymomas [14].

Conclusion

As the tumour is amenable to total radical resection, radical surgery alone is an option. The need for postoperative adjuvant therapy has been controversial for supratentorial ependymoma. Postoperative radiation therapy must be administered in every case of partially resected ependymoma. Adults have a better five-year survival rate than children. When

considered together, age at diagnosis along with extent of the surgical resection was better correlated to outcome. Patients with symptoms lasting less than one month before diagnosis have a worse outcome than those with a more protracted course.

Patients with supratentorial ependymomas have generally a better survival rate than patients with posterior fossa ependymomas.

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12. Hyponatremia in Acute Traumatic Brain Injury: Incidence and Outcome

Vijayakumar G, Raghavendran R

Abstract

Background: *Hyponatremia is one of the most common electrolyte abnormality encountered in traumatic brain injury patients and is also an independent predictor of poor neurological outcome. Incidence of hyponatremia in TBI varies widely in literature so we decided to assess the incidence of hyponatremia in TBI and the outcome of TBI with hyponatremia.* ***Aim:*** *To study the incidence of hyponatremia and its effect on neurological outcome in TBI.* ***Materials and Methods:*** *A retrospective study conducted on patients admitted in neurosurgical ward and critical care unit, between July 2018 and December 2018 in a tertiary care centre. Study included 300 patients with 60 patients having serum sodium level <135 mEq/L on the day of admission and subsequently measured on daily basis up to seven days and the outcome measured on seventh day of admission and at the time of discharge.* ***Statistical Analysis:*** *Analysis was done to find out the effect of hyponatremia on neurological outcome in TBI.* ***Results:*** *Hyponatremia was noticed in 20% of patients in this study. 15% of hyponatremic patients and 5.83% of patients with normal sodium level died. 54% of hyponatremic patients with severe TBI died, whereas only 29.62% of normal sodium level patients with severe TBI died.* ***Conclusion:*** *Hyponatremia was associated with poor outcome both in terms of mortality and increased severity of TBI but the association was not proven to be statistically significant.*

Introduction

Hyponatremia is defined as a serum sodium concentration below 135mEq/L and is one of the most common electrolyte abnormality encountered in patients with traumatic brain injury [(1)]. The reported incidence of hyponatremia in TBI ranges from 9.6 to 51% [(2–6)] and it is well established that hyponatremia is an independent predictor of poor neurological outcome in patients with TBI [(7–9)].

Hyponatremia is one of the common causes of secondary brain injury [10]. When hyponatremia is associated with hypotonicity, it contributes to increased intracellular fluid

volume. If it is not corrected promptly, it may cause serious complications such as malignant brain edema leading to brainstem herniation, and eventually to death [11].

Hyponatremia is associated with significant morbidity and mortality, especially if corrected too fast or too slowly[8]. Sodium correction within first 48 hours of onset may directly correlate with the neurological outcome and can affect overall prognosis.

Common causes of hyponatremia in TBI are dysfunction of hypothalamo- hypophyseal-adrenal axis, SIADH, CSW and use of 20% mannitol[13-18]. Clinical manifestations of hyponatremia are related to its severity, with symptoms appearing when plasma sodium level is less than 125mEq/L.

It is hypothesized that hyponatremia measured at admission can be used as an independent predictor of fatal outcome associated with brain injury. So we decided to undertake a retrospective analysis to study the incidence of hyponatremia and its outcome in patients with TBI.

Methods

A retrospective study conducted on patients admitted in neurosurgical ward and in intensive care unit in a tertiary care centre between July 2018 and December 2018 with data obtained from hospital records.

Study included 300 patients with 60 patients having serum sodium <135 mEq/L on the day of admission and subsequently measured on daily basis up to seventh day or at the time of discharge.

Clinical parameters recorded were complete blood count, renal function test, serum electrolytes and liver function test. The severity of the head injury was graded based on the GCS score as mild (GCS score 13-15), moderate (9-12) and severe (3-8). Hyponatremia was further classified as mild (serum sodium 130-134 meq/L), moderate (serum sodium 125-129 meq/L) and severe (serum sodium < 125 meq/L).

Patients admitted within 24 hours after head injury and with confirmed diagnosis with CT brain were included in the study. Patients with following criteria were excluded from the study: (1) Patients who had prior history of drinking alcohol or abusing any drugs, (2) Prior history of other organ dysfunction (e,g, liver, kidney, adrenal and heart disease). Study was approved by institutional ethical committee.

Statistical Analysis

Association between hyponatremia and severity of head injury was assessed using Chi-Square test. Results were presented with Pearson Chi-Square and likelihood ratio. In all cases statistical significance was considered to be present when p-value was <0.01.

Results

A total of 300 patients admitted with a diagnosis of traumatic brain injury matching the inclusion criteria were included in the study. 60 patients had hyponatremia with an incidence of 20%. Of the total number of patients, 68% were males and 32% were females and mean age of the population was 39.2 years. In this study, 164(54.66%) had mild, 98(32.66%) had moderate and 38(12.66%) patients had severe head injury. Among the patients with hyponatremia, the incidence of mild, moderate and severe hyponatremia was 50%, 35% and 15% respectively.

Table: 1 shows that 17.07% of patients with mild TBI, 21.42% of patients with moderate TBI, and 28.94% of patients with severe TBI had hyponatremia.

Table: 2 shows that 10% of patients with mild hyponatremia had GCS <8 and 40% of patients with mild hyponatremia had GCS <13. 14% of patients with moderate hyponatremia had GCS <8 and 61.90% of patients with moderate hyponatremia had GCS <13. 55.55% of patients with severe hyponatremia had GCS <8 and 40% of patients with severe hyponatremia had GCS <13.

Table 3 shows that total mortality in hyponatremia in TBI was 15% and mortality in mild, moderate and severe hyponatremia was 3.33%, 19.04%, and 44.44% respectively.

Table 4 shows that 15% of hyponatremic and 5.83% patients with normal sodium level patients died in this study. 54.54% of patients with hyponatremia with severe TBI died whereas 29.62% of normal sodium level patients with severe TBI died.

GCS	Hyponatremia		Total
	Yes	No	
Mild (14-15)	28(28.94%)	136(82.92%)	164
Moderate (9-13)	21(21.42%)	77(78.57%)	98
Severe (1-8)	11(17.07%)	27(71.05%)	38
Total	60 (20%)	240 (80%)	300

Table: 1 Incidence of hyponatremia in various grades of TBI.

GCS	Hyponatremia (Meq/L)			Total
	Mild (130-134)	Moderate(126-129)	Severe(<125)	
Mild (14-15)	18(60%)	8(38.09%)	2((22.22%)	28
Moderate(9-13)	9(30%)	10(47.61%)	2(22.22%)	21
Severe(1-8)	3(10%)	3(14.28%)	5(55.55%)	11
Total	30	21	9	60

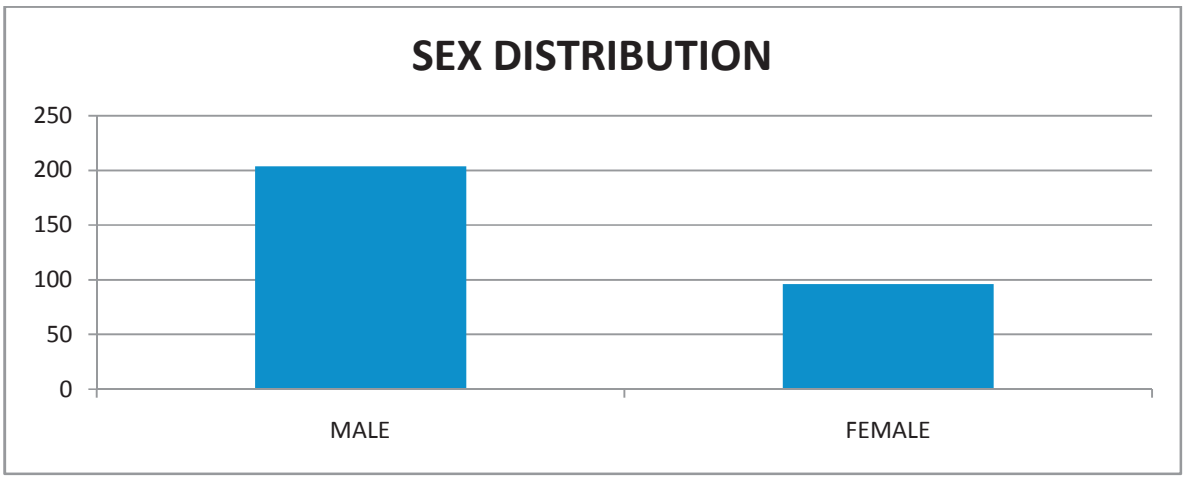
Table: 2 Relationship of severity of hyponatremia with various grades of TBI.

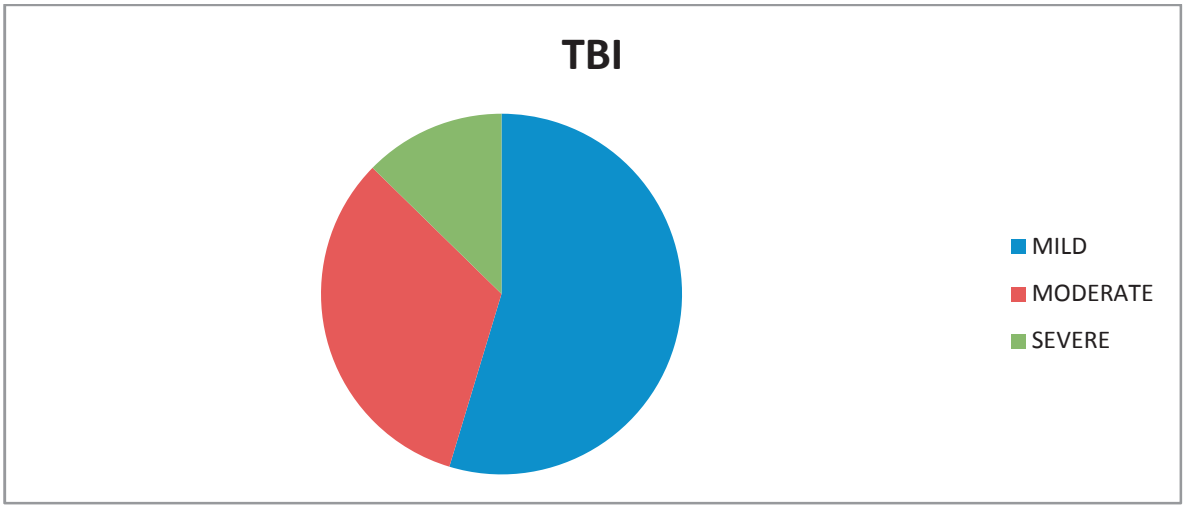
GCS	Hyponatremia			Total
	Mild	Moderate	Severe	
Moderate	0	2	1	3
Severe	1	2	3	6
Total	1(3.33%)	4(19.04%)	4(44.44%)	9(15%)

