Section: Neurosurgery

Original Research Article

VALIDATION OF CLINICAL CLASSIFICATION OF BRAINSTEM GLIOMAS

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Received : 23/05/2025
Received in revised form : 30/06/2025
Accepted : 18/07/2025

Keywords:
Brainstem gliomas. Brainstem lesions. Safe entry zone. White fiber anatomy, Low-grade astrocytoma.

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DOI: 10.47009/jamp.2025.7.4.230

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2025; 7 (4); 1215-1220

ABSTRACT

Background: Aim of the study: The objective of this study is to understand the various surgical strategies used, their complications and outcomes in the management of brainstem gliomas and validation of clinical classification proposed by V.S. Mehta et al. **Materials and Methods:** This observational study was conducted in the department of neurosurgery, Krishna institute of medical sciences, Secunderabad, between March 2018 to March 2020. The study population included 48 patients with Brainstem gliomas who underwent treatment at our Centre. Among 48, 30 patients underwent preoperative Diffusion tensor imaging of Corticospinal tract to determine operability and also surgical corridor of approach in operable lesions. The prospective data from 31/3/2018 to 31/3/2020 and retrospective data from 1/3/ 2016 to 30/3/2018 were collected. The surgical strategy used, complications and outcomes were analyzed. With our findings we propose to validate the clinical classification proposed in a landmark paper published by Mehta V S, Chandra P S, Singh PK, Garg A, Rath G K. Surgical considerations for 'intrinsic' brainstem gliomas: Proposal of a modification in classification. Neurol India 2009;57:274-81. **Result:** There were 48 patients with Brainstem tumors with mean age of 32.3 years (range 0.5 -73years) and slight male predominance. Headache most common presentation. The various modalities used for treatment were Microsurgical excision, Stereotactic biopsy, Endoscopic biopsy and direct radiotherapy. DTI of CST was done in 30 patients with various brainstem lesions to determine operability in DIPG and microsurgical corridor of approach for other lesions. Statistical significance was noted in post-operative modified Rankin scale, progression free survival and overall survival in various brainstem lesions except DIPG, GBM. Despite best possible management DIPG had poor outcome. **Conclusion:** The surgical approach should be tailor made according to the tumor characteristics and direction of displacement of CST on preoperative DTI. Open microscopic excision is the mainstay of management for focal brainstem lesions. STB and Direct radiotherapy are valuable options in patients with infiltrating type of brainstem glioma.

INTRODUCTION

Brainstem glioma is the most frequent tumor of the region. The tumor's extension is considered focal when it occupies 50% of the axial brainstem diameter, and the extension is considered diffuse when the lesion is poorly demarcated and is more than 50% of the brainstem diameter. However, in our study we noted that diffusion tensor imaging (DTI) helps in better differentiation of focal and diffuse lesions.[1]

A clear bimodal age distribution supports the distinction between brainstem gliomas in children and adults.[2] In contrast to the pediatric population, in which brainstem gliomas represent up to 20% of brain tumors and exhibit a rather homogeneous and unfavorable course, adult brainstem gliomas are rare (accounting for only 1–2% of adult brain gliomas) and show heterogeneous radiological patterns and variable prognosis.[3,4]

Preoperative MRI and DTI-CST are now routinely used to assess operability and formulate the most appropriate surgical approach based on tumor size, origin, and extent.[5] The challenge to the neurosurgeon is to develop a microsurgical corridor that will cause the least morbidity, provide adequate working space, and achieve maximal safe resection. Entry into the brainstem must respect defined safe entry zones, which are based on white fiber anatomy and avoid densely packed critical nuclei.[6]

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Multimodal strategies, including microsurgical excision, stereotactic biopsy, adjuvant radiotherapy, and chemotherapy, have been shown to improve clinical outcomes in selected patients.[7]

A PubMed search using the keyword "brainstem gliomas" yielded very limited data from the Indian population specifically addressing surgical morbidity, approach, and outcomes. This underscores the need for region-specific clinical validation.[8]

This study aims to explore the demographic distribution, surgical approaches, and their complications and outcomes, as well as the histological subtypes of brainstem gliomas in the Indian population.

