Posterior Reversible Encephalopathy Syndrome Developing after Aggressive Posterior Fossa Tumor Surgery

Gokhan Bozkurt1 Orkhan Mammadkhanli2 Mahmut Ozden3

1 Department of Neurosurgery, Acibadem Maslak Hospital, Istanbul, Turkey
2 Faculty of Medicine, Medical Park Ankara Hospital, Yuksek Ihtisas University, Ankara, Turkey
3 Department of Neurosurgery, Memorial Bahcelievler Hospital, Istanbul, Turkey

Address for correspondence Orkhan Mammadkhanli, MD, Department of Neurosurgery, Faculty of Medicine, Trakya University, Edirne, 22030, Turkey (e-mail: dr.mammadkhanli@gmail.com).

Abstract
Posterior reversible encephalopathy syndrome (PRES) is a rare neurologic disorder, having such common radiological findings as vasogenic edema and white matter changes in watershed areas. The clinic and radiological outcome may not be reversible in 10 to 20% of patients, like in the case of our patient. Here, we discuss the pathogenetic factors that are essential in developing PRES after posterior fossa surgery. A 4-year-old female was admitted to our clinic with a recurrent/residual mass in the posterior fossa. She previously underwent posterior fossa surgery three times (for what was diagnosed as anaplastic astrocytoma through pathohistology) in another center. She was operated thrice in 5 days, and the tumor radically removed. Two days later, after the last surgery, while waking up, our patient developed seizures and altered consciousness. Her neurological condition was severe. Magnetic resonance imaging findings were compatible with those of PRES. Our patient had multiple risk factors for PRES that were as follows: multiple posterior fossa surgeries, anamnesis of chemotherapy and radiotherapy, high-dose steroid use, intracranial pressure changes, and hypertensive attacks due to surgical manipulation. In preventing the development of PRES, we should beware of sudden changes in blood pressure during surgery and meticulously manipulate the brain stem to avoid any disturbance of the central nervous system homeostasis. PRES may transform into real encephalopathy. If the patient has some of these risk factors, PRES would probably develop after surgery.

Keywords
► anaplastic ependymoma
► brain stem compression
► posterior fossa surgery
► posterior reversible encephalopathy syndrome (PRES)
Established Facts

An already known fact is that PRES is associated with many different conditions like malignant hypertension, immunosuppressive therapy, eclampsia, electrolyte imbalances, and autoimmune diseases.

Novel Insights

New information in our case is developed PRES secondary to intracranial hypotension (after elevated intracranial pressure [ICP]), aggressive tumor debulking and shunt revision which led to severe falling ICP.

Introduction

Posterior reversible encephalopathy syndrome (PRES) presents with various clinicoradiologic syndromes (headaches, seizures, vision loss, altered mental condition clinically and diffuse subcortical white matter vasogenic edema; predominantly in the parietooccipital regions, radiologically). PRES is associated with many different conditions like malignant hypertension, immunosuppressive therapy, eclampsia, electrolyte imbalances, and autoimmune diseases. A history of chemotherapy, steroid use, intracranial hypotension, shunt revision, peri- and postoperative hypertension, and hypertension due to manipulation of the brainstem (especially at the ventrolateral medulla) might contribute to PRES development.

We present a pediatric patient who previously was operated for recurrent anaplastic ependymoma. The patient underwent three posterior fossa- and one shunt-revision surgeries over 5 days. Subsequently, PRES developed. The patient had multiple risk factors for the development of PRES. Here, we described the pathophysiology behind PRES in our patient. Through this study, we aimed to increase awareness about PRES among neurosurgeons.