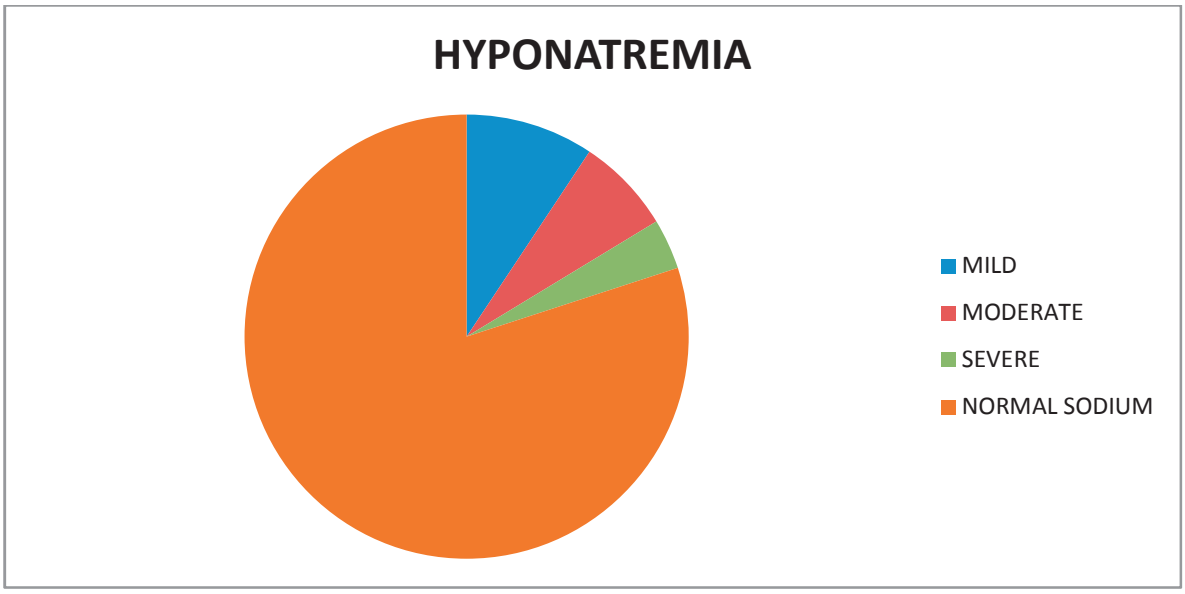
Table: 3. Correlation of mortality in severity of hyponatremia with various grades of TBI.

GCS	Hyponatremia	
	Yes	No
Mild(14-15)	0	2
Moderate (9-13)	3	4
Severe (1-8)	6 (54.54%)	8 (29.62%)
Total	9(15%)	14(5.83%)

Table: 4. Correlation of mortality between patients with hyponatremia and normal sodium.







Discussion

Hyponatremia is very common in traumatic brain injury patients, and it is one of the significant risk factors leading to secondary brain damage [5]. The risk of complications like cerebral edema is more within first 48 h of onset due to water shift into brain cells because of low osmolality as compared to chronic hyponatremia (onset>48 h), as most of compensatory mechanisms are not fully developed in acute hyponatremia [11-15].

The incidence of hyponatremia in traumatic brain injury varies widely in literature. Sherlock et al reported an incidence of 9.6% [3], Moro et al in a retrospective analysis of 298

patients with TBI documented an incidence of 16.8 % [2], Meng X et al found that one third of their patients with TBI had hyponatremia and Yumoto et al have reported an incidence of 51% [4]. In our study the incidence of hyponatremia was 20% and the incidence of mild, moderate and severe hyponatremia in total study population was 10%, 7%, and 3% respectively.

Conclusion

In this study, we found that there was an association between the presence of hyponatremia and increasing severity of head injury. 55% of patients with severe hyponatremia had severe head injury (GCS<8) as compared to only 10% and 14% of patients with mild and moderate hyponatremia respectively. This association was found to be statistically significant (p value < 0.01)

In our study 15% of hyponatremic and 5.83% patients with normal sodium level patients died

In our study we found a statistically significant correlation between severity of hyponatremia and severity of TBI. Also the mortality rate in patients with similar GCS was higher in the group of patients with hyponatremia as compared with normal sodium levels. However this association was not found to be statistically significant after applying Chi-square test (p-value >0.495).

Limitations

This was a retrospective study carried out with small sample size. While many studies done in the past are prospective while determining outcome. It was a single center study. Multi-center studies on a large sample size may be required further to validate this concept and to obtain statistically significant results.

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13. Symptom Analysis in a Short Series of Spinal Space Occupying Lesions

Madhan S, Devanand Senthil Kumar S

Introduction

The symptoms of spinal cord tumours range from pain (which may be local/diffuse/radicular/night pain), motor weakness, sensory disturbances to bladder and bowel disturbances. Many a time, we find that the symptomatology is at variance with what is taught traditionally.

Aim

Aim of our study is to 1) analyze, compare and contrast the clinical presentations, pre-op diagnosis & management of spinal tumours in a short series of cases and 2) to find out whether the symptomatology & symptom progression in daily clinical practice correlates with that taught traditionally.

Materials and Methods

Eight patients admitted between December 2017 and February 2018 were included in this study. In our series of 8 patients, 5 were female and 3 were male. Out of 8 patients 3 patients presented with weakness of limbs, one presented with numbness and weakness of limbs, 4 patients presented with local pain & weakness, 3 patients had urinary symptoms and 4 had bowel symptoms. Investigations revealed that out of the eight patients, two had extradural lesions, three had intradural extramedullary (IDEM) lesions and three had intramedullary lesions. All the 8 patients underwent surgery and specimens were subjected to HPE.

Of the two extradural tumours, HPE turned out to be a round-cell tumour in one patient and a secondary deposit from an unknown origin in the other patient. Of the 3 cases of IDEM, HPE turned out to be schwannoma in 2 patients and psammomatous meningioma in 1 patient. Of the 3 intramedullary tumours, HPE turned out to be an ependymoma in 2 patients and a tuberculoma in 1 patient.

In this study, we have analyzed the symptoms and signs with particular reference to 1) Symmetricity, 2) Rate of progression, 3) Pain, 4) Spasticity, 5) Bladder and bowel involvement.

Features	Extradural	Intradural-Extramedullary	Intramedullary
Involvement (Symmetrical/Asymmetrical)	Symmetrical	Asymmetrical	Usually asymmetrical
Progression	Rapid	Usually slow	Slow
Root Pain	More common	Common	Rare
Spasticity	Common	May be present	Less common
Bladder and bowel involvement	Late	Late	Early
Fasciculations	Rare	Rare	Common
Muscle atrophy	Uncommon, limited	Uncommon, limited	Long segment due to anterior horn cell involvement
Pain and temperature sensations	Lost late	Lost, If spinothalamic tract Is involved	Lost early
Dissociative sensory loss	Absent	Absent	Present
Spinal tenderness	Common	Common	Rare
Trophic skin changes	Uncommon	Rare	Present
Bony changes on X-rays	Present	May be present	Absent

Table 1.Common Clinical Features of Spinal Tumours

Clinical diagnosis was made and compared with radiological and intra operative findings. The common clinical features of extradural, IDEM & Intramedullary tumours are shown in Table 1.

Case 1:

S.No.		Age/ Sex	53 Years / Male
1		Clinical Parameters	
	Clinical Diagnosis According To Traditional Teaching Intramedullary	1.Involvement (Symmetrical / Asymmetrical)	Asymmetrical
		2.Progression	Rapid (4 Months)
		3.Root Pain	Absent (Only Low Back Pain)
		4.Spasticity	Hypotonia
		5.Bladder & Bowel Involvement	Early-7 Days From Onset Of Symptoms
2	Radiological Diagnosis		IDEM Tumour
3	Intra-Operative Diagnosis		Extradural Tumour
4	Post – Operative Diagnosis (HPE)		Small Round Cell Tumour

Table 2 shows the clinical, radiological, intra-operative and histopathological diagnosis.

Case 2:

S.No.		Age / Sex	29 Years / Female
1	Clinical Diagnosis According to Traditional Teaching Differential Diagnosis 1.Extradural 2.Intramedullary	Clinical Parameters	
		1.Involvement (Symmetrical / Asymmetrical)	Symmetrical
		2.Progression	Rapid (One Day)
		3.Root Pain	Absent
		4.Spasticity	Hypotonia
		5.Bladder & Bowel Involvement	Early involvement (Retention & Constipation)
2	Radiological Diagnosis		IDEM Tumour
3	Intra-Operative Diagnosis		Extradural Tumour
4	Post – Operative Diagnosis (HPE)		Small Round Cell Tumour

Table 3 shows the clinical, radiological, intra-operative & histopathological diagnosis.

Case 3:

S.No		Age / Sex	42 Years / Female
1	Clinical Diagnosis According To Traditional Teaching Differential Diagnosis 1.Intramedullary 2.IDEM	Clinical Parameters	
		1.Involvement (Symmetrical / Asymmetrical)	Asymmetrical
		2.Progression	Slow (1 ½ Years)
		3.Root Pain	Absent
		4.Spasticity	Present
		5.Bladder & Bowel Involvement	Not Involved
2	Radiological Diagnosis		Extradural Tumour
3	Intra-Operative Diagnosis		IDEM Tumour
4	Post – Operative Diagnosis (HPE)		Psammomatous Meningioma WHO Grade 1

Table 4 shows the clinical, radiological, intra-operative & histopathological diagnosis.

Case 4:

S.No		Age / Sex	64 Years / Male
1	Clinical Diagnosis According To Traditional Teaching Extradural	Clinical Parameters	
		1.Involvement (Symmetrical / Asymmetrical)	Symmetrical
		2.Progression	Rapid (6 Months)
		3.Root Pain	Absent
		4.Spasticity	Normal Tone
		5.Bladder & Bowel Involvement	Not Involved
2	Radiological Diagnosis		IDEM Tumour
3	Intra-Operative Diagnosis		IDEM Tumour
4	Post-Operative Diagnosis (HPE)		Schwannoma WHO Grade 1

Table 5 shows the clinical, radiological, intra-operative & histopathological diagnosis.

Figure 1A 1B & 1C shows the sagittal & coronal and axial sections of T2 weighted MR image of this patient.

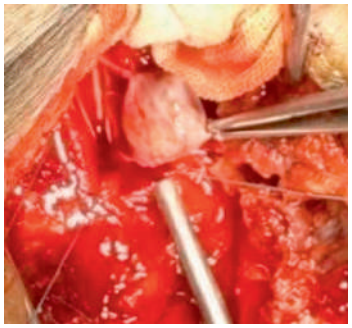

Figure 1D shows intra-operative picture.

Case 5:

S.No		Age / Sex	40 Years / Male
1	Clinical Diagnosis According To Traditional Teaching Differential Diagnosis 1.Extradural 2.Intramedullary	Clinical Parameters	
		1.Involvement (Symmetrical / Asymmetrical)	Symmetrical
		2.Progression	Rapid (5 Months)
		3.Root Pain	Absent
		4.Spasticity	Present
		5.Bladder & Bowel Involvement	Bladder Symptoms (Urinary Retention)
2	Radiological Diagnosis		IDEM Tumour
3	Intra-Operative Diagnosis		IDEM Tumour
4	Post – Operative Diagnosis (HPE)		Schwannoma WHO Grade 1

Table 6 shows the clinical, radiological, intra-operative & histopathological diagnosis.


F

Figure 2A shows the sagittal section of T2 weighted MR image of this patient.