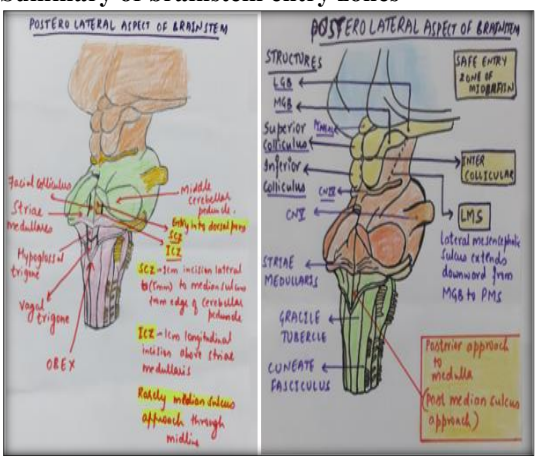
In a landmark study, Mehta et al. proposed a novel, clinically relevant classification of brainstem gliomas based on imaging characteristics and surgical resectability.[1] Our objective is to validate this classification further using our experience, with emphasis on preoperative DTI of corticospinal tracts and the tailored surgical approaches that followed.

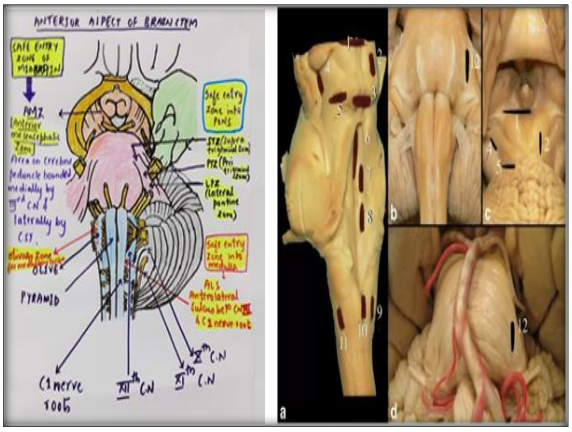
MATERIALS AND METHODS

Patient selection

All patients who underwent management for brainstem lesions during the study duration were included. The diagnosis confirmed with clinical, radiological and pathological analysis. A single centre, Prospective and retrospective observational study of brainstem lesions Retrospective data from 1 March 2016 to 30 March 2018 and Prospective data from March 2018 to 31 March 2020. Surgical resection of lesions was performed by senior author (Dr Manas. K. Panigrahi) Pre-operative, operative and post-operative variables were documented. Various parameters viz type of lesion, location of lesion, type of surgical approach and post-operative outcome was observed. An informed consent to contact patients on telephone was obtained from all the participants or their caregivers. Most of our patients underwent pre-op DTI of CST, Intra-op nerve monitoring was utilized when essential. The study was approved by institutional ethics committee (approval number: No KFRC/SRS/2018/59 02; Date 22/09/2018)

Summary of brainstem entry zones





Entry points representing 12 brainstem safe entry zones have been marked and numbered on the specimen including (1) supracollicular, (2) transcollicular, (3) infracollicular, (4) lateral mesencephalic sulcus, (5) inferior brachial triangle, (6) median sulcus of the fourth ventricle, (7) suprafacial triangle, (8) infrafacial triangle, (9) dorsal intermediate sulcus, (10) dorsal median sulcus of the medulla (11) dorsolateral sulcus, and (12) ventral pontine zones.

Objectives

Primary Objectives were to study clinical presentation in brainstem gliomas, to determine resectability of Brainstem lesions and to understand microsurgical corridor for maximal safe resection of lesion, to understand the complications and outcome of surgery in each type of lesion. Secondary Objectives were to study demography of the population under study and the histopathology of the lesions. With our observations in the study we propose to validate the clinical classification proposed by Dr V.S. Mehta et al.

