Endoscopic Management of Intracerebral Hemorrhage

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Key words
- ICH treatment
- Intracerebral hemorrhage
- Intraventricular hemorrhage
- IVH treatment
- Neuroendoscopy

Abbreviations and Acronyms
CSF: Cerebrospinal fluid
CT: Computed tomography
ICH: Intracranial hemorrhage
IVH: Intraventricular hemorrhage


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Citation: World Neurosurg. (2013) 79, 2S:S17.e1-S17.e7. http://dx.doi.org/10.1016/j.wneu.2012.02.025

*Journal homepage: **www.WORLDNEUROSURGERY.org***

*Available online: **www.sciencedirect.com***

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OBJECTIVES: **Massive intracerebral and intraventricular hemorrhages require aggressive and rapid management to decrease intracranial hypertension. The amount of intraventricular blood is a strong prognostic predictor, and its fast removal is a priority. Neuroendoscopy may offer some advantages over more traditional surgical approaches.**

METHODS: **All relevant data described in our experience and in publications about minimally invasive treatment of intraventricular and intracerebral hemorrhage found through MEDLINE searches and related references are reviewed.**

RESULTS: **We described the technical details of neuroendoscopic management, highlighting the potential pitfalls and advantages of the techniques.**

CONCLUSION: **Early neuroendoscopic surgery is a feasible approach, allowing, in most instances, rapid clinical and radiological improvement.**

PART 1: ENDOSCOPIC TREATMENT OF HEMATOCEPHALUS

Massive intraventricular hemorrhage is a life-threatening condition that requires aggressive management to decrease intracranial hypertension. Intraventricular blood is a strong prognostic predictor of outcome. We describe the technical details and clinical management of the neuroendoscopic aspiration of intraventricular blood in our 12 years' experience, highlighting pitfalls and advantages of the technique.

Introduction

Cleaning cerebral ventricles after blood inundation is a life-saving maneuver (**Figure 1**). In the history of neurosurgery, the aim of a complete hematocephalus cleansing has been pursued with countless procedures, but none of them have resumed the gold standard features of a less invasive and effective technique such as neuroendoscopy. There has been increasing interest in the medical and surgical management of massive intraventricular hemorrhage (IVH) (3, 11, 13, 19, 27, 28, 36). Blood has deleterious effects (9, 10) on cerebrospinal fluid (CSF)

Figure 1. Schematic illustration depicting the trajectory and suction work of a flexible endoscope in the treatment of intraventricular hemorrhage.

circulation, causing impairment (21), intracranial hypertension (12), and acute (14) or delayed hydrocephalus (15). Mortality estimates for IVH range from 50% to 80%. The most common cause of IVH is spontaneous intracranial hemorrhage (ICH) (7, 17), followed by subarachnoid hemorrhage (33). Approximately 10% of patients with aneurysmal subarachnoid hemorrhage and 40% of those with primary ICH experience IVH (7, 33). Despite vast neurointensive management, mortality remains high, with only 38% of patients surviving the first year (7). IVH is a neurosurgical emergency that requires aggressive and rapid management to decrease intracranial hypertension. The amount of intraventricular blood is a strong prognostic factor (1, 24, 35) and its fast removal a priority. The control of intracranial pressure by external ventricular drainage is a rescue surgical action (18), but tetraventricular blood flooding should be often managed with bilateral ventricular catheter, which frequently becomes obstructed by clots and need to stay in place longer for blood washout. The fibrinolytic system of CSF is limited; blood remains for weeks after hemorrhage, and clots acutely obstruct ventricular CSF pathways whereas delayed clot resolution leads to obstruction of extraventricular CSF pathways. Blood degradation (3, 9, 10, 17, 20) products contribute to patients' poor clinical status, being responsible for chronic shunt-dependent hydrocephalus in more than 30% of them (7, 12, 15). Reduction in the ventricular clot size seems to be the only method for reducing mortality after the ICH has stabilized or the aneurysm has been secured.