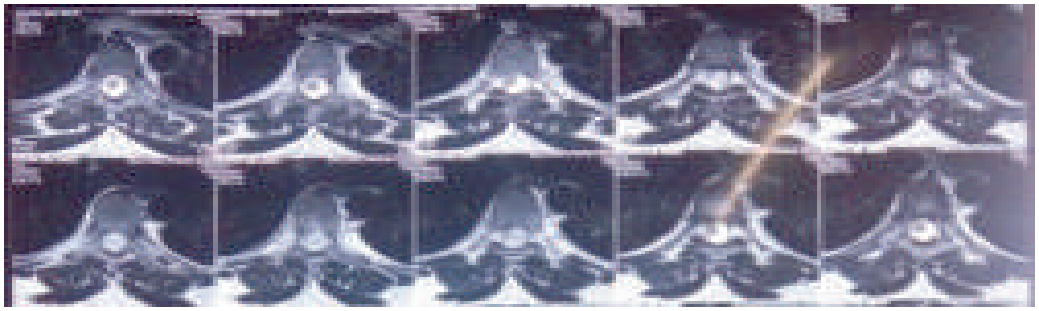

Figure 2B shows axial sections of T2 weighted MR image of this patient

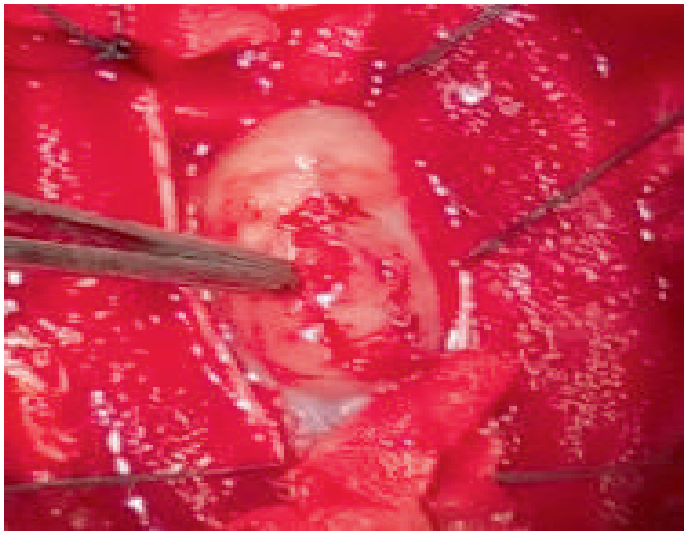

Figure 2C shows intra-operative appearance.

Case 6:

S.No		Age / Sex	17 Years / Female
1	Clinical Diagnosis According To Traditional Teaching Extradural	Clinical Parameters	
		1.Involvement (Symmetrical / Asymmetrical)	Asymmetry
		2.Progression	Rapid (5 Months)
		3.Root Pain	Absent
		4.Spasticity	Present
		5.Bladder & Bowel Involvement	Not Involved
2	Radiological Diagnosis		IDEM Tumour
3	Intra-Operative Diagnosis		Intramedullary Tumour
4	Post – Operative Diagnosis (HPE)		Pilocytic Astrocytoma WHO Grade 1

Table 7 shows the clinical, radiological, intra-operative & histopathological diagnosis.

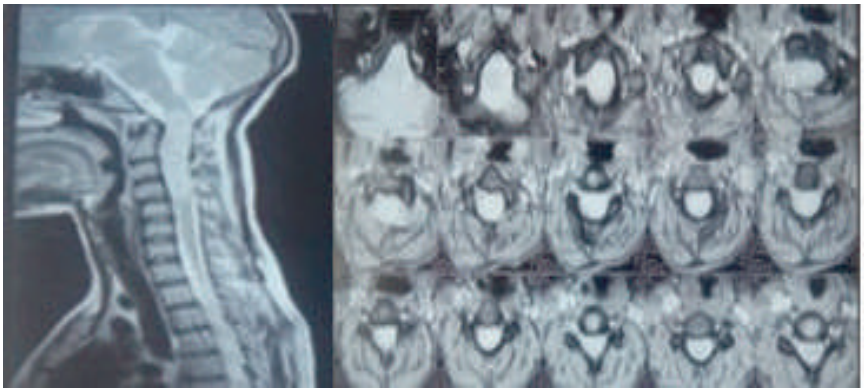

Figure 3A shows the sagittal section of T2 weighted MR image of this patient.

Figure 3B shows axial sections of T2 weighted MR image of this patient

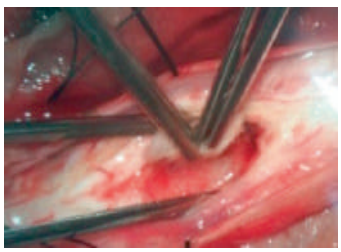

Figure 3C shows intra-operative appearance.

Case 7:

S.No		Age / Sex	14 Years / Female
1		Clinical Parameters	
	Clinical Diagnosis According To Traditional Teaching1.Extradural2.Intramedullary	1.Involvement	Symmetrical
		2.Progression	Rapid (5 Months)
		3.Root Pain	Absent
		4.Spasticity	Hypotonia
		5.Bladder & Bowel Involvement	Developed Urinary Retention After 5 Months
2	Radiological Diagnosis		Intramedullary Tumour
3	Intra-Operative Diagnosis		Intramedullary Tumour
4	Post – Operative Diagnosis (HPE)		Myxopapillary Ependymoma WHO Grade 1

Table 8 shows the clinical, radiological, intra-operative and histopathological diagnosis.

Case 8:

S.No		Age / Sex	35 Years / Female
1	Clinical Diagnosis According To Traditional Teaching Intradural Extramedullary	Clinical Parameters	
		1.Involvement (Symmetrical / Asymmetrical)	Asymmetrical
		2.Progression	Rapid (2 Months)
		3.Root Pain	Absent
		4.Spasticity	Normal Tone
		5.Bladder & Bowel Involvement	Not Involved
2	Radiological Diagnosis		Intramedullary Tumour
3	Intra-Operative Diagnosis		Intramedullary Tumour
4	Post – Operative Diagnosis (HPE)		Tuberculoma

Table 9 shows the clinical, radiological, intra-operative & histopathological diagnosis.

Tables 11, 12 and 13 show the consolidation of salient clinical features of spinal tumours in our study.

Features	Extradural	Our Study
Involvement (Symmetrical / Asymmetrical)	Symmetrical	Asymmetrical In 50%Of The Cases
Progression	Rapid	Rapid In 100% Of Cases
Root Pain	More Common	Nil
Spasticity	Common	Nil (Hypotonia In 100% Of Cases)
Bladder & Bowel Involvement	Late	Early In 100% Of Cases
Pain & Temperature Sensations	Lost Late	Lost Early In 100% Of Cases
Fasciculations	Rare	No Fasciculations
Muscle Atrophy	Uncommon, Limited	Absent
Dissociative Sensory Loss	Absent	Absent
Spinal Tenderness	Common	Present
Trophic Skin Changes	Uncommon	Absent
Bony Changes On X-Rays	Present	Present

Table: 11 Consolidated Salient Clinical Features Of Extradural Tumours In Our Study

On analyzing the symptoms of the patients in our study both patients with extradural compression (Tumour) had hypotonia, earlier bladder & bowel involvement & earlier loss of pain& temperature in contrary to the traditional teaching. Moreover asymmetrical involvement was present in one of the patients with extradural compression (Tumour) in contrary to the traditional teaching (extradural tumours cause symmetrical involvement).

Features	Intradural-Extramedullary	Our Study
Involvement (Symmetrical / Asymmetrical)	Asymmetrical	Symmetrical Weakness In 66% Of Idem Cases
Progression	Usually Slow	Rapid Progression In 66%Of Patients(5 Months, 6 Months)
Root Pain	Less Common	Absent In 100% Of Patients
Spasticity	May Be Present	Present In 66% Of Patients
Bladder & Bowel Involvement	Late	Early Bladder Symptom In 33% Of Patients (Within 1 Month-Retention)
Pain & Temperature Sensations	Lost, If Spinothalamic Tract Is Involved	Decreased In 66% Of Patients
Fasciculations	Rare	No
Muscle Atrophy	Uncommon, Limited	No
Dissociative Sensory Loss	Absent	Absent
Spinal Tenderness	Less Common	Absent
Trophic Skin Changes	Rare	No
Bony Changes On X-Rays	May Be Present	No Obvious Changes

Table:12 Consolidated Salient Clinical Features Of Intradural Extramedullary Tumours In Our Study

Of the 3 patients with Intradural extramedullary compression (Tumour),2 patients had rapid progression of symptoms,1 patient had earlier involvement of bladder, 2 patients had symmetrical involvement of motor weakness in contrary to the traditional teaching (IDEM tumours cause slow progression of disease, late involvement of bladder & bowel and asymmetrical involvement).

Features	Intramedullary	Our Study
Involvement (Symmetrical / Asymmetrical)	Usually Asymmetrical	Asymmetrical In 66% Of Patients
Progression	Slow	Rapid Progression In 100% Of Patients (2, 5 & 6 Months)
Root Pain	Rare	Absent In 100% Of Patients
Spasticity	Less Common	Spasticity In 33%, Hypotonia In 33% & Normal Tone In 33% Of Patients
Bladder & Bowel Involvement	Early	Not Involved In 66% Of Patients, 33% Of Patients Had Urinary Retention (After 5 Months)
Pain & Temperature Sensations	Present	Absent In 100% Of Patients
Fasciculations	Absent	Local Erosion Of Vertebral Bodies Present In 100% Of Patients
Muscle Atrophy	Common	No
Dissociative Sensory Loss	Long Segment Due To Anterior Horn Cell Involvement	No Wasting In 66% Of Patients, & Wasting In 33% Of Patients
Spinal Tenderness	Lost Early	Decreased In 100% Of Patients
Trophic Skin Changes	Rare	Absent
Bony Changes On X-Rays	Present	Absent In 100% Of Cases

Table:13 Consolidated Salient Clinical Features Of Intramedullary Tumours In Our Study

Of the 3 patients with intramedullary tumours, 2 patients had rapid progression of symptoms, 2 patients did not have bladder and bowel symptoms until admission. One patient did not have bladder and bowel symptoms for 5½ months, but developed urinary retention 15 days prior to admission. These are in contrary to the traditional teaching (intramedullary tumours have slower progression of disease and earlier involvement of bladder and bowel).

Conclusion

There is a significant variation in the clinical presentation and symptom progression of the cases in our series with respect to root pain, symmetricity, spasticity, bladder and bowel involvements when compared to our traditional teaching. Meticulous clinical evaluation and careful interpretation of radiological investigations will go a long way in avoiding surgical surprises and better surgical planning, leading to a good outcome. Large numbers of patients have to be studied in detail before arriving at a conclusion. Such a study is underway in our institute.

14. A Comparison of Pre-Operative and Post-Operative Clinical Signs with Electrophysiological Parameters in Degenerative Lumbar Disc Disease

Saranyan R, Raghavendran R

Abstract

Introduction*: In this present world, low back ache is a common debilitating problem. It is mostly because of degenerative disc disease. There is no definitive management available to evaluate the patient before surgery and predict the probable outcome.* ***Objective****: There is a discrepancy between the MRI findings and clinical findings which creates false positive and false negative results. These shows there are no definitive investigation criteria and patient selection for degenerative disc disease and the surgical success rate is moderately high. So it is important that we identify the group of patients who will benefit from surgical procedure and we can give them a reliable prognosis.* ***Methods****: Nerve conduction study is done pre-op and repeated twice after surgery on second and tenth post op day. Amplitude, latency and velocity results of all three Nerve conduction studies were analyzed and compared.* ***Results:*** *Electrophysiological studies augment selection criteria of patients undergoing surgery for low back pain. It is also helpful in prognosticating outcome.* ***Conclusion:*** *Combining Electrophysiological studies with clinical and imaging modalities gives better outcome.*

Key words: degenerative disease, Lumbar spine, neural compression

Introduction

Low back pain and leg pain radiating from the back affects a substantial proportion of population and is one of the leading causes of disability in our society and the cost of treatment is increasing progressively every year. The outcome of the operative treatment of degenerative disc disease [(1)] is often unpredictable, despite variety of surgical procedures.

Several scientific publications have documented good to excellent surgical results in high percentage of patients. The correlation between clinical signs, MRI and surgical findings [(2)] is frequently reliable as is the evaluation of false positive and false negative findings which can be influenced by the experience of both the radiologist and the surgeon.