Statistical Analysis

Microsoft excel software was used to enter data. Descriptive statistics used for demographics Chi square test was used to analyze categorical variables. A P value ≤ 0.05 was considered significant. Whereas a $P < 0.1$ is reported as a trend. All statistical analysis was done using Statistical Package for social Sciences (SPSS) for windows, version 17.0, IBM Computers, New York, USA.

RESULTS

The study population consisted of 48 patients with brainstem lesions. Among these lesions 18 were noted in pediatric age group (≤ 18 years) and 20 in adults. Mean age of the study population was 32.3 years. There were 28 males and 20 females. Most common presenting symptom was headache which was noted in 44.2% of the patients. Other common presentations were giddiness (11.5%), gait disorders (23.1%), cranial nerve deficit (28.8%), motor deficit (23.1%), seizure(3.8%). 3 patients with DIPG were referred for radiotherapy and rest 45 patients were managed as follows.

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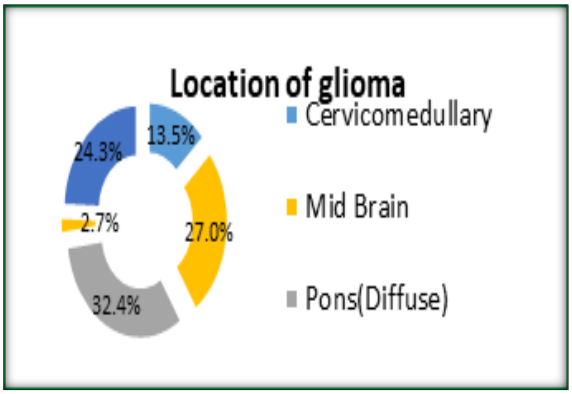
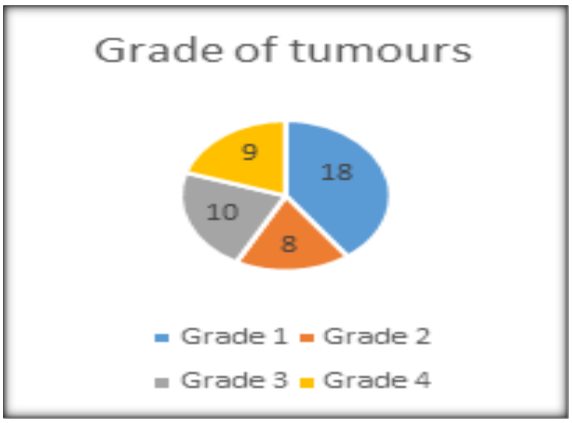
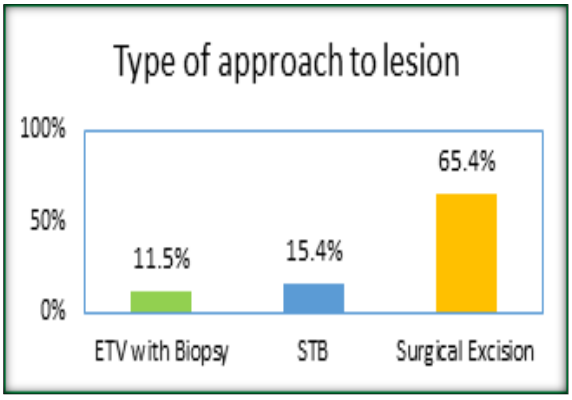
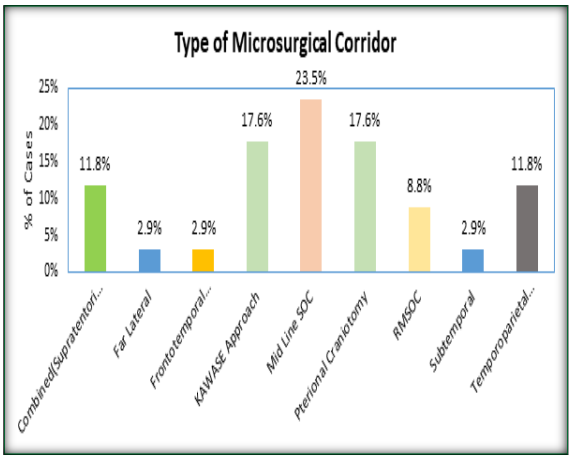
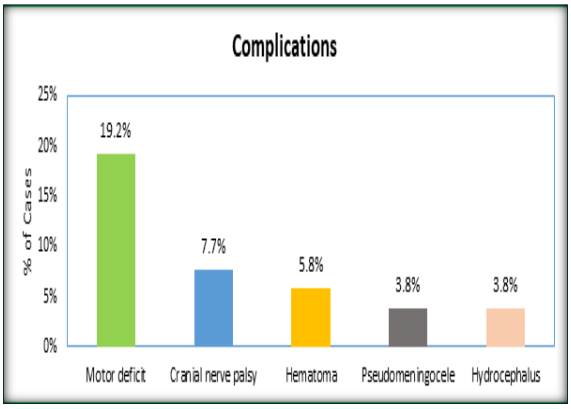


