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Intraventricular hemorrhage following removal of external ventricular drains: Report of 2 pediatric cases

Pietro Spennato (MD)*, Giuseppe Mirone (MD), Ferdinando Aliberti (MD), Claudio Ruggiero (MD), Giuliana Di Martino (MD), Giuseppe Cinalli (MD)

Department of Pediatric Neurosurgery, Santobono-Pausilipon Children's Hospital, Naples, Italy

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ABSTRACT

Risk of intraventricular bleeding following External Ventricular Drains (EVDs) placement is well recognized. On the contrary, hemorrhage following removal of EVD is considered highly unlikely. We report two cases of massive, symptomatic intraventricular hemorrhage that occurred soon after removal of EVD, in two pediatric patients, one affected by posterior fossa tumor, and the other by acute post-traumatic hydrocephalus. This complication significantly affected outcome: in both cases EVD should be replaced, hospitalization was prolonged and further surgery was required for persisting hydrocephalus. The first patient also presented neurological deficits and delay in starting oncological therapies. There are currently no articles that specifically address hemorrhagic risk in EVDs removal. Only one paper that evaluates EVD associated hemorrhage also discuss about hemorrhages caused by removal of the catheter in children. Such risk appears to be not negligible, with hemorrhagic rate of 21.9%. More often, these hemorrhages have few clinical significance, but severe sequelae, may also occur. This should be considered in decision making, and in discussing the risks with a patient's family.

1. Introduction

External ventricular drains (EVDs) are commonly used in pediatric neurosurgery. Complications of EVDs are well recognized, including infection and hemorrhage. Rates of intracranial hemorrhage following EVD placement account for 0 to 17.6% [1–5]. Otherwise risk of hemorrhage following removal of EVD is not established. We report two cases of massive, symptomatic intraventricular hemorrhage that occurred soon after removal of EVD, in two pediatric patients, one affected by posterior fossa tumor, and the other by acute post-traumatic hydrocephalus.

2. Case reports

2.1. Case 1

An 8-year-old boy presented with rapid worsening of the conscious state, after one week history of headache and vomiting. He underwent computed tomography (CT) scan and Magnetic Resonance Imaging (MRI) that showed a mass in the fourth ventricle with tensive supratentorial hydrocephalus (Fig. 1A). He underwent urgent surgery; in the operative room (OR): in supine position a right frontal external ventricular drainage was implanted in standard fashion. The patient was then turned in prone position and the fourth ventricular mass was uneventfully resected (histological diagnosis was medulloblastoma). In the post-operative period the patient was trasnferred to ICU, with an open drainage, and the bag positioned at 15 cm above the level of the ear. On post-operative day 1, an MRI confirmed gross total removal of the tumor in absence of complications; the patient was extubated and admitted in the neurosurgical ward. He woke up progressively, recovering a normal state of consciousness. The drainage was kept opened for 8 days, then it was clamped and CT scan obtained (Fig. 1B). The clamping was well tolerated and a CT scan obtained 48 h later did not show increase of the ventricular size (Fig. 1C). Because the patient was calm and cooperating, the drain was removed bedside, without sedation. During the procedure, no cerebrospinal fluid (CSF) was lost. Three hours later the patient presented general seizure and prolonged loss of consciousness that required intubation and re-admission in ICU. CT scan revealed massive intraventricular hemorrhage (Fig. 1D). A right frontal EVD was urgently replaced in OR. An MRI with angiographic sequences did not show any congenital or acquired vascular malformations. The patient spent one week in ICU, then he was readmitted in the ward. He presented bilateral convergent strabismus and a neurological status similar to akinetic mutism: he was awake, but did not

* Corresponding author.
E-mail address: p.spennato@santobonopausilipon.it (P. Spennato).