It becomes important that we should identify the subgroup most likely to benefit from surgery in order to select whom to operate upon, and also to give a reasonable estimate of prognosis to the patients. This study investigates whether nerve conduction study [(4)], with clinical correlation can be used to identify the subgroup with better postoperative outcome[(1)].

Materials and Methods

The study was conducted at the Institute of neurosurgery, Madras Medical College and Rajiv Gandhi Government General hospital, Chennai – 600003 from Jan to March 2015 after obtaining clearance from the institutional ethics committee. The aim of the study was to compare the pre op and post op clinical signs with electrophysiological parameters in patients with neural compression due to degenerative lumbar disc disease.

Participants and Procedure:

This was a prospective analytical study conducted from January 2015 to March 2015 at the Institute of Neurosurgery, Madras Medical College, Chennai.

Patients with age from 25 to 65 years, patients with pain of more than three months duration and patients with weakness or numbness of lower limb were included in the study. Patients with non-compressive lumbar medical diseases, who underwent previous surgery or trauma to the spine, patients with age more than 65 years and patients with diabetes mellitus were excluded from the study. All patients were subjected to a detailed neurological examination and neurological deficit was documented. They were all subjected to electrophysiological study before surgery.

Post op:

Electrophysiological study was done on the second and tenth postoperative days and findings documented. Statistical analysis was done using Epi-Info, SPSS, and MS Excel software.

Results

Patient characteristics:

A total of 20 patients were included in the study. 12 were males and eight were females. The mean age was 53.3±6.5 with range of 43-65 years. The mean duration of symptoms was 6.6±1.3 with a range of 4-9 months. Both were not statistically significant.

Clinical findings and intervention:

After examination, the clinical level was identified in each patient. 11 patients had symptoms localizing to the L4-L5 level, the remaining 9 localized to L5-S1.

MRI confirmed a L4-l5 level in 11 patients and L5-S1 in 9 patients. The patients with L4-L5 pathology underwent L4 laminectomy, foraminotomy and discectomy. Patients with L5-S1 pathology underwent L5 laminectomy, foraminotomy and discectomy.

Pre and Post-operative nerve conduction studies:

The following parameters were studied pre and post operatively: Anterior Tibial Latency, Anterior Tibial Amplitude

	No of Patients	Minimum	Maximum	Mean	Std. Deviation
Pre Op-Anterior Tibial Latency	20	5.6	7.7	6.825	0.5486
2nd Day Post Op-Anterior Tibial Latency	20	5.3	7	6.095	0.4883
10th Day Post Op-Anterior Tibial Latency	20	4	7	5.635	0.8499

Table 1: Pre and Post-operative anterior tibial latency

	No of Patients	Minimum	Maximum	Mean	Std. Deviation
Pre Op-Anterior Tibial Amplitude	20	2	4	3.43	0.782
2nd Day Post Op-Anterior Tibial Amplitude	20	2	4	3.45	0.862
10th Day Post Op-Anterior Tibial Amplitude	20	2	6	4.06	1.233

Table 2: Pre and Post-operative Anterior Tibial Amplitude

	No of Patients	Minimum	Maximum	Mean	Std. Deviation
2nd Day Post Op-Anterior Tibial F wave	20	39	63	56.3	7.498
10th Day Post Op-Anterior Tibial F wave	20	39	75	62.15	10.874

Table 3: Post-operative Tibial F wave

	No of Patients	Minimum	Maximum	Mean	Std. Deviation
Pre Op-Posterior Tibial Amplitude	20	1	2	1.6	0.41
2nd Day Post Op-Posterior Tibial Amplitude	20	1	2	1.78	0.332
10th Day Post Op-Posterior Tibial Amplitude	20	1.4	3.8	2.37	0.7399

Table 4: Pre and Post-operative Posterior Tibial Amplitude

	No of Patients	Minimum	Maximum	Mean	Std. Deviation
Pre Op-Posterior Tibial Velocity	20	31	62	41.55	8.593
2nd Day Post Op-Posterior Tibial Velocity	20	39	65	47.6	8.363
10th Day Post Op-Posterior Tibial Velocity	20	51	69	56.5	4.02

Table 5: Posterior Tibial F Wave

Analysis and discussion

All Patients who had improvement in Clinical Status had improvement in their Electrophysiological parameters[4][9]. Patients who did not improve clinically (Table 6) also had improvement in their Electrophysiological status[11].

Electrophysiological Status			
Clinical Status	Improved	Not Improved	Total
Improved	12	0	12
Not Improved	0	8	8
TOTAL	12	8	20

Table 6: Electrophysiological Status

Anterior Tibial Characteristics:

The mean velocity before surgery was 42.2±7.9 and increased to 47.8±6.5 on the second day of operation. The mean improvement 5.5±3.9 was statistically significant (P<0.001)[6].

The mean latency of second and 10th day was 6.1±0.5 and 5.6± 0.8 respectively (Tables 1and 2). The difference 0.5±0.6 was statistically significant (P<0.001). The means of amplitude on second day was 3.5±0.9 and increased on tenth day of surgery[4] as 4.1±1.2. The mean increase 0.6±0.7 was statistically significant (P<0.001). The mean velocity at second day was 47.8±6.5and increased to 56.9±3.8 on tenth day of operation. The mean improvement 9.2±5.7 was statistically significant (P<0.001). The mean F wave on second day was 56.3±7.5 and the same increased to 62.2±10.9 on tenth day. The mean increase to 5.9±5.9 was statistically significant (P<0.001).

Posterior Tibial Characteristics:

The mean latency of pre and post op second day was 7.2±1.1 and 6.5±0.8 respectively. The difference 0.8±0.8 was statistically significant (P<0.001) as seen in Tables 3, 4 and 5. The means of amplitude before surgery was 1.6±0.4 and the increased on second day of surgery as 1.8±0.3. The increase was statistically significant (P<0.001)[5].

The mean Velocity before surgery was 41.6±8.6 and increased to 47.6±8.4 on second day of operation. The mean improvement 6.0±4.8 was statistically significant (P<0.001).

The mean Latency of second and 10th day was 6.5±0.8 and 6.2± 0.8 respectively. The difference 0.3±0.9 was statistically not significant (P>0.05). The means of Amplitude on second day was 1.8±0.3 and increased on tenth day of surgery[11] to 2.4±0.7. The mean increase 0.6±0.5 was statistically significant (P<0.001).

The mean Velocity at second day was 47.6±8.4 and increased to 56.5±4.0 on tenth day of operation[10]. The mean improvement 8.9±6.9 was statistically significant (P<0.001). The mean F on second day was 56.7±7.7 and increased to 63.8±11.8 on tenth day. The mean increase of 7.1±5.8 was statistically significant (P<0.001).

The mean Latency of pre and 10th day was 7.2±1.1 and 6.2± 0.8 respectively. The difference 1.0±1.4 was statistically significant (P<0.001). The means of A on pre op was 1.6±0.4 and increased on tenth day of surgery to 2.4±0.7. The mean increase 0.8±0.5 was statistically significant (P<0.001).

The mean Velocity at pre op was 41.6±8.6 and increased to 56.5±4.0 on tenth day of operation. The mean improvement 15.0±7.6 was statistically significant (P<0.001).

Clinical Findings:

The clinical findings of subjects were compared before surgery with second day of surgery and second day with tenth day of surgery. Radicular pain, straight leg raising test, power of extensor hallucis longus, sensory loss and ankle jerk[13] were tested and documented.

Before surgery, 18(90%) and post-operatively,2(10%) persons had radicular pain. Out of 18(90%) persons on second day of surgery, 7(35%) patients became normal and in 11 (55%), it persisted. On tenth day, except 2(10%) patients all 18(90%) patients had complete relief from radicular pain[11]. This was statistically significant (P<0.01) and tenth day finding was also statistically significant (P<0.001).

Post-operatively 18(90%) SLR became negative and in 2(10%) it was positive. Out of 18(90%) persons, on second day of surgery 9(45%) it became negative and 9 (45%) were positive. On tenth day, except 1(5%) patient all 19(95%) patients were negative for SLR[9]. The improvements in second day was statistically significant (P<0.01) and tenth day was also statistically significant (P<0.001).

Before surgery 11(55%) and 9(45%) had EHL weakness and normal EHL power respectively. Out of 11(55%) patients, on second day of surgery 4(20%) patients recovered and in 7 (35%) persisted. On tenth day, except 6(30%) patients, all 13(95%) patients had normal EHL power[10]. The improvements in second day (P>0.05) and tenth day was not statistically significant (P=1.00).

Before surgery 12(60%) had sensory deficit and 8(40%) it was normal. Out of 12(60%) patients, on second day of surgery 3(15%) patients had normal and 2 (10%) still abnormal. On tenth day, except 2(30%) persons all 18(90%) persons had normal sensation[12]. This improvement was not statistically significant (P>0.05), but the attainment of normal from second day to tenth day was statistically significant (P<0.05).

Before surgery 2(10%) and 18(90%) patients had abnormal and normal ankle jerk respectively. Out of 2(10%) patients, on second day of surgery 1(5%) person had normal jerk and 1 (5%) still abnormal. On tenth day all 20(100%) persons had normal Ankle jerk[12]. This improvement from before surgery to second day was not statistically significant (P>0.05) and second day to tenth day was not statistically significant (P=1.00).

The radiating pain was present in 18(90%) and absent in 2(10%) respectively. After 10 days 18(90%) patients became normal and 2(10%) continued to be positive. Regarding the SLR 18(90%) were positive before surgery and after surgery on tenth day, 19(95%) patients became normal and only 2(10%) were positive. In respect of EHL 11(55%) had weakness and 9(45%) were normal. On tenth day only 14(70%) had normal EHL[14]. The remaining 6(30%) had weakness. Before surgery 12(60%) patients had weakness and on tenth post operative day, the prevalence of weakness was only in 2(10%) persons. In respect of ankle jerk only 2(10%) patients had absent jerk. On tenth day all 20(100%) persons normal jerk. All the above findings except EHL all were statistically significant (P<0.01).

Conclusion

All patients who had improvement in clinical Status had improvement in their Electrophysiological parameters also. None of the patients who did not improve in Clinical Status had significant improvement in their Electrophysiological Status. The mean latency and velocity levels significantly improved after surgery at 2ndday.The amplitude level did not significantly change after surgery on 2ndday.Latency, amplitude, velocity and F wave significantly improved from 2nd day of surgery to 10th day of surgery (P<0.001).Hence, electrophysiological markers can be used for assessment of surgical efficacy, prognostic effect and realistic assessment of Failed Back Syndrome

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15. Ventriculoperitoneal Shunt Complications – An Institutional Experience

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Background

Ventriculo Peritoneal Shunt surgeries are performed for hydrocephalus. The various complications related to shunt surgeries are 1)Malfunction - VP shunt malfunction can occur as a result of (a)partial or complete blockage of the shunt, (b)disengagement, disconnection or fracture, (c) dislodgement and (d) valve failure because of a mechanical malfunction, 2)Infection and 3)Overdrainage or under drainage.

Aim

Aim of this study is to analyze the various complications related to shunt surgeries experienced in our institute, management of the complications and the preventive measures taken to avert the occurrence of such complications.

Study design

This is a retrospective, analytical study.

Materials and Methods

This study was conducted at Institute of Neurosurgery, Madras Medical College, Chennai, for a period of 1 year from January 2018 to December 2018. Hydrocephalus Patients with Ventriculoperitoneal Shunt who had complications in immediate post op period or during followup were included in our study. Patients with VP shunt complications, who refused admission or treatment and those who went Against Medical Advice were excluded from our study.

