CLINICAL STUDY

Neuroendoscopic management of haematocephalus

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Abstract

The purpose of the paper was to publish the results of endoscopic treatment of primary and secondary haematocephalus in the group of 23 patients, treated by means of Wolf endoscopic system combined with frame based navigation with the aid of virtual reality environment.
The procedure is aimed to remove blood clots from the cerebral ventricles and to reduce the volume of parenchymal haematoma in secondary haematocephalus during single surgical session. In the majority of the treated patients septostomy was added to make revision of both lateral ventricles possible from a single approach, and the operation was completed with endoscopic third ventriculostomy to reduce the amount of blood in the basal cisterns and to reestablish the patency of cerebrospinal fluid pathways, so that lumbar puncture can be safely done to facilitate the process of cleaning blood away from the cerebrospinal fluid. The surgery always facilitates the resorption of residual blood as well as blood degradation products, therefore late complications, such as posthaemorrhagic hydrocephalus, membranes and stenosis formation was prevented. Improvement of the clinical condition was obtained without the need for permanent drainage systems insertion. Lethal outcome in one patient and unfavourable clinical result in another three patients were unrelated to the endoscopic treatment. ***(Tab. 1, Fig. 2, Ref. 10.)***
Key words: intracerebral hematoma, haematocephalus, endoscopy.

Haematocephalus is caused by bleeding into the cerebral ventricles, either from primary intraventricular source, or more frequently by intraventricular penetration of blood from intraparenchymal haematoma located in the proximity of the ventricular wall, for instance in hypertonic haematoma cases or during aneurysm rupture (1).

In the past haematocephalus was considered to be dangerous or even ominous clinical sign. However, it soon became apparent, that primary intraventricular bleeding did not present a serious threat to the patient, because the blood could be removed by a relatively simple puncture. Moreover, in the case of secondary intraventricular bleeding the progress of imaging technique enabled safe removal of intracerebral blood clots as well.

In the acute period of the disease the impact of bleeding and clinical condition depended on the amount of blood in the cerebral ventricles together with the extent of cerebral injury afflicted by the bleeding in the case of secondary haematocephalus. Massive intraventricular bleeding fills in rapidly the ventricular space with blood clots, so that neither haemolytical properties of the cerebrospinal fluid nor the compliance of this fluid-filled space cannot play its role (2). Therefore the acute blockage of cerebrospinal fluid circulation causes hydrocephalus and subsequent gradual increase of the intracranial pressure. Contemporary microsurgical, stereotactic and drainage surgeries can not prevent the formation of membranaceous structures or stenotic lesions in the cerebral ventricles due to blood degradation products resorption. These mechanisms attribute to the findings of posthaemorrhagic hydrocephalus and cysts.

These complications arise in a stepwise manner and to cope with them endoscopic technique can be employed. Moreover, endoscopic technique proved to be beneficial since the first manifestations of bleeding, because it greatly precises the picture derived from the results of imaging techniques and optimal solution can be accepted from the beginning.

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Tab. 1. Causes and locations of bleeding.

Causes of bleeding	Age and gender	Extent
Primary haematocephalus	6 pts	
Head injury (frontal area)	51 m	Small subdural haematoma P dx.,panhaematocephalus
Anticoagulation treatment	79 m	Occlusion of foramen Monroi
	51 f	Right lateral ventricle
Arterial hypertension, equivoical mesencephalic lesion	57 m	Left lateral ventricle
Arterial hypertension, equivoical hippocampal lesion	56 f	IVth, IIIrd and right lateral ventricle
Arterial hypertension, equivoical right thalamic lesion	63 m	Panhaematocephalus
Secondary haematocephalus	17 pts	
Arterial hypertension up to 230/110 mmHg	81 m	Panhaematocephalus
	76 m	Basal ganglial sin, midline shift
	52 m	Brainstem
	45 m	Brainstem
	54 m	Right thalamus
	73 f	Right thalamus
	51 f	Left thalamus
	74 m	Left thalamus
	57 f	Cerebellum, IVth ventricle
	60 m	Cerebellum, IVth ventricle
Haemorrhage into ischemic tissue	55 m	Cerebellum dx., IVth and IIIrd ventricle
	69 f	Right parietal lobe, midline shift
	51 f	Right temporal lobe
Aneurysmal bleeding	59 m	AntCommArt., SAH, Right subdural haematoma
	46 f	MCA, PICA, SAH
	36 m	After aneurysm treatment
	78 m	AntCommArt, SAH