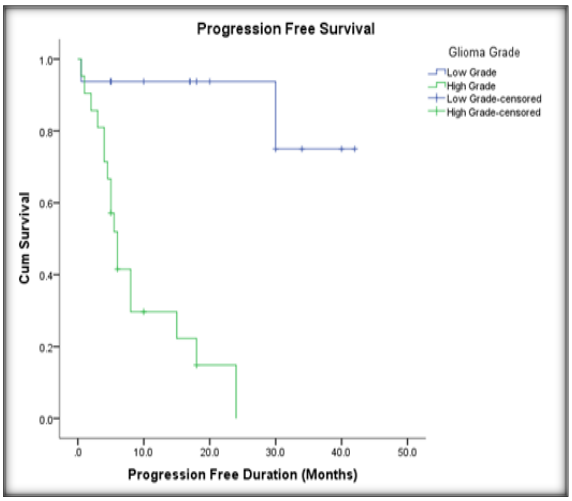




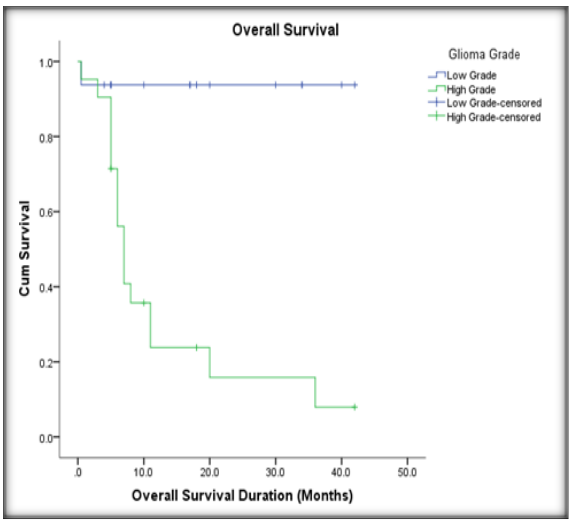




We observed that except in patients with Infiltrative DIPG and Brainstem GBM all other patients with Brainstem gliomas had improvement in modified Rankin Scale postoperatively with significant p value. Paired t test.



P Value < 0.023



P value < 0.015

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Demographic characteristics of study subjects

MRS		Mean	Std. Deviation	P Value
Pre op		2.84	0.583	<0.001
Post op		2.42	0.62	

Mean Progression free survival and overall survival

Progression free survival

Glioma Grade	Total N	N of Events	Censored	
			N	Percent
Low Grade	26	2	14	0.9
High Grade	19	17	4	0.2
Overall	45	19	18	0.5

Overall survival

Glioma Grade	Total N	N of Events	Censored	
			N	Percent
Low Grade	26	1	15	0.9
High Grade	19	17	4	0.2
Overall	45	18	19	0.5