The details of the patients like age, sex, clinical presentation, clinical findings, radiological investigations, biochemical investigations, the indication for ventriculoperitoneal shunt, the various complications that occurred in the immediate post op period or during follow up , treatment given & the outcome were analyzed retrospectively from the records.

Results

Among 98 patients with complications, 96 patients were included in the study.

Complications ranging from abscess formation at ventricular catheter site(3) to disconnection/disengagement / breakage(3), migration(4) wound gaping(10), peritubal leak(3), overdrainage(7), development of subdural hygroma(2) & slit ventricles(5), pseudomeningocele(1), peritoneal pseudocyst(2), EDH(2), shunt infection(7), under drainage(19), blockage of shunt(19), valve failure(12) and extrusion of distal end of catheter (oral(2) and anal (2)). Two patients who were not willing for further treatment were excluded from this study.

Out of the 96 patients 65 were paediatric patients & the remaining 31 were adults. The age distribution of the patients has been depicted in Table.1 & 2.

Paediatric	Number (65)	Percentage among total patients (96) - 67.7%
Neonates (< 4 weeks)	2	0.02%
Infants (1 month – 1 year)	18	18.75%
Toddler (1 year – 3 years)	13	13.50%
3 – 13 years	32	33.33%

Table 1.Age Distribution – Pediatric Patients

Age group	Number (31)	Percentage among total patients (96) – 32.29%
13- 20 years	10	10.42%
21-30 years	5	5.20%
31-40 years	8	8.33%
41-50 years	3	3.10%
51-60 years	3	3.10%
61-70 years	1	1.04%
71-80 years	1	1.04%

Table 2 - Age Distribution - Adult Patients

Among 96 patients 63 were male of which 43 was paediatric & the remaining 20 were adults. The remaining 33 patients were female of whom 22 were paediatric& 11 were adults (Table.3).

Gender	Paediatric patients (65)	Adult patients (31)
Male (65.63%)	43	20
Female (34.38%)	22	11

Table 3 - Gender

Causes			Paediatrics (65)	Adults (31)
Congenital [41 +7= 48] 50%	Primary aqueductal stenosis		34	5
	Chiari type 2 without myelomeningocele		3	0
	Chiari type 2 with myelomeningocele		2	0
	Myelomeningocele / encephalocele		2	0
	Secondary aqueductal gliosis		0	2
Acquired [24+22=46] 47.91%	Post infective		14	13
	Post hemorrhagic		2	0
	Secondary to masses	Non neoplastic	0	2
		Neoplastic	6	2
		Post operative	1	3
	Associated spinal tumors		0	0
	Post traumatic		1	2
Others (2)-2.08%	Normal pressure hydrocephalus		0	2

Table 4 - Indications for Shunt in Our Study

Congenital causes & acquired causes were equally responsible for VP shunt surgery in our study. Of the congenital causes primary aqueductal stenosis had been responsible for VP shunt surgery in 34 paediatric patients & 5 of the adult patients during their childhood. Secondary aqueductal stenosis was responsible for shunt in 2 adults. Chiari type 2malformation with myelomeningocele was responsible for shunt in 3 paediatric & Chiari type 2malformation without myelomeningocele was responsible for shunt in 2paediatric patients. Myelomeningocele was responsible for shunt in 1 paediatric patient & 1 paediatric patient with encephalocele developed hydrocephalus following encephalocele repair leading to shunt surgery.Table.4

Of the acquired causes post infective hydrocephalus was responsible for VP shunt placement in 14 paediatrics& 13 adult patients. Post hemorrhagic hydrocephalus was responsible for VP shunt in 2 paediatric patients. Table.4

Non-neoplastic mass (colloid cyst) obstructing the Foramen of Monro was responsible for VP shunt placement in 2 adult patients. Posterior fossa Sol (neoplastic) was responsible for VP shunt placement in 6 paediatric& 2 adult patients prior to definitive surgery. One paediatric& 3 adult patients had developed hydrocephalus following excision of intracranial sol leading on the VP shunt placement. One paediatric patient & 2 adult patients had developed hydrocephalus following trauma leading on to VP shunt placement. Normal pressure hydrocephalus was responsible for VP shunt placement in 2 elderly patients. (Table.4)

Complications

The various complications & the number of patients with each complications are mentioned in Table 5.Out of the 96 patients taken up for this study 38 patients had malfunction , 12 patients had infection , 7 patients had overdrainage, 19 patients had underdrainage, 10 patients had wound gaping & 12 patients had other complications.
Among the 38 patients with malfunction proximal end/site blockage accounted for malfunction in 18 patients & distal end blockage accounted for shunt malfunction in 1 paediatric patient.

Disconnection was responsible for shunt dysfunction/malfunction in 2 paediatric patients (Fig 1). Two adult patients had both disconnection & migration (Fig 2 & 3). Figure 1C-CT brain of the same patient in Fig 1& shows bilateral ventricular catheter with hydrocephalus.

			Paediatrics	Adults
Malfunction 38 (39.58%)	Blockage / obstruction	Proximal	15	3
		Distal	1	0
	Disconnection / break		2	1
	Dislodgement/ migration	Ventricular catheter	2 (inward)	1 (outward)
		Distal end of catheter	0	1
	Valve failure		10	2
Infection 12 (12.5%)	Abscess	Intra cranial	2	1
		Abdominal site	0	1
	Shunt infection		4	4
Over drainage 7 (7.29)%	Slit ventricles		0	5
	Sub dural hygroma		2	0
Underdrainage 19 (19.79%)			12	7
Hardware erosion 1			1 (excluded from study	0
Silicone allergy/skin breakdown/ wound gaping 10 (10.41%)	Cranial wound 3 (3.13%)		2	1
	Abdominal wound 7 (7.29%)		4	3
Others 12 (12.50%)	Proximal site complications 6 (6.25%)	Peritubal leak (3)	3	0
		Pseudomeningocele (1)	1	0
		EDH (2)	1	1
		Peritoneal pseudo cyst (2)	1	1
	Distal site complications 6 (6.25%)	Extrusion of distal end via oral cavity (2)	2	0
		Extrusion of distal end via anus (2)	2	0

Table 5: Complications

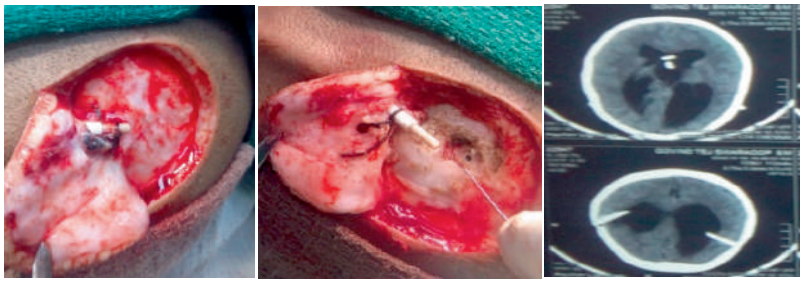

Fig 1 A Fig 1b Fig 1c

Nutritional status of paediatric patients	Total no of VP shunt surgery 291	Patients developed complications 65
Weight equal or more than that of the percentile for that age group	104	19
Weight less than that of the percentile for that age group	187	46

Table 6: Nutritional status of paediatric patients

	Elective	Emergency	Total
Number VP shunt surgeries	95	256	351
No of patients with complications	20 (21%)	76 (79%)	96

Table.7. Elective vs Emergency

	Elective	Complications	Emergency	Complications
Done by surgeons with 3 or more years experience	59	2	36	12
Done by surgeons with less than 3 years of experience	36	18	220	64
Total		20		76

Table.8. Surgeons experience

Number of patients who had shunt infection	Duration of surgery more than 1 hour	Duration of surgery less than 1 hour
8	6 (75%)	2(25%)
Paediatrics (4)	4	0
Adults (4)	2	2

Table.9. Duration of surgery

Fig 2A *Fig 2B* *Fig 2C*

Patient in figure 2A presented with swelling in nape of neck on right side & he was evaluated with a suspicion of branchial cyst. He gave a history of right VP shunt at childhood. X-ray cervical spine AP & lateral (Fig 2B) and X –ray abdomen erect view (Fig 2C) revealed disconnection of ventricular catheter from shunt system & migration of shunt system into abdominal cavity. Distal portion of Ventricular catheter was ligated & a new VP shunt was placed on left side.

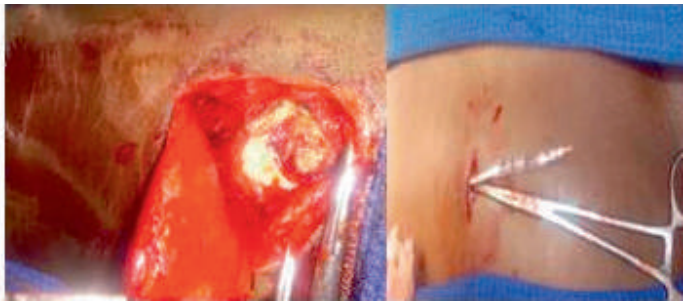

Fig 3A *Fig 3B*

Patient in Fig 3A & B presented with dysfunction of left sided cystoperitoneal shunt done for posterior fossa arachnoid cyst. At surgery patient was found to have disconnection of ventricular catheter & the shunt system. Ventricular catheter had migrated out of cyst & shunt system had migrated to chest.

Two paediatric patients had migration of ventricular catheter intraparenchymally. Valve failure was responsible for shunt dysfunction in 12 patients. Twelve patients had shunt infection in the form of intracranial abscess in 3 patients, abdominal site abscess in 1 patient & signs of meningitis, like fever, neck stiffness in 8 patients. All these 8 patients with features of meningitis were managed conservatively. All the 3 patients with intracranial abscess had a history of skin & subcutaneous infection along the shunt tube track which had led to the

development of cerebral abscess at the site of ventricular tip (Fig 4A & 4B). Abscess excision was done in all these 3 patient with removal of shunt tube. One patient with abdominal wound gaping managed conservatively developed abdominal wall abscess which was excised.

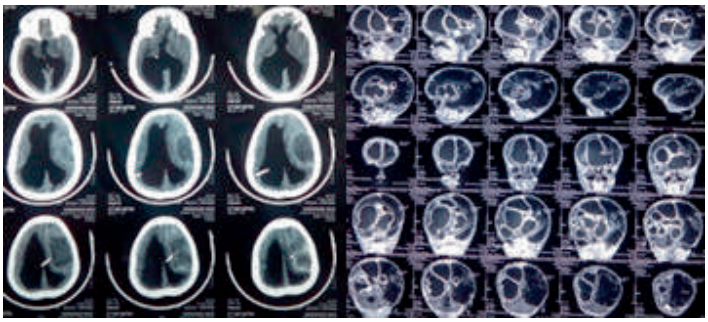

Fig 4A *Fig 4B*

Overdrainage was responsible for slit ventricle syndrome in 5 adult patients, who had undergone shunt revision & in 2 paediatric patients who had developed subdural hygroma leading on to burr hole evacuation of hygroma along with the removal of shunt tube.

Underdrainage was responsible for shunt revision in 12 paediatric& 7 adult patients who presented with features of raised ICP without any other obvious cause.

One paediatric patient had hardware erosion, but he was excluded from our study as his parents were not willing to undergo further treatment (Fig 5).

Fig 5

Cranial wound gaping was seen in 3 patients & abdominal wound gaping was seen in 7 patients.

Among these 10 patients, 2 paediatric patients had multiple shunt revisions due to recurrent cranial & abdominal wound gaping with CSF leak probably due to silicone allergy

which could not be established. One patient underwent Lumboperitoneal shunt, Endoscopic third ventriculostomy& fulguration of choroid plexus, while the other patient underwent ventriculopleural shunt. Both these patients had persistent wound leak & wound gapping & ultimately both these patients succumbed.

