

NARRATIVE REVIEW

Consensus guidelines for the management of posterior fossa tumour for low and middle-income countries

Hafiza Fatima Aziz¹, Mohammad Hamza Bajwa², Naureen Mushtaq³, Saqib Kamran Bakhshi⁴, Kaynat Siddiqui⁵, Saad Akhtar Khan⁶, Rabeet Tariq⁷, Muhammad Shakir⁸, Mehar Masroor⁹, Fatima Suleman¹⁰

Pakistan Brain Tumour Consortium: (Authors list at the end of the supplement), Syed Ather Enam¹¹.

Abstract

The posterior fossa is a limited compartment therefore lesions compressing its structures can result in devastating outcomes. It can cause significant neurological deficit due to mass effect on critical structures and hydrocephalus. Due to the nature of the infratentorial region, urgent surgical intervention is often the first-line option. Surgical neuro-oncologists guide patients and caregivers through the course of this disease and to inform them about the various options for management and long-term outcome optimisation. There is currently conflicting data; however, institutional experiences can guide us towards achieving improvements in surgical outcomes and quality of life. Advances in molecular classifications coupled with high-dose radiation treatment improve our capacity for improving overall survival in these patients. Common childhood tumours are ependymomas, medulloblastomas, and juvenile pilocytic astrocytomas, while adults often present with metastases, and less commonly, cerebellar haemangioblastomas and gliomas. This paper outlines management strategies with consideration for multidisciplinary care and resource-limited settings.

Keywords: Cerebellar neoplasms, medulloblastoma, caregivers, hemangioblastoma, astrocytoma, ependymoma, hydrocephalus, neuro-oncology, neurosurgery, brain tumour, posterior fossa.

DOI: <https://doi.org/10.47391/JPMA.S3.GNO-22>

Introduction

Posterior fossa brain tumours (PFBT) pose challenges for neuro-oncologists in balancing interventions for achieving long-term oncological control with quality of life and functional durability. Paediatric PFBT commonly present with obstructive hydrocephalus and gait

instability; these are mainly medulloblastoma, ependymomas, and juvenile pilocytic astrocytomas.¹ The most common adult malignancy within the posterior fossa is metastasis, as the prior pathologies are relatively rare in adults.² Cerebellar haemangioblastomas may also be present, particularly within Von-Hippel Lindau syndrome – necessitating a thorough examination for other stigmata.

Generally, standard care for PFBT includes surgery followed by adjuvant radiation or chemotherapy, depending on pathology. Controversies exist with regards to persistent hydrocephalus despite surgical resection, reported in almost 1/3rd of patients; this necessitates diversion either through VP shunt or ETV procedure, each of which has its own complications and failure rates.³ While VP shunts are associated with more complications such as infection and requiring redo-shunt procedures, ETV were shown to have earlier time-to-failure however with longer durability. Long-term quality of life after PFBT surgery has shown to be affected by socioeconomic status and hydrocephalus.⁴ Other issues such as posterior fossa syndrome (cerebellar mutism syndrome), impaired swallowing, and cognitive impairment following radiation treatment also pose long-term challenges.⁵⁻⁷

Methodology

The literature search of the high-quality data on posterior fossa tumours was done in July 2022 on different databases including PubMed, Google Scholar, Scopus, and Embase. The most relevant and high-quality studies were analyzed to develop the evidence-based recommendations. An expert panel was convened consisting of specialists and leading experts within the field of neuro-oncology to identify the gaps in diagnosis and management of posterior fossa tumours within Pakistan. This group was tasked with identifying best-practice recommendations and their application within the context of Pakistan as an LMIC. Recommendations were collated, reviewed and debated regarding utility and evidence-based practices, in a process that has been previously detailed.⁸

^{1,2,4,5,8-11}Department of Neurosurgery, The Aga Khan University, ³Department of Paediatric Oncology, The Aga Khan University, ⁷Jumma Research Laboratories, The Aga Khan University, Karachi, Pakistan