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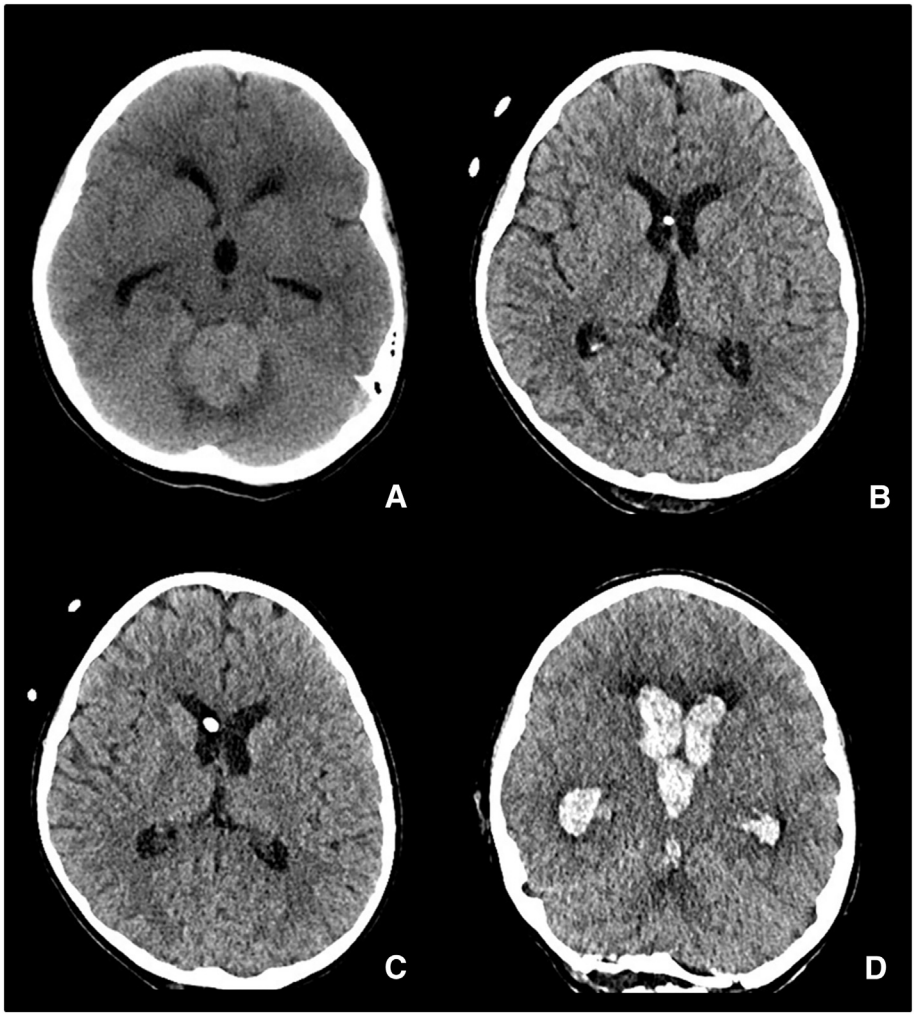

Fig. 1. Case 1. A: Preoperative CT scan showing posterior fossa tumor with supratentorial hydrocephalus. B: CT scan on post-operative day 8, showing the position of the catheter. C: Post-operative CT scan obtained 48 h after EVD clamping. D: CT scan obtained 3 h after EVD removal, with massive intraventricular hemorrhage.

speak or move. This neurological status lasted for 3 weeks, then gradually resolved. CSF progressively cleared, but after clamping the drainage, hydrocephalus recurred. Finally a ventriculo-peritoneal (VP) shunt was implanted and the patient discharged for oncological therapies.

2.2. Case 2

An 11-month-old baby was brought to the emergency services after a fall from bed. The child was drowsy and vomiting. CT scan showed a clot in the aqueduct and in the fourth ventricle, with triventricular hydrocephalus (Fig. 2A). A right frontal EVD was implanted in OR, in standard fashion, following which the child improved and remained normal for the following days. The drainage was kept opened for 16 days, until CSF cleared. After 48 h of well tolerated clamping (Fig. 2B), the drain was removed bedside. Six hours later the patient became markedly sleepy. A CT scan revealed intraventricular hemorrhage (Fig. 2C). EVD was urgently repositioned. Also in this case, MRI with angiographic sequences did not show any congenital or acquired vascular malformations. Neurological recovery was immediate. On day 25, CSF cleared, but attempts to close the drain resulted in worsening in the conscious state and of hydrocephalus on CT scan. Endoscopic third ventriculostomy was successfully attempted and the child is normal and shunt-free at 1 year follow up (Fig. 2D).

3. Discussion

Removal of a permanent shunt is known to be complicated by intracerebral and intraventricular hemorrhage [5]. In long-standing cases the shunt catheter may adhere to the ventricular wall or choroid plexus, so removal may lead to intracranial bleeding. Bleeding following EVD removal, which is implanted for shorter periods, is highly unlikely. The potential causes for these hemorrhages are speculative [3]. It is possible that scalp bleeding may track along the course of the catheter. The catheter may injure a small vessel during insertion and tamponade it until its removal. The catheter can become adherent to the choroid plexus or surrounding parenchyma that may bleed on removal. Direct trauma to the parenchyma from EVD withdrawal is possible, although removals are performed without a rigid inner stylet. If bleeding occurs, it usually presents as punctate hemorrhage along the drainage tract, with few clinical sequelae. Instead, we report two cases in which removal of the catheter caused massive intraventricular hemorrhages, that significantly affect outcome: in both cases EVD should be replaced, hospitalization was prolonged and further surgery was required for persisting hydrocephalus. The first patient also had neurological deficits and delay in starting oncological therapies.