m — male, f — female

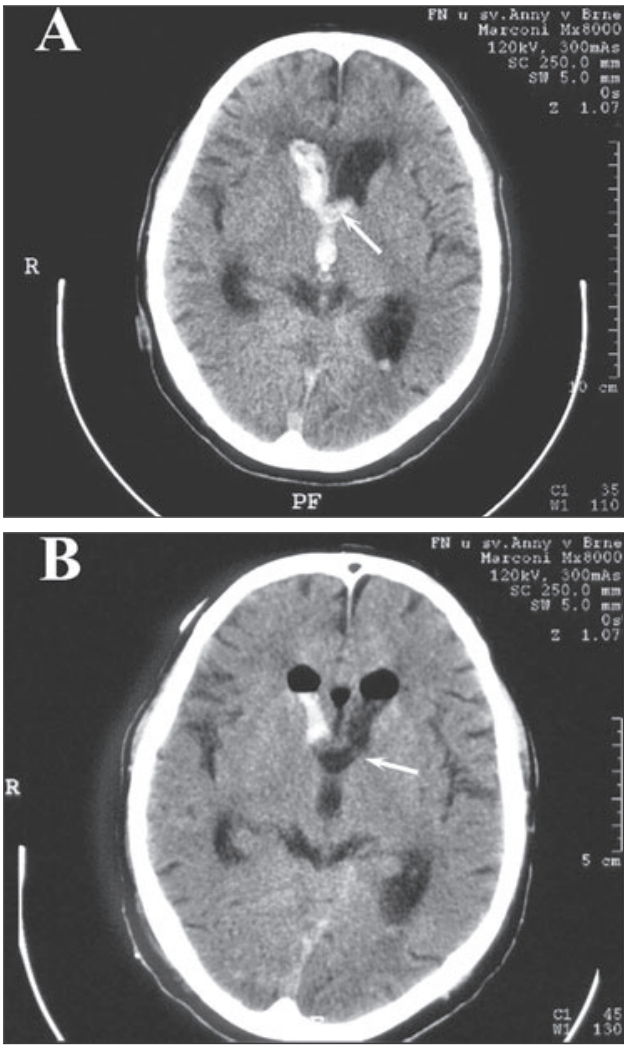

Fig. 1. Primary haematocephalus (a – haematocephalus after anticoagulation treatment with subsequent blockage of the left lateral ventricle with subsequent dilatation as a result, b – deliberation of cerebrospinal fluid circulation after surgery. Cavum septi pellucidi became apparent. Septostomy enabled the reduction of blood in the right lateral ventricle.)

Material and method

Since 2000 23 patients underwent endoscopic surgery for primary or secondary hydrocephalus at Neurosurgical Clinic Masaryk University, Faculty Hospital St. Anna, Brno. The causes and extent of bleeding are presented in Table 1.

Secondary hydrocephalus was observed more frequently, and in both groups of primary and secondary hydrocephalus there was a predominance of patients aged over 50 together with slight predominance of males. CT scan was the mainstay of the presurgical diagnosis in the majority of cases and cerebral angiography was added in selected cases only.

Generally speaking secondary haematocephalus does not usually result in panhaematocephalus.

The timing of endoscopic surgery depended on the interval between the onset of bleeding and the time of admission to neurosurgery and the clinical condition on presentation. 4 patients underwent emergency surgery after shortest possible delay after bleeding onset, and the same number of patients were operated on within 24 hours. In another three patients, the surgery was performed until the third day, and only exceptional patients underwent surgery after 1 week interval.