Correspondence: Syed Ather Enam **Email:** ather.enam@aku.edu

Importance of surgical clearance

Patients presenting with neurological signs suggestive of obstructive hydrocephalus and posterior fossa signs should have a complete radiological workup. MRI brain study with contrast allows characterisation of these lesions, degree of hydrocephalus, and assessment of nearby critical structures. For paediatric patients, MRI spine with contrast should ideally also be performed within the same setting as PFBT may present with drop metastases to the spine, further complicating management. Here, the role of an experienced radiologist or fellowship-trained neuroradiologist is crucial in effectively communicating the understanding of distinct imaging features on MRI and confidently determining the management pathway. For instance, in cases where a tumour exhibits benign features, resembling a haemangioma or juvenile pilocytic astrocytoma (JPA), extensive spine MR imaging may not be necessary. On the other hand, detecting likely malignant lesions on MRI can help plan for extensive surgery. Often, workup may be delayed due to patients presenting in obtunded conditions – in such cases, radiology can be obtained within 72 hours after surgery, and should ideally be performed when possible, as recommended by international consensus guidelines.⁹ Since adult patients commonly present with metastatic lesions, a CT chest, abdomen, and pelvis with IV contrast is recommended to rule out primary pathologies.

Surgical resection is guided on principles of achieving maximum safe resection, opening CSF pathways, and decompression of critical structures, often the midbrain. Degree of surgical resection in PFBT has a strong association with overall survival and avoidance of persistent hydrocephalus¹⁰ thus reinforcing maximal safe resection. It is ideal to avoid a simple biopsy of the lesion or diverting with a VP shunt. In resource-limited settings, although a simple biopsy may initially falsely 'improve' symptoms; the patient will eventually require a second, more difficult, redo-procedure to achieve greater tumour reduction. As has been shown in many LMICs, many neuro-oncological patients are lost-to-follow-up, ultimately resulting in a worse outcome for these patients.¹¹ Lesions adherent to critical structures may be resected while leaving residual tumours in areas where not possible, such as critical vascular structures or the midbrain. This remnant tumour can be treated optimally later on with radiation therapy, particularly targeted, stereotactic radiosurgery. A postoperative scan to assess tumour resection and for any complications should be performed within 48 hours of surgery.

Considerations for adjuvant therapy and follow-up

The posterior fossa is the most commonly irradiated intracranial compartment in the paediatric population despite the toxicity profile. Craniospinal irradiation to control microscopic disease has been linked to significant improvements within overall survival for PFBT, albeit with cognitive and endocrinological morbidity. This has been further improved with hyperfractionated regimens with tumour-bed radiation boost, to reduce radiation toxicity to surrounding normal neural tissue. Ideally, this is determined on assessment of risk of the patient, with a paediatric neuro-oncologist. Surgeons aiming for safe resection may find it useful to leave tumour adherent to critical structures and refer for radiation (stereotactic radiosurgery) to achieve good control with intact neurological function. In ependymoma particularly, routine neuroaxis radiation is not advised unless evidence of dissemination is seen.

Surgery remains the mainstay of treatment in many of PFBT patients, barring metastatic or unresectable disease. Advancements such as greater use of pre-resection ETV and targeted radiotherapy have expanded the safety profile of surgery for PFBT. Unfortunately, with ETV there still remain limitations and some patients will ultimately need VP shunt insertion for long-term control. There are promising results with endoscopic cauterization of the choroid plexus (CPC) combined with ETV to limit CSF production and improve overall success.¹² These options may be more viable in resource-limited settings, where avoiding another repeat surgery with shunt complications in the long-term may not be feasible for many patients.

Extent of resection remains a major predictor for survival in medulloblastoma, ependymoma, and JPA – high-dose radiation of the tumour bed has shown marked improvement in long-term survival as well. Unfortunately, we are still looking for better ways to approaching and treating DIPG and ATRT. Recurrent disease should be evaluated in multidisciplinary tumour boards in tandem with paediatric neuro-oncologists and other experts; especially with residual posterior fossa ependymoma, repeat surgery is a viable option.