Only few papers that evaluated EVD associated hemorrhage also discuss about hemorrhage caused by the removal of the catheter [1–4], and only one in children [2]. Gardner [1] evaluated all adults who underwent EVD placement at their hospital in a 5-year period. In their series, 77 (41%) of 188 EVDs were associated with imaging evidence of

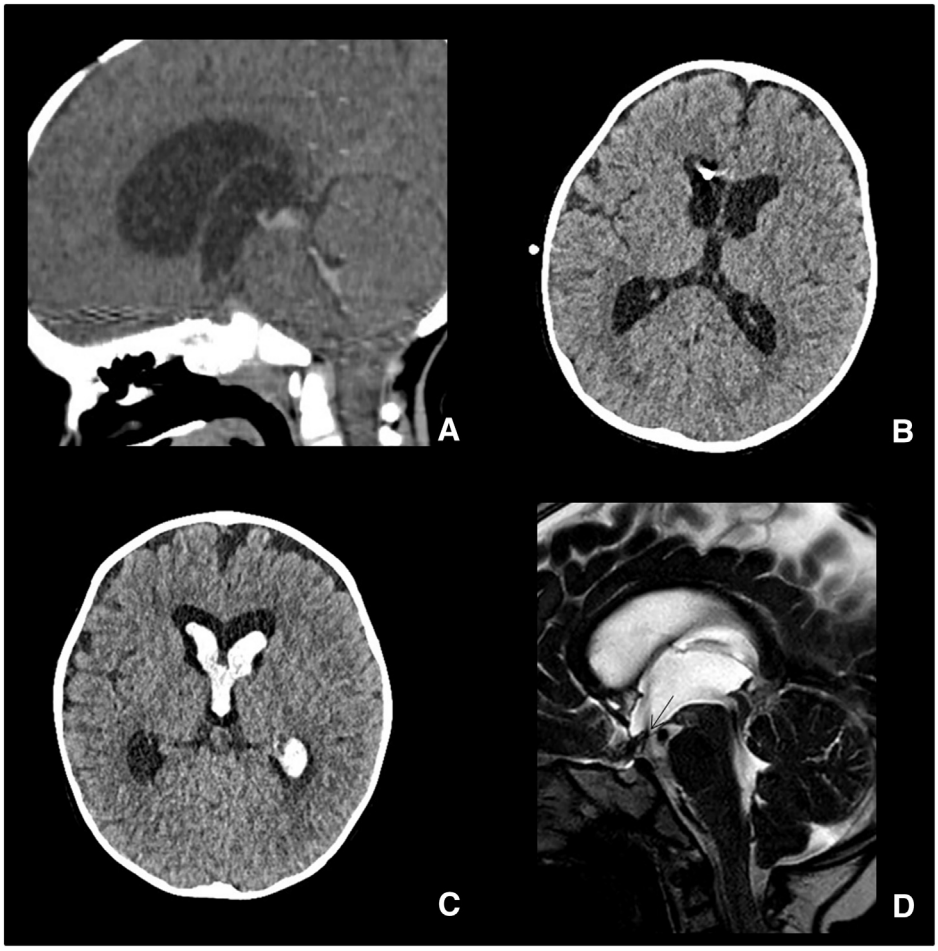

Fig. 2. Case 2: A: Preoperative CT scan showing blood clot in the aqueduct and in the third ventricle. B: Pre-removal CT scan. C: CT scan revealing intraventricular hemorrhage following EVD removal. D: Mid sagittal T2 WI MRI following ETV. Note the flow artefact at the level of the stomy (*arrow*).

hemorrhage after either placement or removal. In 13 cases the hemorrhages occurred following removal: in all cases they were insignificant that did not affect outcome. Miller [2] reported a 10% hemorrhage rate with EVD placement and 21.9% with EVD removal in a pediatric population of 63 patients. Incidence of postremoval hemorrhage was calculated only in those cases in which a postremoval imaging was obtained (32 patients). Seven patients had hemorrhage following EVD removal: 3 were completely intraventricular, 3 were intraparenchymal, and 1 was both intraparenchymal and intraventricular. Four of the hemorrhages were not clinically significant, and 3 (the largest, $> 50\ cm^3$) occurred in deeply sedated (not clinically evaluable) patients. EVD was replaced in only 1 patient. The authors also studied risk factors for hemorrhage in their 7 patients: two were taking heparin and 2 had undergone bone marrow transplants. There was not statistically significant difference in INR range, platelets range, days spent with EVD among patients with and without hemorrhages. In our patients risk factors for intracranial hemorrhage were excluded. Haematological screening for coagulopathy and MR angiography were normal and remained normal during the follow up. In a more recent publication Miller analyzed a series of 482 EVDs placed in both adults and children [3]. Fifty-five new hemorrhages (22.5%) were noted after 244 EVD removals in patients in whom imaging was obtained after the EVD was removed. Intracerebral hemorrhages accounted for the majority of the hemorrhages (46), intraventricular hemorrhage in 6 patients and a combination of hemorrhages in 3 patients. No patients required surgical evacuation; however, 2 patients needed EVD replacement. One patient died due to a large intracerebral hemorrhage after EVD removal. Several parameters were evaluated in this study to determine the risk of hemorrhage EVD removal: only the bedside placement was associated with an increase in EVD removal hemorrhage.

4. Conclusion

EVD removal may be risky for the patient, especially in pediatric age. Coagulation parameters and the use of anticoagulants or antiplatelet agents, should be evaluated during external ventricular drainage and before drain's removal. As suggested by Miller [2,3] these data can be useful in decision making, and in discussing the risks of EVDs with a patient's family.

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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