Case Report

A 4-year-old female patient who was previously operated for a fourth ventricular tumor three times, and later for placement of a ventriculoperitoneal shunt due to secondary hydrocephalus. In these surgeries, tumors extending from the foramen Luschka to the cerebellopontine angle (CPA) remained residual. As these tumors were histopathologically reported as anaplastic ependymomas, chemotherapy and high-dose steroids were accepted. Upon admission to our clinic, the patient suffered a relapse of the midline posterior fossa tumor, and also of both side tumors (these tumors increased in size) that arose in the CPA. Informed written consent was obtained from the parents of the patient for the publication of this case report and any accompanying images. The brain stem was compressed 270 degrees from three sides (the midline and both CPA angles). Tumors were in three different places; thus, three surgeries in different regions were performed. Neurologic examination revealed brain stem compression and long tract involvement, together with hydrocephalus. Moreover, in anamnesis, the patient had a mutism after previous surgeries, which continued 2 months. Afterward, over 5 days, three surgeries were performed, for the midline tumor and for both CPA tumors. In the first surgery, the preoperative ventriculoperitoneal shunt was revised, and the midline tumor was removed. There was no problem after the first surgery. Following the second surgery, the patient had perioperative and postoperative hypertension that was controlled under conservative treatment. Finally, following the third surgery, uncontrolled hypertension (despite medical treatment it continued 3 days) was noticed. During surgery, after manipulation of the brain stem (since the tumor arose from Luschka), intraoperative hypertension, and asystoles were observed; however, these asystoles (two times) were up to 3 seconds. The tumor was removed totally. Between every surgery, the patient was awakened for checking neurological conditions. There was no additional neurological deficit. We did not want to perform three surgeries consecutively, to better understand the problems that could arise. The patient was intubated after surgery. While intubated, but in spontaneous breathing (when she was not under anesthesia), seizures developed immediately after postoperative day (following day after surgery), one of the third surgery during the awakening phase. Antihypertensive therapy and antiepileptic drugs were commenced. Magnetic resonance imaging...
was observed (transformation of vasogenic edema into cytotoxic edema was not any awareness. Two weeks after the admission MRI, a entire tumor; therefore, radical surgery was planned. Aim in surgery of ependymoma is the extent of resection and moreover lead to dissemination causing drop metastasis. Five of these patients underwent recurrent operations. All of the patients had an elevation of the ICP preoperatively. We believe the main pathogenic factor that the patients were preoperative ICP elevation, and if the tumor was located in the fourth ventricle or had a CPA localization, surgical manipulations of this area, rapid decompression and a sudden change in the ICP may be key factors in the development of PRES. We observed that all of

Discussion

Aim in surgery of ependymoma is the extent of resection and safe surgery to prevent neurological deficit. This type tends to infiltrate adjacent brain, have a higher proliferation rate, and moreover lead to dissemination causing drop metastasis in the central nervous system. As we know, the extent of resection is recognized as the mainly prognostic marker in adults and in children. Therefore, there is no other treatment option for ependymoma. We aimed to remove the patients were preoperative ICP elevation, and if the tumor was located in the fourth ventricle or had a CPA localization, surgical manipulations of this area, rapid decompression and a sudden change in the ICP may be key factors in the development of PRES. We observed that all of
the patients recorded in literature who developed PRES had at least one of the risk factors.

From the literature review, the general outcome in PRES seems to be a return to the baseline neurological status. In neurosurgical patients, it could be difficult to differentiate between neurologic deficits occurring due to primary lesions, after the surgical procedure, or as a result of the PRES itself. Also, we stated that the clinic and radiological outcome may not be reversible in 10 to 20% of patients, as in the case of our patient. We should remember that PRES in pediatric patients had a 15% mortality rate. In our patient, the vasogenic edema became cytotoxic. This factor showed that not all cases of PRES in patients exhibit a reversible character. If the patient has a severe dysfunction of homeostasis, the ensuing encephalopathy could be irreversible.

Adding to literature, as rare cases of PRES are also important, because the etiology and pathophysiology are poorly understood, and will probably be explained better after an adequate number of cases.

Conclusion

Acute changes in the ICP secondary to radical tumor excision and shunt revision might have contributed to the development of PRES in our patient, who had a recent history of chemotherapy and high-dose of corticosteroids.

We should meticulously manipulate brain stem and its environs, especially in region of the RVLM and the fourth ventricle. Beware of sudden and severe changes in the blood pressure and ICP (especially acute drops) during posterior fossa surgery. Rapid decompression of posterior fossa tumors in the presence preoperative ICP elevation may be key factor in the development of PRES after aggressive posterior fossa surgery.

Ethical Approval

Informed written consent was obtained from the parents of the patient for publication of this case report and any accompanying images.

Authors’ Contributions

Orkhan Mammadkhanli and Gokhan Bozkurt were involved in the conception and design; acquisition, analysis, and interpretation of data; drafting; revising; and final approval of the manuscript. Mahmut Ozden contributed to the acquisition, analysis, and interpretation of data.

Funding

None.