EVD insertion can be a temporising procedure while planning definitive surgery particularly in cases of initial hydrocephalus – however, a recent systematic review has unfolded a unique perspective into the use of EVDs in asymptomatic hydrocephalus as well.¹³ EVDs should ideally be removed within 48-72 hours – if hydrocephalus persists, a permanent VPS may be considered. This will

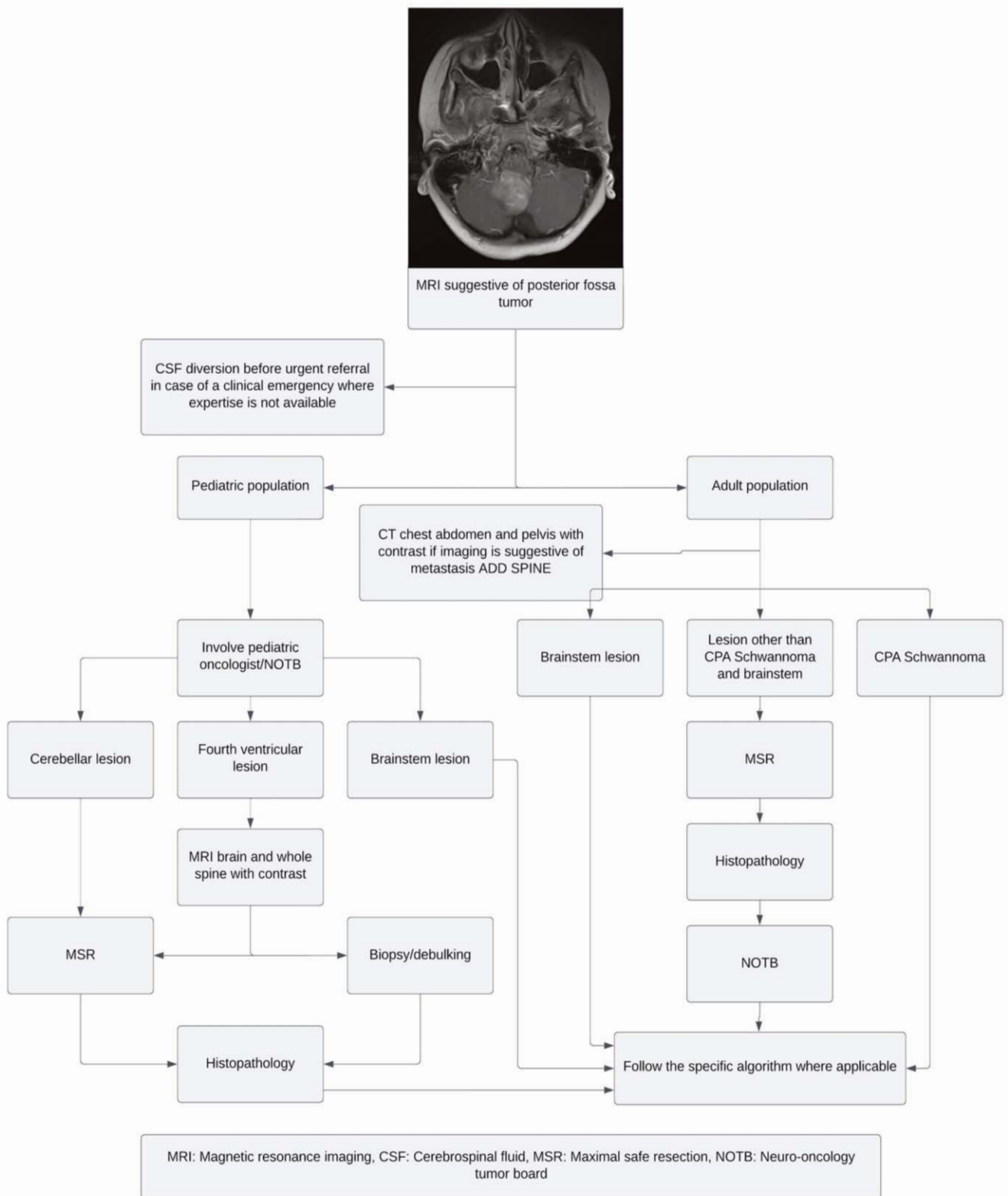


Figure-1: Management of Posterior fossa tumours algorithm.

Table-1: Summary of Recommendations for Posterior Fossa Neoplastic Lesions.