Glioma Grade	Meana				Median			
	Estimate	Std. Error	95% Confidence Interval		Estimate	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound			Lower Bound	Upper Bound
Low Grade	39.406	2.511	34.484	44.329	.	.	.	.
High Grade	12.604	2.920	6.880	18.328	7.000	.719	5.592	8.408
Overall	22.428	3.128	16.297	28.560	20.000	11.080	.000	41.716

8. Role of DTI-CST in determining resetability and microsurgical corridor of approach to lesion.

8 out of 12 patients with diffuse pontine glioma underwent evaluation with preoperative Diffusion tensor imaging of corticospinal tracts. 5 out of 8 patients showed only displacement of Corticospinal tracts hence they underwent surgical resection, whereas 3 out of 5 patients showed infiltration of CST hence they underwent Stereotactic biopsy (2) or referred to radiotherapy (1).

22 out of 33 other brainstem gliomas also underwent DTI of CST to know infiltration, direction of splaying/displacement CST, which determines the surgical corridor of approach.

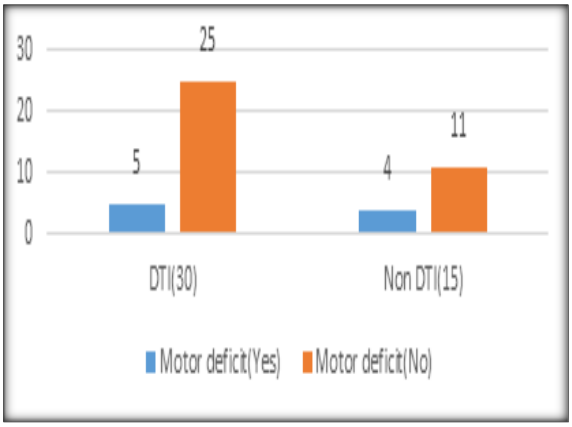
Some Illustrative cases showing Observation of DTI-CST and its corelation with surgical corridor of approach.

Sl No.	Age and sex	Type of lesion	Direction of displacement of CST	Type of approach
1	58yr/F	Midbrain pilocytic astrocytoma	Anteriorly and laterally	Combined supra and infratentorial approach
2	59yr/M	Left thalamopeduncular astrocytoma	Infiltration of CST	ETV+Biopsy
3	28yr/F	Left thalamopeduncular glioma	Posteriorly and laterally	Left temporoparietal craniotomy and subtotal excision
4	8yr/M	Midbrain pilocytic astrocytoma	Posteriorly and laterally	Left pterional craniotomy and transsylvian excision of lesion
5	25yr/M	Diffuse Pontine glioma	Infiltration of CST	STB
6	7yr/F	Diffuse pontine glioma	Infiltration of CST	Radiotherapy
7	5yr/F	Diffuse pontine glioma	Displaced anteriorly and medially	RMSOC and excision of lesion
8	1 yr/M	Diffuse pontine glioma	Displaced posteriorly and medially	Right pterional craniotomy and transylvian excision
9	69 yr/M	Diffuse pontine glioma	Displaced anteriorly and medially	Kawase approach
10	43 yr/M	Midbrain oligoastrocytoma	Displaced posteriorly and laterally	Right pterional craniotomy and excision of lesion
11	63yr/M	Left thalamopeduncular GBM	Infiltration of CST	STB

5 (16 %) out of 30 patients (2 patients referred for radiotherapy) who underwent DTI of Corticospinal tract preoperatively before undergoing surgical management had worsening or new onset motor deficit, whereas 4 (25.2 %) out of 15 patients (1 patient referred for radiotherapy) in whom DTI was not done had postoperative worsening of motor deficit or new onset motor deficit. We observed that patients with preop DTI assessment had lesser

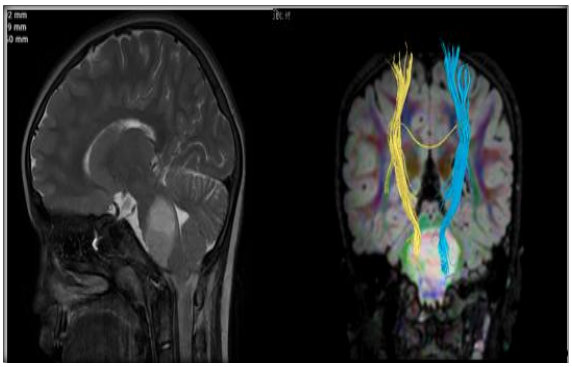
ISSN (O): 2687-5365; ISSN (P): 2753-6556

chances of motor deficit, though it was not statistically significant (p value 0.412).