Conflict of Interest

None declared.

Acknowledgment

Preparation for publication of this article is partly supported by the Turkish Neurosurgical Society.

References

1. Hinchey J, Chaves C, Appignani B, et al. A reversible posterior leukoencephalopathy syndrome. N Engl J Med 1996;334(08): 494–500
2. Patel AJ, Fox BD, Fulkerson DH, et al. Posterior reversible encephalopathy syndrome during posterior fossa tumor resection in a child. J Neurosurg Pediatr 2010;6(04):377–380
3. Moriatry JL Jr, Lim M, Storm PB, Beauchamp NJ Jr, Olivi A. Reversible posterior leukoencephalopathy occurring during resection of a posterior fossa tumor: case report and review of the literature. Neurosurgery 2001;49(05):1237–1239, discussion 1239–1240
4. Le EM, Loghin ME. Posterior reversible encephalopathy syndrome: a neurologic phenomenon in cancer patients. Curr Oncol Rep 2014;16(05):383
5. Parikh NS, Schweitzer AD, Young RJ, et al. Corticosteroid therapy and severity of vasogenic edema in posterior reversible encephalopathy syndrome. J Neurol Sci 2017;380:11–15
6. Santillan A, Aamodt W, Bhavaraju-Sanka R. Pears & Oysters: Spontaneous intracranial hypotension and posterior reversible encephalopathy syndrome. Neurology 2016;86(06):e55–e57
7. Niwa R, Oya S, Nakamura T, Hana T, Matsui T. Rapid intracranial pressure drop as a cause for posterior reversible encephalopathy syndrome: two case reports. Surg Neurol Int 2017;8:103
8. Lamy C, Oppenheim C, Mas JL. Posterior reversible encephalopathy syndrome. Handb Clin Neurol 2014;121:1687–1701
9. Geiger H, Naraghi R, Schobel HP, Frank H, Sterzel RB, Fahlushi R. Decrease of blood pressure by ventrolateral medullary decompres- sion in essential hypertension. Lancet 1998;352(9126):446–449
10. Kan P, Couldwell WT. Posterior fossa brain tumors and arterial hypertension. Neurosurg Rev 2006;29(04):265–269, discussion 269
11. Coffee RE, Nicholas JS, Egan BM, Rumboldt Z, D’Agostino S, Patel S. Arterial compression of the retro-olivary sulcus of the medulla in essential hypertension: a multivariate analysis. J Hypertens 2005;23(11):2027–2031
12. Delgado-López PD, Corrales-García EM, Alonso-García E, et al. Central nervous system ependymoma: clinical implications of the new molecular classification, treatment guidelines and controversial issues. Clin Transl Oncol 2019;21(11):1450–1463
13. Gephart MG, Taft BP, Giese AK, Guzman R, Edwards MS. Perioperative posterior reversible encephalopathy syndrome in 2 pediatric neurosurgery patients with brainstem ependymoma. J Neurosurg Pediatr 2011;7(03):235–237
14. Kamiya-Matsuoka C, Cachia D, Olar A, Armstrong TS, Gilbert MR. Primary brain tumors and posterior reversible encephalopathy syndrome. Neurooncol Pract 2014;1(04):184–190
15. Sorour M, Sayama C, Couldwell WT. Posterior reversible encephalopathy syndrome after surgical resection of a giant vestibular schwannoma: case report and literature review. J Neurol Surg A Cent Eur Neurosurg 2016;77(03):274–279
16. Takeuchi S, Kageyama H, Tsuzuki N, et al. Posterior reversible encephalopathy syndrome during posterior fossa tumor resection in a child. J Neurosurg Pediatr 2010;6(04):377–380
17. Barytko WS. Posterior reversible encephalopathy syndrome, part 2: controversies surrounding pathophysiology of vasogenic edema. AJNR Am J Neuroradiol 2008;29(06):1043–1049
18. Marra A, Vargas M, Striano P, Del Guercio L, Buonanno P, Servillo G. Posterior reversible encephalopathy syndrome: the endothelial hypotheses. Med Hypotheses 2014;82(05):619–622
19. Fisler G, Monty MA, Kohn N, Assaad P, Trope R, Kessel A. Characteristics and outcomes of critically ill pediatric patients with posterior reversible encephalopathy syndrome. Neurocrit Care 2020;32(01):145–151