Other complications related to proximal site like peritubal leak occurred in 3 paediatric patients, pseudomeningocele (Fig 6) at shunt site in 1 paediatric patient & EDH at operative site in 1 paediatric& 1 adult patient. Peritubal leak settled spontaneously by regular pumping of reservoir, whereas the patients with EDH & pseudomeningocele underwent EDH evacuation, shunt removal, shunt placement on opposite side & pseudomeningocele repair with shunt removal & new shunt placement on the opposite side, respectively.

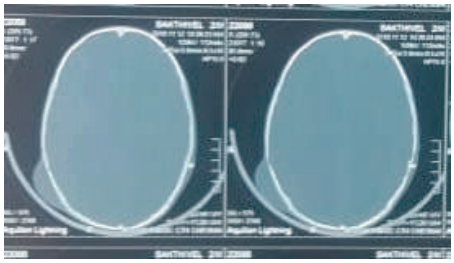

Fig 6

Other complications related to distal site were peritoneal pseudocyst in 1 paediatric& 1 adult patient, extrusion of distal end of catheter via oral cavity (Fig 7) in 2 patients & via anus (Fig 8) in 2 patients. Both the patients with peritoneal pseudocyst underwent marsupilisation of the pseudocyst. Of the 2 patients who were brought with complaints of extrusion of distal end of shunt tube via anus, the shunt tube had receded into the bowel in 1 patient which was evident by yellowish discolouration (bilious staining) at the time of shunt revision & perforation of small bowel. The other patient with anal shunt tube extrusion (Fig 8) underwent shunt removal.

Fig 7 *Fig 8*

Both the patients with extrusion of distal end of catheter via oral cavity were referred to Paediatric surgeon, they were managed by laparotomy, removal of shunt tube & repair of gastric perforation.

Management

About 11 patients were managed conservatively. Of them 4 were paedaitric patients with shunt infection & 4 were adult patients with shunt infection. Remaining 3 were paediatric patients with peritubal leak.

About 64 patients underwent shunt revision. Of them abdominal end revision alone was done in 4 patients, whereas 28 patients had undergone both cranial & abdominal end revision. Out of these 28, 18 patients had new shunt placement on the same side. In the remaining 10 patients cranial end was adjusted & CSF flow was established. Hence same shunt tubes were retained. In another 32 patients new shunt tube was placed on the opposite side. A total of 50 patients had new shunt placement. Of them 18 were on the same side & 32 were on the opposite side.

			Paediatrics	Adults
Conservative with antibiotics - 11 (11.45%)			7	4
Shunt revision - 64 (66.67%)	Abdominal end alone - 4 (4.17%)		2	2 + 2 (opposite side shunt placed
	Both abdominal & cranial end -28 (10 + 18 new shunt placement) (29.17%)		21	7
	New shunt tube placement - 50 (52.08%)	Same side - 18 (18.75%) (18.75%)	13	5
		Opposite side - 32 (33.33%)	22	10
Shunt tube removal - 17 (17.79%)			12	5
ETV - 3 (3.125%)			2 + 1	0
Other shunts - 2 (2.08%)	Ventriculo pleural - 1		1	0
	Lumboperitoneal - 1		1	0
Burr holes & evacuation of hygroma - 2 (2.08%)			2	0
Craniotomy & evacuation of EDH - 2 (2.08%)			1	1
Pseudomeningocele repair - 1 (1.04%)			1	0
Peritoneal pseudocyst excision - 2 (2.08%)			1	1
Abscess excision - 4 (4.167 %)			2 (both cranial)	2 (1- cranial ; 1- abdominal wall

Table 10

In about 17 patients shunt tube was removed. Of the 17 patients, 3 patients underwent ETV, 1 patient underwent lumboperitoneal shunt & 2 patients had

Ventriculopleural shunts. Among the remaining 11, in the 2 patients with overdrainage (subdural hygroma), 4 with extrusion of distal end of catheter & 4 with abscess, no new shunts were placed. A new shunt tube was placed on the other side in the single patient with pseudomeningocele.

Ventriculopleural shunt was done in a patient with recurrent abdominal wound gaping & CSF leak. Lumboperitoneal shunt was done in 1 patient with recurrent abdominal and cranial wound gaping & CSF leak. Two patients with subdural hygroma underwent burr holes & evacuation of hygroma. In 2 patients with shunt site EDH, evacuation of EDH was done. One patient with pseudomeningocele underwent repair, with shunt placement on opposite site & 2 patients with peritoneal pseudocyst underwent marsupilisation. Table 10 shows the various management options carried out in our study.

Outcome

Out of 96 patients 6 patients expired. One of the 6 patients was an adult with abscess at the ventricular tip site, who succumbed following surgery due to septicemia. The remaining 5 were paediatric patients who had undergone multiple (more than 5 surgeries) & repeated shunt revisions. Table 7 shows the outcome of patients in our study.

Outcome	Paediatrics	Adults
Discharged - 90 (93.75%)	60	30
Expired - 6(2.25%)	5	1

Table.11

Conclusion and Clinical significance

The main reasons for complications associated with shunt surgery are

1. Patient factors like nutritional status –low birth weight.
2. choosing the correct system based on opening pressure
3. Prolonged surgical time.

To limit or avoid VP shunt complications, the following factors should be taken into consideration

1. Shunt surgery should be done as the first case
2. shortening the surgical time
3. Shunt surgeries must be done by the most experienced neurosurgeons.
4. The connectors should be secured properly
5. Programmable shunts should be used when appropriate (cost limits its usage in Government Institutions)

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16. Posterior Circulation Aneurysms and AVMs – An Institutional experience

Kesavan G, Balamurugan S, Raghavendran R

Introduction

The posterior circulation consists of vertebral artery, basilar artery and its branches. The microsurgical anatomy of the posterior circulation is very complex and variable. Surgical approaches to this area are considered risky due to the presence of the various important blood vessels and neural structures. The surgical management of these lesions has its own distinct intricacies and requires careful planning, especially in deciding the trajectory of approach. The past decade has also seen an increasing role of endovascular treatment for all aneurysms, especially for aneurysms of the posterior circulation, where it has superseded microsurgical clipping. However, in the Indian scenario, endovascular experience is often unavailable or very expensive. Microsurgical clipping then becomes a primary modality of treatment for these patients. Posterior fossa arteriovenous malformations account for only 5-7% of all intracranial AVMs. With the advances of modern neuroimaging, the frequency rate of posterior fossa AVMs grew to 10-15%. The incidence of posterior fossa AVMs at autopsy is even higher, reaching 20% of all intracranial AVMs

Aim of the study and design

This is a retrospective study from January 2018 to February 2019 to analyze the surgical results of aneurysms and AVMs arising from the posterior circulations in two Neurosurgical units, at RGGGH and MMC, Chennai.

Materials and methods

Clinical data of all 20 cases with a diagnosis of posterior circulation aneurysms (Basilar artery, Anterior and Posterior inferior cerebellar artery, Superior cerebellar artery) and arteriovenous malformations were collected retrospectively. All patients were evaluated with computerized tomography (CT) angiography and Digital Subtraction Angiography (DSA) prior to surgery. All patients in our series underwent microsurgical clipping. 17 patients were operated by the 3rd author and 3 patients were operated by the 2nd author. All patients were followed-up in the outpatient clinic after discharge. The Glasgow outcome scale (GOS) was used to grade their postoperative neurological status at discharge.

Results

Between January 2018 and February 2019, 16 patients with aneurysms & 4 AVM patients were treated in our hospital. Of these, 6 patients had basilar top aneurysm , 4 patient had Anterior inferior cerebellar artery aneurysm, 4 patient had Posterior inferior cerebellar artery aneurysm , 2 patient had superior cerebellar artery aneurysm and 4 patient had posterior circulation AVM . There were 11 males and 9 female with the mean age of 45 years (median 48 years, range =18–70 years).

Case	*Age*	*Sex*	*Site*	*Ruptured*	*Presentaion*	*Deficits*	*Case*	*Age*	*Sex*	*Site*	*Ruptured*	*Presentaion*	*Deficits*
1	55	M	Basilar	Yes	SAH	Nil	11	70	F	AICA	Yes	SAH	Nil
2	58	M	Basilar	Yes	Loc	Nil	12	45	F	AICA	Yes	SAH	Nil
3	49	M	Basilar	No	Headache	Nil	13	41	M	AICA	Yes	Headache	Nil
4	40	F	Basilar	No	Headache	3rd n - temp	14	61	F	AICA	No	Headache	Nil
5	54	F	Basilar	Yes	SAH	Hydrocephalus	15	40	M	SCA	No	Headache	3rd n palsy
6	63	F	Basilar	Yes	SAH	3rd n palsy	16	21	M	SCA	Yes	Loc	Cerebellar
7	51	F	PICA	Yes	SAH	Nil	17	30	F	Avm	-	Headache	Nil
8	39	M	PICA	Yes	SAH	Nil	18	18	F	Avm	-	Vomiting	Nil
9	53	M	PICA	No	Loc	Hydrocephalus	19	25	M	Avm	-	Headache	Nil
10	48	M	PICA	Yes	SAH	Nil	20	36	M	Avm	-	Headache	Nil

Craniotomy and Approaches

The sub temporal approach was used for basilar top artery segment. For SCA aneurysms also sub temporal approach was used. For AICA retromastoid suboccipital craniectomy was done. For cerebellar AVM midline suboccipital craniectomy and for PICA aneurysm far lateral approach was used.

Clipping

Aneurysm clipping was attempted in 16 patients except 4 AVM cases. All patients underwent postoperative CT brain. Complete angiographic occlusion of the aneurysm was achieved in all 16 patients where clipping was attempted.

Morbidity

The most common complication, which occurred following surgery, was oculomotor nerve palsy, which was seen temporarily. Two patients had complete resolution, and one patient had partial improvement within 3 months of surgery. Hydrocephalus was seen in 2 patients and needed ventriculoperitoneal (VP) shunts. One AVM patient (21 years male) was a medical student, initially developed left cerebellar signs and pseudomeningocele and had complete recovery.

Mortality

Two patients died following surgery. One patient had an intraoperative rupture of basilar artery aneurysm with severe brain swelling. Clipping was done, and a decompressive craniectomy was performed. However, the patient developed diffuse brain edema and died. One patient developed a frontotemporoparietal hemorrhagic infarct following surgery and underwent decompressive craniectomy and lax duroplasty and this patient also expired.

Follow Up

During follow up there was no rebleed in discharged patients. Out of 20, two patients expired and two patients had low Glasgow outcome scale. Complications seen were transient 3rd nerve palsy, hydrocephalus, vasospasm, infection and hemorrhagic infarct.

Discussion

Basilar top aneurysms (BTAs) account for approximately 7% of all intracranial aneurysms. They carry a higher risk of rupture than aneurysms in other locations, and are frequently wide-necked[1]. The bifurcation angle of the basilar artery into the two posterior cerebral arteries creates a special zone of higher wall shear stress, which facilitates the formation of aneurysms. The high morbidity of BTAs is associated with the narrow space in which they occur, in an eloquent brain area and in close vicinity to perforator vessels, and to their higher incidence of subarachnoid hemorrhage (SAH), which is the presenting picture in up to 70% of cases.

Complex anatomy makes the treatment of BTAs technically challenging, whether by open surgery or by endovascular means. Endovascular intervention is becoming the mainstay for management of these formidable aneurysms, but it has limitations, especially with large/giant or wide-necked lesions.