Patient Selection

Patients with primary or secondary intraventricular hemorrhage can present with a variety of symptoms, depending on the underlying cause and the ventricular extension of clots. The clinical scenarios may vary from alertness with headache, nausea and vomiting, to weakness, changes in consciousness, up to coma. Treatment depends on the patient's medical and clinical condition. The underlying cause of ventricular inundation is a key factor. Oral anticoagulant therapy should be considered a contraindication for early endoscopic treatment. If ventricular blood is an epiphenomenon of intracerebral hemorrhage, it is important to decide whether the cerebral hematoma has priority of treatment and if the ventricular extension of clots may be better relieved by the use of an external ventricular drainage rather than immediate endoscopic treatment. It is generally our policy in these cases to treat patients surgically for hematoma removal if deemed, and to place an external ventricular drainage immediately. Patients are then monitored in the intensive care unit and with serial computed tomographic (CT) scans; if a good clinical response is obtained in the early days after surgery, we reconsider endoscopic removal of clots in cases with massive ventricular hemorrhage and tetraventricular extension. If ventricular clots are secondary to aneurysm rupture or arteriovenous malformations, we perform early surgery or coiling to secure the aneurysm or malformation and then in selected cases, such as Fisher 4 subarachnoid hemorrhage with massive tetraventricular clots, we perform early endoscopic aspiration in patients who are intubated and have a Glasgow Coma Scale score $\geq$6 (motor response 4–5) in order to decrease intracranial hypertension by endoscopically cleansing clots and thus finally improve their clinical status.

Preoperative Preparation

Despite their clinical condition, all patients with IVH immediately undergo CT, angio-CT, and digital subtraction angiography or magnetic resonance imaging when needed. Urgent blood work is obtained, with special focus on prothrombin time and liver and kidney function. Preoperative management includes identification and correction of coagulation disorders, prophylactic anticonvulsants, and body temperature and glycemia correction. Mean arterial pressure should be kept below 110 mm Hg and systolic pressure below 150 mm Hg.

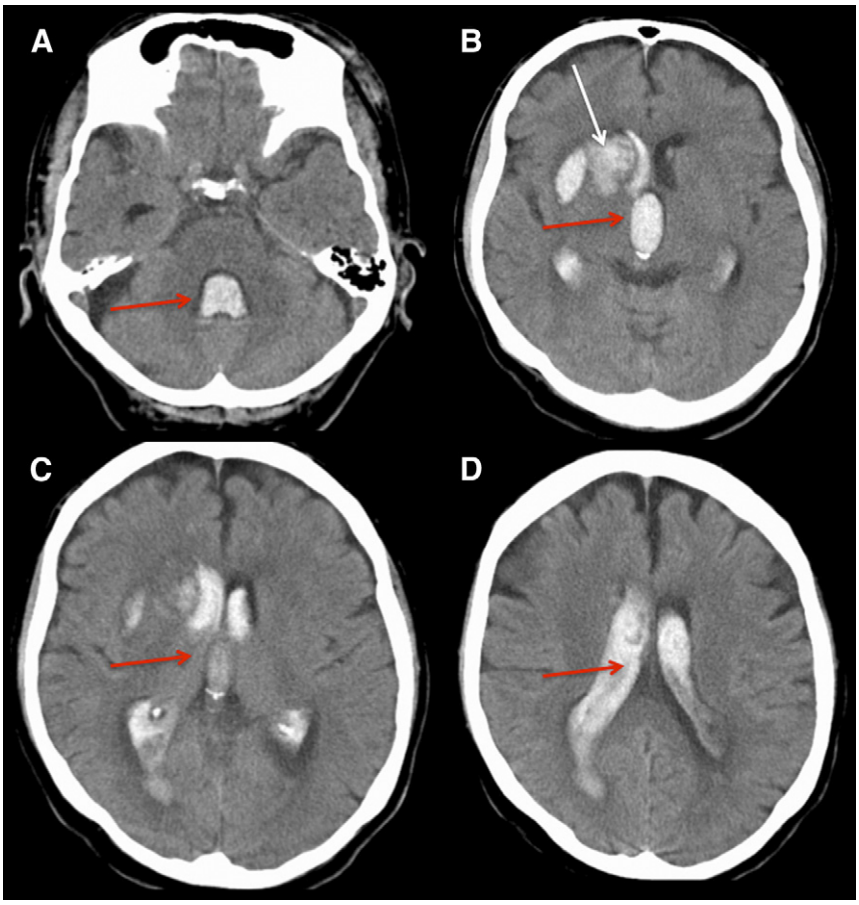

Figure 2. Endoscopic aspiration of intraventricular hemorrhage. Computed tomography of the head reveals a right caudate hemorrhage (*white arrow*, **B**) with severe tetraventricular flood and acute hydrocephalus (*red arrows*, **A**, **C**, and **D**).

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