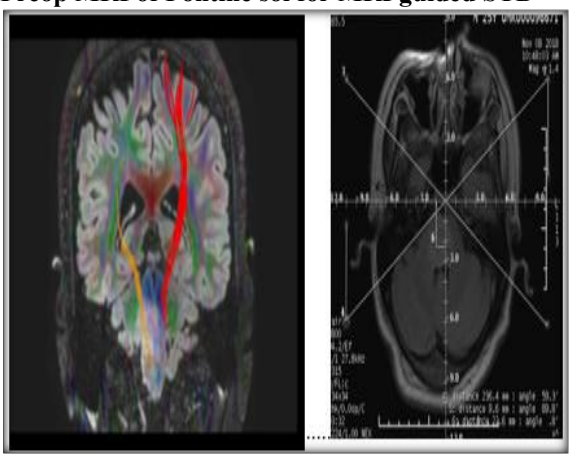
Illustrative cases

Case 1: A 7year old girl presented with progressive left side weakness since 6 months. On evaluation she was diagnosed with DIPG and DTI showed infiltration of tracts with reduced FA values. Hence referred for radiotherapy. (Preop images of DIPG).



Case 2: A 25 year male presented with right 6th cranial nerve palsy with headache, diagnosed as pontine sol and DTI showed infiltration of CST, patient underwent MRI guided Steretactic biopsy. Biopsy suggestive of Glioblastoma grade 4.

Preop MRI of Pontine sol for MRI guided STB



Case 3: A 8year old child presented with progressive right upper sided weakness with diplopia. On evaluation he was diagnosed with Midbrain sol and DTI showed displacement of CST posteriorly and laterally. He underwent left pterional craniotomy, trans-sylvian approach and near total excision of sol.

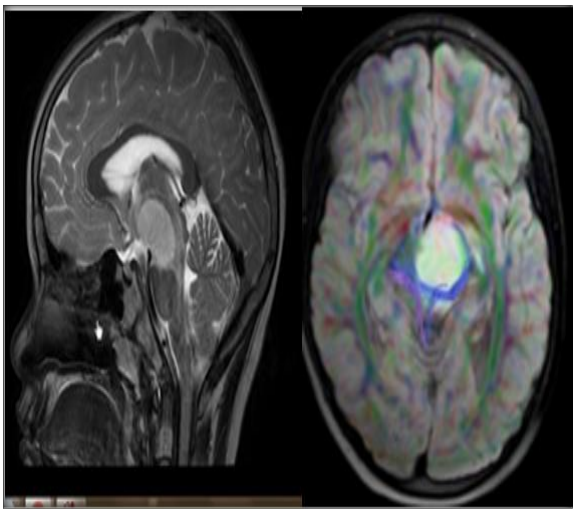
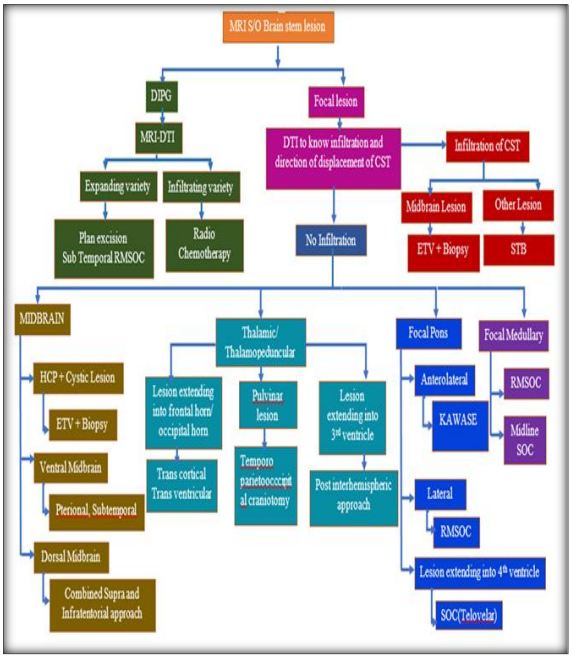