Aneurysms arising from the posterior inferior cerebellar artery (PICA) are uncommon, accounting for 0.5–3% of all intracranial aneurysms. Symptoms and signs usually include subarachnoid hemorrhage, neck pain, dizziness, and coma[2, 3]. PICA is one of the three vessels that provide arterial supply to the cerebellum. It is the most variable and tortuous cerebellar artery[1,2]. Branches are - Anterior and lateral medullary segments - small perforating medullary branches (absent in 50%) and Supratonsillar segment - tonsillohemispheric branch and inferior vermian branch.

Typically it supplies:

1. posteroinferior cerebellar hemispheres (up to the great horizontal fissure)
    - cerebellar tonsils: 85% of the time
    - biventral lobule: 80%
    - nucleus gracilis: 85%
    - superior semilunar lobule: 50%
2. inferior portion of the vermis
3. lower part of the medulla: 50%

The SCA arises from the basilar trunk. Cadaveric studies have found that it is one of the most constant posterior fossa arteries, however, the pattern of origin from the BA may vary, and Yasargil has classified them into 7 patterns. Aneurysms arising from the proximal SCA projecting superiorly lie in the space between the PCA and SCA. In the past, the proximal SCA and the rostral basilar were considered perforator free zones. This perception has been challenged by cadaveric studies which show that this zone gives rise to critical interpeduncular perforators supplying oculomotor nerve, the posterior thalamus, the substantia nigra, the red nucleus and the floor of the fourth ventricle, and the proximal occlusion of the SCA during clip application can cause brainstem dysfunction and cerebellar infarction due to poor distal collateralization[4].

The surgical options used for aneurysms arising from the SCA in our series include the subtemporal approach[5]. We feel that the main factors to be considered during surgery for these aneurysms include (1) height of the basilar bifurcation in relation to the posterior clinoids (2) direction of projection of the fundus (3) SCA origin in relation to the tentorial edge and (4) relationship of the SCA to the oculomotor nerve[6].

Infratentorial AVMs may be located within cerebellum, brainstem or both. McCormick has published a study of 104 cases of infratentorial AVMs, in which 69 were located within the brainstem, most commonly in the pons. Batjer and Samson showed that two thirds of the posterior fossa AVMs is located within the cerebellum, 20% in the brainstem and 20% in both cerebellum and brainstem[7,8].

Bleeding is the most common form of presentation of posterior fossa AVMs[9]. In most clinical series the incidence of subarachnoid or intraparenchymal bleeding was reported to be between 75 and 92%. Recent studies have suggested that brainstem AVMs presentation is less common with bleeding than cerebellum AVMs. Accumulating data have demonstrated an independent association of infratentorial AVM location and hemorrhagic presentation[10]. This is alarming, in light of the considerably greater morbidity and mortality associated with posterior

fossa AVM rupture. Fortunately, with accumulating surgical experience and the cultivation of multimodality AVM therapy, therapeutic success continues to improve. Posterior fossa AVMs were frequently associated with aneurysms (25%) on the feeding arterial pedicles of the nidus and were often the cause of hemorrhage.

Progressive neurological deficits (including those secondary to mass effect, ischemia, and hydrocephalus) were the second most common mode of presentation. Cranial nerve palsies, often affecting the trigeminal nerve, have been associated with lesions of the cerebellopontine angle and brain stem. Headache, a relatively non-specific symptom, can occur in as many as 10% of the patients diagnosed with unruptured AVMs. At the time of detection, at least 15% of people affected by AVMs are asymptomatic. The incidence of asymptomatic posterior fossa AVMs may rise in the future with the increasing use of advanced neuroimaging modalities for nonspecific symptomatology.

Gold-standard diagnosis is represented by Digital subtraction angiography, and if necessary, stereo-angiography[11]. It is the most useful and sensitive method to identify and evaluate the AVMs (provides the richest information regarding nidus characteristics, feeding and drainage vessels), and to highlight the operative planning of the AVM.

All patients must undergo formal six-vessel catheter angiography for accurate characterization of the anatomy and hemodynamics of the AVM. In particular, all feeding arteries and draining veins must be diligently identified preoperatively, in the preparation for a complete resection.

High-resolution magnification studies are required for both vertebral arteries, both internal carotid arteries, and both external carotid arteries, because approximately 10% of infratentorial AVMs are fed by one or both external carotid arteries. No other investigation can replace conventional DSA in therapeutic decision.

The basic strategy for microsurgical resection of AVMs can be described in five steps:

A. creation of a craniotomy centered over the nidus,
B. adequately exposing the feeding vessels and the draining veins,
C. gradual devascularization of the lesion by occlusion of the arterial feeders,
D. circumferential separation of the AVM from the adjacent parenchyma,
E. Division of the draining veins and extirpation of the lesion.

Conclusion

Microsurgical anatomy of the posterior circulation is extremely complex and variable. Postoperative prognosis is favorable and there is less complications when operated upon. So it is imperative to adequately manage posterior circulation anomalies.

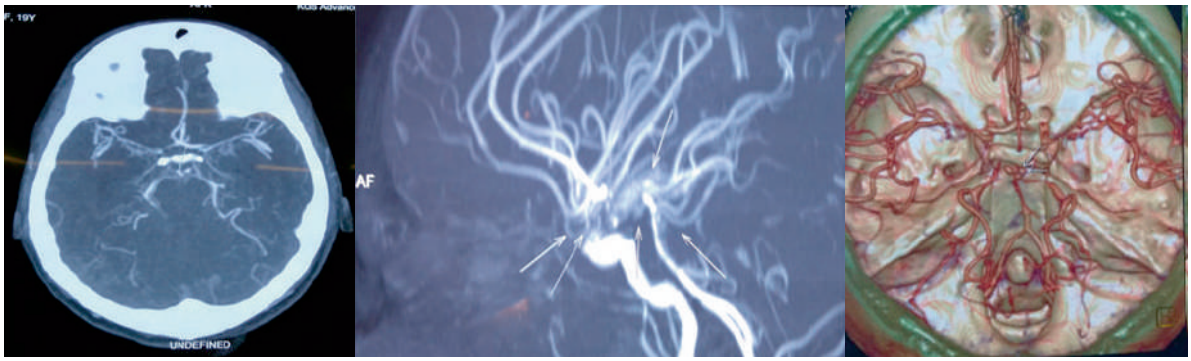

Figure 1A, 1B & 1C: CT Angiogram showing trilobed basilar artery tip with SAH

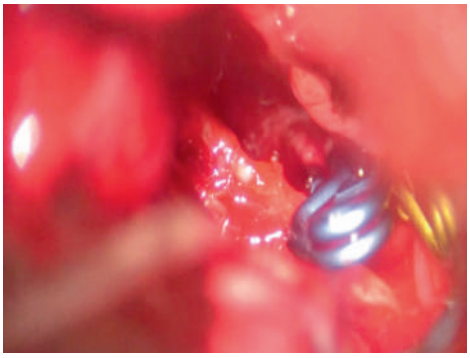

Figure 1D: Clip applied over the basilar tip aneurysm.

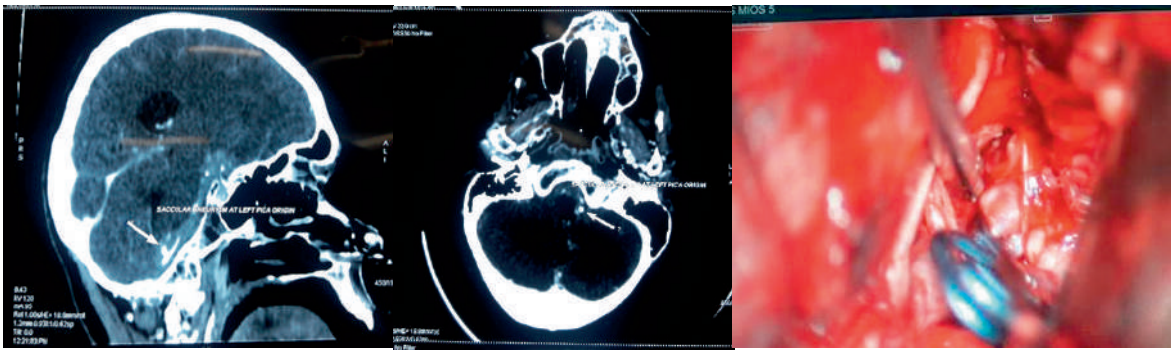

Figure 2A & 2B: Right AICA aneurysm / Figure 2C: Right AICA aneurysm - Clipped

Figure 3A & 3B: CT Angiogram showing AICA aneurysm

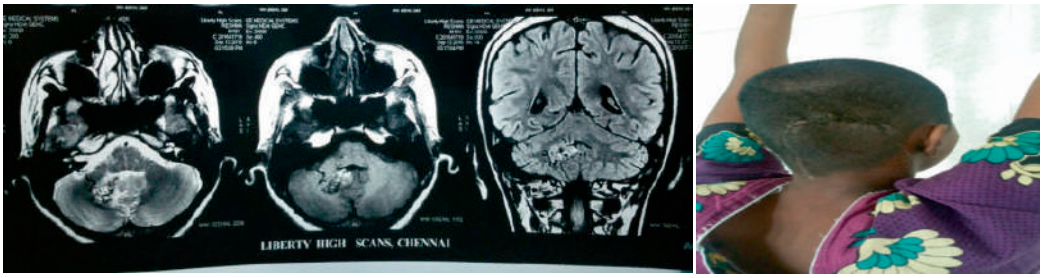

Figure 4A & 4B: MRI brain showing right cerebellar AVM and Post op clinical picture

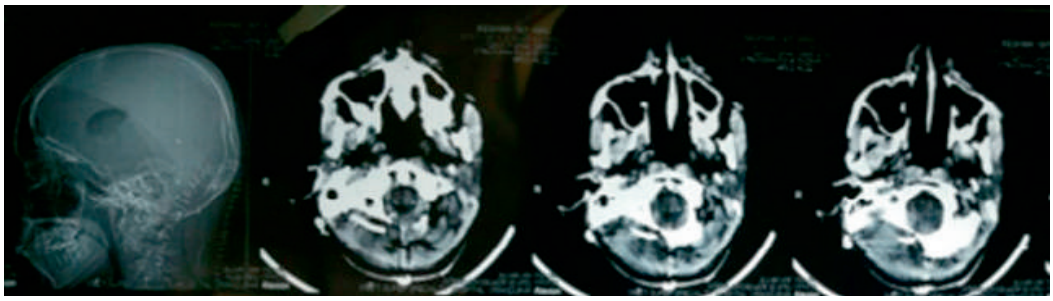

Figure 4C: Post op CT showing clip in situ

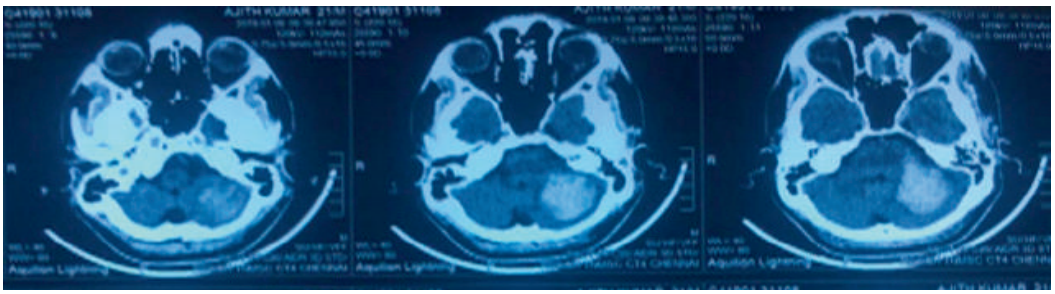

Figure 5A: CT Brain showing left cerebellar ICH

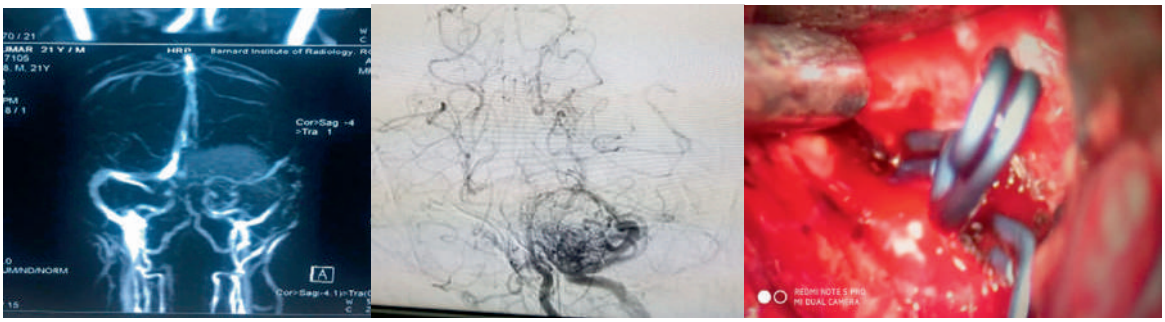

Figure 5B & 5C: MRI Angiogram showing left cerebellar AVM&DSA showing left cerebellar AVM