Radiology	<ul style="list-style-type: none"> • MRI brain with and without contrast. • 'Minimum required' MRI protocol: <ul style="list-style-type: none"> o Imaging on at least 0.5T. o Sequences: Axial T2 and coronal or axial FLAIR sequence; pre-contrast T1 and contrast enhanced T1. • Tumour location, size, margins, enhancement pattern, presence of hydrocephalous, haemorrhage/mineralisation, oedema, involvement of critical neurovascular structure. • If imaging is suggestive of the metastatic lesion, systemic imaging is required (CT CAP/PET). • For surgical planning, CTA is required to delineate vascular anatomy where needed. • Postoperative MRI is recommended and tailored to each pathology. <ul style="list-style-type: none"> o For intra-axial/fourth ventricular lesion a post-operative MRI is recommended within 72 hours of surgery or after 6 weeks if delayed. For extra-axial after 3 months. o To identify the extent of resection. o To have a baseline to compare successive imaging. o Not required after biopsy.
Neurosurgery	<ul style="list-style-type: none"> • CSF diversion before urgent referral in case of a clinical emergency where expertise is not available. • Maximal safe resection with preservation of critical neurovascular structures.
Medical and Radiation Oncology	<ul style="list-style-type: none"> • Tailored approach for each pathology after discussing in NOTB.
Neuropathology	<ul style="list-style-type: none"> • Haematoxylin and Eosin (H&E) preparation for histological typing. • Relevant immunohistochemical stains for definite characterisation based on the histology of the tumour.
Follow-up	<ul style="list-style-type: none"> • First follow-up at post-op day 10 for wound assessment, stitch removal, discussion related to histopathology and NOTB recommendations. • Clinical follow-up with MRI tailored to histopathological diagnosis.

MRI: Magnetic resonance imaging, FLAIR: Fluid-attenuated inversion recovery, CT-CAP: Computed tomography of chest, abdomen and pelvis, PET: Positron Emission Tomography, CTA: Computed tomography angiography, CSF: Cerebrospinal fluid, NOTB: Neuro-Oncology tumour board.

require extensive counselling of the family regarding warning signs of shunt malfunction, need for life-long care, and potential re-do procedures. Clinical tools for

predicting postoperative hydrocephalus in PFBT may have a role in selecting high-risk patients; the modified Canadian Preoperative Prediction Rule for Hydrocephalus (mCPPRH) uses age, degree of hydrocephalus, tumour metastasis, pathology type, and trans-ependymal oedema as co-factors for prediction.¹⁴ A recent study from China in 2022 expanded this clinical tool within their own institution, finding key risk factors to include higher grade tumours, metastatic disease, and postoperative ventricular blood predicting need for postoperative shunt requirement.¹⁵ Further utilisation of these tools and validation at other centres may be clinically useful, warranting closer follow-ups and caregiver education in patients with PFBT.

Diagnostic pearls

In summary, patients presenting with posterior fossa lesions should be worked up in a methodological fashion as shown in Table 1 and Figure 1.

Conclusion

Long-term improvement of outcomes in PFBT patients requires careful surgical planning and maximising our ability to resect the tumour. For specific disease subtypes, it is beneficial to use multidisciplinary care plans for postoperative radiotherapy and chemotherapy.

Disclaimer: None.

Conflict of Interest: None.

Funding Disclosure: None.