Figure 12: Preop MRI of Ventral midbrain lesion

CONCLUSION

In conclusion we propose an alogorithm for management of Brainstem gliomas and further validate the clinical and radiological classification proposed by Dr V.S.Mehta et al.



ISSN (O): 2687-5365; ISSN (P): 2753-6556

Classification proposed by Dr V.S.Mehta et al and our validation

Type of Intrinsic Brainstem glioma	Features	Our classification	Surgery
A. Intrinsic variety	The tumour is well within brainstem axis without any parenchymal breach		
A.1 Expanding variety	a. Well defined on MRI b. good preservation of Motor function c. Size may be >2cm	DTI shows only displacement of CST with normal FA values	Surgery
A.2 Diffuse infiltrative variety	a. No margin of delineation b. Rapid progression of symptoms	DTI shows infiltration of CST with altered FA values	No surgery as per V.S.Mehta et al classification We propose either direct Radiotherapy or STB or Endoscopic biopsy if midbrain lesion extending into posterior third ventricle
A.3 Ventrally located	a. Pure ventral	Decision based on direction of displacement of CST on DTI	No surgery as per V.S.Mehta et al classification but If MIDBRAIN lesion Pterional or subtemporal approach and excision And if PONTINE lesion then Kawase approach can be planned

REFERENCES

1. Mehta VS, Chandra PS, Singh PK, Garg A, Rath GK. Surgical considerations for 'intrinsic' brainstem gliomas: proposal of a modification in classification. Neurol India. 2009;57(3):274–81.
2. Laigle-Donadey F, Doz F, Delattre JY. Brainstem gliomas in children and adults. Curr Opin Oncol. 2008;20(6):662–7.
3. Liu H, Qin X, Zhao L, Zhao G, Wang Y. Epidemiology and survival of patients with brainstem gliomas: a population-based study using the SEER database. Front Oncol. 2021;11:692097.
4. Leibetseder A, Leitner J, Mair MJ, et al. Prognostic factors in adult brainstem glioma: a tertiary care center analysis and review of the literature. J Neurol. 2022;269(3):1574–90.
5. Xiao X, Kong L, Pan C, et al. The role of diffusion tensor imaging and tractography in the surgical management of brainstem gliomas. Neurosurg Focus. 2021;50(1):E10.
6. Cavalcanti DD, Preul MC, Kalani MY, Spetzler RF. Microsurgical anatomy of safe entry zones to the brainstem. J Neurosurg. 2016;124(5):1359–76.
7. Frazier JL, Lee J, Thomale UW, et al. Treatment of diffuse intrinsic brainstem gliomas: failed approaches and future strategies. J Neurosurg Pediatr. 2009;3(4):259–72.
8. Ius T, Lombardi G, Baiano C, et al. Surgical management of adult brainstem gliomas: a systematic review and meta-analysis. Curr Oncol. 2023;30(11):9772–85.
9. Yao Y, Ulrich NH, Guggenberger R, et al. Quantification of corticospinal tracts with diffusion tensor imaging in brainstem surgery: prognostic value in 14 consecutive cases. World Neurosurg. 2015;83(6):1006–14.
10. Meybodi AT, Lawton MT, Spetzler RF. Virtual exploration of safe entry zones in the brainstem: comprehensive definition and analysis of the operative approach. World Neurosurg. 2020;138:e677–86.

ISSN (O): 2687-5365; ISSN (P): 2753-6556