Figure 5D: After AVM removal clip applied

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17. A Rare Presentation of Primary Ewing's Sarcoma of Skull - Case Report

Ramasamy C

Abstract

Ewing's sarcomas are the second most common bone tumors in children and primary involvement of the cranium is uncommon with less than 3% cases reported worldwide. We present a case of primary Ewing's sarcoma of the cranium in a 9 year old child managed in our hospital.

Key words: *Ewing's sarcoma, skull tumour*

Introduction

Ewing's sarcomas are the second most common bone tumors in children and primary involvement of the cranium is uncommon with less than 3% cases reported worldwide. This condition often has a fatal outcome, although the prognosis is improving with radiotherapy and chemotherapy following surgery. We present a case of primary Ewing's sarcoma of the cranium in a 9 year old child seen in our hospital.

Case Presentation

A 9 year old female patient was admitted with complaints of swelling in the scalp, above the right ear of 2 months duration. The mass was localized under the right temporal muscle and attached to the surface of the temporal bone. A physical examination showed a firm, immobile, mildly tender, and slightly elastic subcutaneous mass measuring 7 × 5 cm in size in the temporal region with normal overlying skin. No cervical lymph node enlargement was noted.

Investigations

General, systemic, and neurological status were normal, as well as her blood examination results. Computed tomogram of the brain revealed a mass with bony spicule formation on the temporal bone without bony destruction or intracranial extension. (Figure 1)

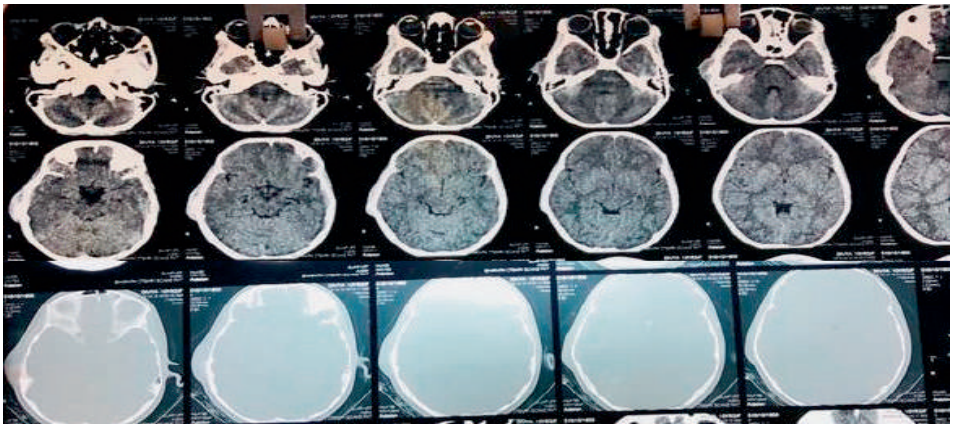

Figure 1: CT Scan - right temporal extracranial lesion

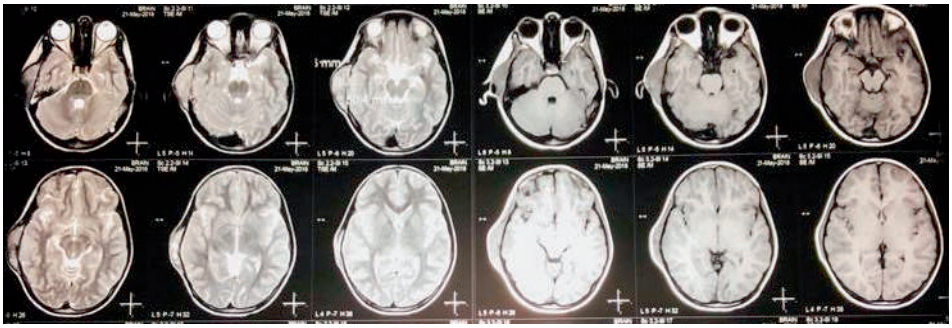

Figure 2: MRI of the brain revealed a right temporal extra cranial lesion. The lesion was hypointense in T1-weighted image (T1WI) with a strong heterogeneous contrast enhancement and of mixed intensity in T2WI.

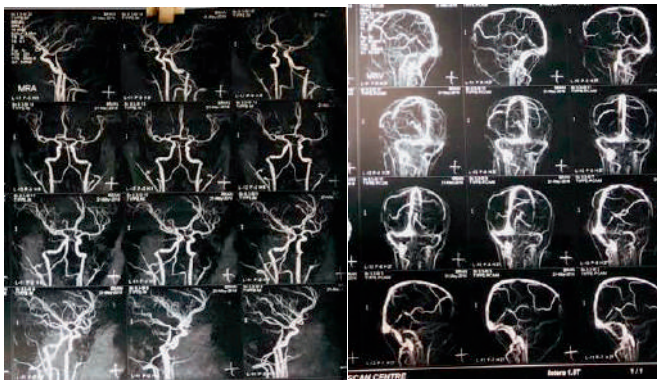

Figure 3: The lesion was associated with increased vascularity and drainage as noted in MRA/MRV. Differential diagnosis included eosinophilic granuloma and pleomorphic undifferentiated sarcoma.

A temporo-parietal craniotomy and gross total removal of the tumor with duroplasty was performed. The overlying scalp was found to be free, the bone was eroded and the tumor was found to be mostly extra-dural (figure 4). The patient underwent a gross total excision of tumour and histopathology was reported as Ewing's sarcoma. Post excision chemo-radiation was given and patient is symptom free at one year follow-up.

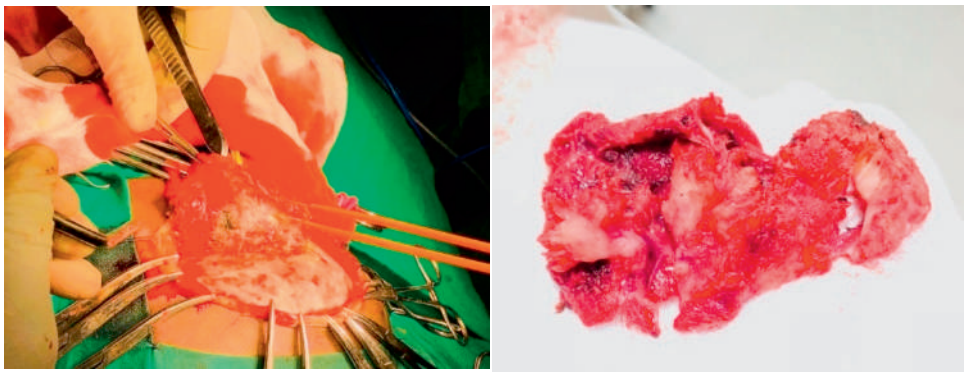

Figure 4

Discussion

Ewing's sarcoma, a small round cell tumour was first described by James Ewing in 1921 and is most commonly diagnosed in the second decade of life. Although it is the second most common form of primary bone cancer in childhood, the primary involvement of the calvarium is rare. Ewing's sarcoma typically grows extradurally and often reaches a very large size before dural invasion or clinical detection occurs.

Symptoms tend to develop as a result of dural invasion, hydrocephalus or raised intracranial pressure. Headache and scalp swelling are the most common symptoms, and papilloedema is the most common sign. The duration of symptoms before presentation ranges from 2 weeks to 2 years. Men are affected more than women by a ratio of 1.8:1. Approximately 90% of cases occur in the first two decades of life with the peak incidence between 5 and 13 years.

Ewing's sarcoma can be considered as an undifferentiated form of peripheral primitive neuro-ectodermal tumour. Histologically, these tumours are characterized by sheets of small round blue cells with an increased nucleocytoplasmic ratio. Pseudo-rosettes may be present, but sheets of cells are more characteristic. Mitoses are common. Bony spicules may be present, and CD99 and vimentin may be expressed.

Plain radiographs of the skull may reveal layering of bone in an 'onion peel' arrangement, with layers of bone mottling and erosion, as well as new bone formation. This distinctive periosteal reaction and calcification may also be noted on CT. In some cases, the tumor manifests as a lytic lesion on plain radiographs and CT. Bone healing after chemotherapy is better demonstrated in CT scans. MRI may show heterogeneous signal characteristics and avid contrast enhancement of any associated soft tissue component.

Ewing's sarcoma exhibits increased radioisotope uptake in nuclear bone scanning images suggesting an ossification process. Scintigraphy is particularly helpful in detecting the presence of any extracranial lesions. Surgical resection plays an important role in the management of cranial Ewing's sarcoma. Excision of the tumour should be as radical as possible to minimize tumour mass and increase the effectiveness of adjuvant therapy.

The dura should be inspected for tumour infiltration, and if infiltration is noted, the dura should be resected as well. Local recurrence after resection has been reported.

Adjuvant therapy after resection, including radiotherapy and chemotherapy, is essential. The recommended radiotherapeutic method is supervoltage radiation, because it is better tolerated and causes less destruction to normal tissue compared with other forms of radiotherapy. Adjunctive chemotherapy with a combination of vincristine, cyclophosphamide, cisplatin, etoposide, dactinomycin and doxorubicin has raised the overall 5-year survival rate from 5–10% to 50–60%.

Various factors indicate a good outcome for patients with cranial Ewing's sarcoma: duration of symptoms for a period of longer than 6 months; absence of fever or systemic symptoms; peripheral localization of the tumour and absence of metastases; initial lactate dehydrogenase levels of <170 IU/l; leucocyte count of <7000/dl; and lymphocyte count of <2000/dl.

Recurrence of Ewing's sarcoma of bone in general is most common within 2 years of initial diagnosis (approximately 80%). Higher rates of local failure are seen in patients older than 14 years with tumours more than 8 cm in length. Time to recurrence has been considered the most important prognostic factor. Although improved by treatment regimens, the prognosis for many patients with Ewing's sarcoma continues to be poor because of early metastasis to the lungs and to other bones. Early metastasis is less common in cases of primary Ewing's sarcoma, and thus primary Ewing's skull tumours are considered to carry a better prognosis.

Conclusion

The treatment of primary Ewing's sarcoma of the cranium still remains to be radical surgery, aggressive multidrug chemotherapy, and radiotherapy. The outcome is usually good if there is no early recurrence or metastasis.

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