References

1. Muzumdar D, Ventureyra EC. Treatment of posterior fossa tumors in children. *Expert Rev Neurother* 2010;10:525-46. doi: 10.1586/ern.10.28.
2. Grossman R, Ram Z. Posterior Fossa Intra-Axial Tumors in Adults. *World Neurosurg* 2016;88:140-5. doi: 10.1016/j.wneu.2015.12.066.
3. Dewan MC, Lim J, Shannon CN, Wellons JC. The durability of endoscopic third ventriculostomy and ventriculoperitoneal shunts in children with hydrocephalus following posterior fossa tumor resection: a systematic review and time-to-failure analysis. *J Neurosurg Pediatr* 2017;19:578-84. doi: 10.3171/2017.1.PEDS16536.
4. Baqai MWS, Tariq R, Shah Z, Bajwa MH, Shamim MS. Quality of life in survivors of pediatric medulloblastoma: a systematic review and meta-analysis. *Childs Nerv Syst* 2023;39:1159-71. doi: 10.1007/s00381-023-05886-4.
5. Bakhshi SK, Mitha R, Mushtaq N, Shamim MS. Cerebellar Mutism Syndrome after surgical resection of posterior fossa neoplastic lesions. *J Pak Med Assoc* 2020;70:1667-8.
6. Kulkarni AV, Piscione J, Shams I, Bouffet E. Long-term quality of life in children treated for posterior fossa brain tumors. *J Neurosurg Pediatr* 2013;12:235-40. doi: 10.3171/2013.6.PEDS12535.
7. Panwala TF, Fox ME, Tucker TD, King TZ. The Effects of Radiation and Sex Differences on Adaptive Functioning in Adult Survivors of Pediatric Posterior Fossa Brain Tumors. *J Int Neuropsychol Soc* 2019;25:729-39. doi: 10.1017/S135561771900033X.
8. Bajwa MH, Shah MM, Mustansir F, Gauhar F, Baig E, Zafar SN, et al.

- A Guideline On Guidelines – Neuro-Oncology Guideline Standards For Low And Middle-Income Countries. *J Pak Med Assoc* 2024;74(Suppl 3):s87-92. Doi: 10.47391/JPMA.S3.GNO-10.
9. Leblond P, Massimino M, English M, Ritzmann TA, Gandola L, Calaminus G, et al. Toward improved diagnosis accuracy and treatment of children, adolescents, and young adults with ependymoma: the International SIOP Ependymoma II Protocol. *Front. Neurol.* 2022;13:887544. doi:10.3389/fneur.2022.887544.
 10. Zhang C, Zhang T, Ge L, Li Z, Chen J. Management of Posterior Fossa Tumors in Adults Based on the Predictors of Postoperative Hydrocephalus. *Front Surg* 2022;9:886438. doi: 10.3389/fsurg.2022.886438.
 11. Khalid MU, Bajwa MH, Shah MM, Zafar SN, Laghari AA, Akhuzada NZ, et al. Factors associated with lost to follow up in patients with brain tumours: A multi-centre study in Pakistan. *J Pak Med Assoc* 2022;72(Suppl 4):s16-24. doi: 10.47391/JPMA.11-S4-AKUB03.
 12. Cinalli G, Spennato P. Controversies in the Endoscopic Management of the Various Forms of Hydrocephalus. In: Sgouros S, eds. *Neuroendoscopy*. Heidelberg, Germany: Springer-Verlag Berlin Heidelberg, 2014; pp 47-56. doi: 10.1007/978-3-642-39085-2_4
 13. Anania P, Battaglini D, Balestrino A, D'Andrea A, Prior A, Ceraudo M, et al. The role of external ventricular drainage for the management of posterior cranial fossa tumours: a systematic review. *Neurosurg Rev* 2021;44:1243-53. doi: 10.1007/s10143-020-01325-z.
 14. Foreman P, McClugage S, Naftel R, Griessenauer CJ, Ditty BJ, Agee BS, et al. Validation and modification of a predictive model of postresection hydrocephalus in pediatric patients with posterior fossa tumors. *J Neurosurg Pediatr* 2013;12:220-6. doi: 10.3171/2013.5.PEDS1371.
 15. Zhang N, Zhang D, Sun J, Sun H, Ge M. Contribution of tumor characteristics and surgery-related factors to symptomatic hydrocephalus after posterior fossa tumor resection: a single-institution experience. *J Neurosurg Pediatr* 2022;31:99-10. doi: 10.3171/2022.10.PEDS22281.

DISCLAIMER

Articles published in JPMA and Supplements of JPMA do not represent the views of the editor or editorial Board. Authors are solely responsible for the opinions expressed and the accuracy of the data.

The contribution of each author towards the published research included in this supplement is the responsibility of the authors and their institutions. It is expected to be in accordance and compliance with the ICMJE Guidelines.

Any questions/queries raised by readers should be directed to the corresponding author.