Endoscopic surgery is combined with stereotactic frame based navigation, using Riechert Mundinger or more frequently Zamorano Dujovny device. The frame is firmly attached to the patient's head, and CT presurgical planning scans are obtained. The scans are transferred to the workstation of the neurosurgical depart-

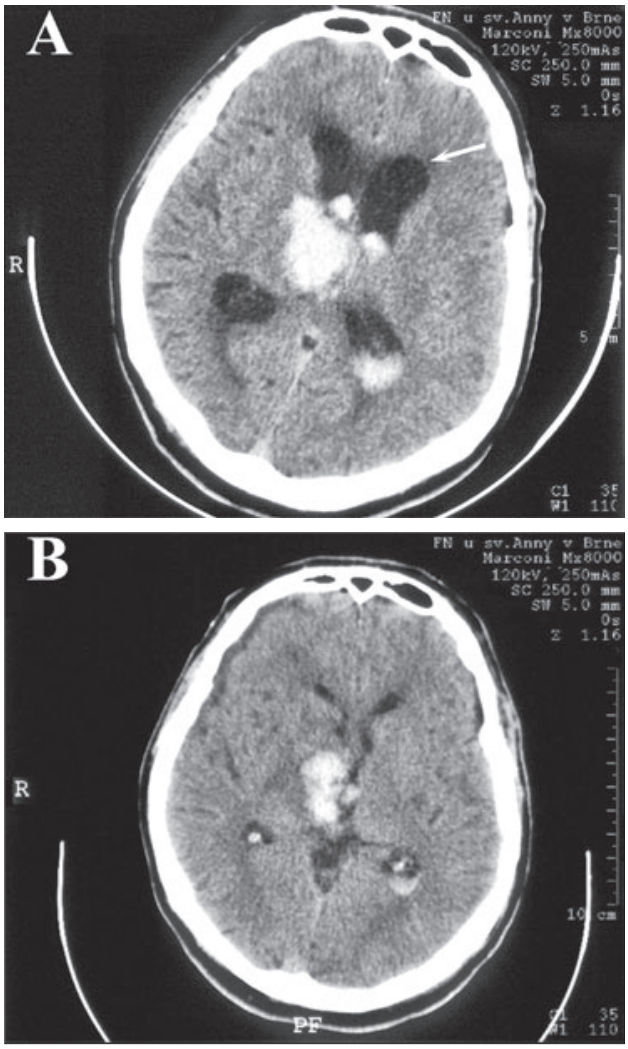

Fig. 2. Secondary haematocephalus (a – before surgery – right thalamic haemorrhage blocking the IIIrd ventricle, hydrocephalus of lateral ventricles, b – disappearance of hydrocephalus after sur-

ment by means of the hospital PACS system and navigation software Praezis Plus is used to prepare the surgical plan together with virtual reality. Rigid endoscopic system Wolf meets the demands for the endoscopic procedure.

The surgical procedure should meet the demand of blood elimination from the ventricular system, together with irrigation of blood clots from inside the cerebral ventricles and reestablisment of the patency of cerebrospinal fluid patways (Fig. 1a, b). All the requirements are met much more easily in primary haematocephalus cases than in secondary haematocephalus, where an attempt to evacuate the intraparenchymal clot should be considered. Copious irrigation of the haematoma cavity with saline solution maintains orientation and visibility in the surgical field. As a difference from the strict adhaerence to the stereotactic guidance in the surgeries of the ventricular system, the endoscope is free hand manipulated inside the cavity of the haematoma with meticulous respect to the surrounding neural tissue during the removal of blood clots and haemostasis achievement.

The remaining blood clots adhaerent to the walls of the haematoma cavity are left untouched not to elicite further bleeding into the cavity. Therefore, the endoscope meets the requirements comparable with these for ventriculoscopy for evaluation of the extent of brain damage (Fig. 2a, b).

Both in the case of primary and secondary haemocephalus it seems to be advantageous to complete the operation with septostomy to assure free comunication between the compartments of lateral ventricles, or the surgery is supplemented by endoscopic ventriculocisternoanastomosis to establish communication with the basal cisterns.

Endoscopic surgery facilitates greatly the resorption of the remaining blood and blood degradation products from the ventricles and therefore late complication of intraventricular bleeding, such as hydrocephalus and cyst formation, are reduced or prevented.

More difficult situation arises in secondary haemocephalus due to aneurysmal rupture. There was a controversy in the past if the haematoma should have been treated before the elimination of the aneurysm or after, or during the same surgery, which was the preferred mode. Contemporary endovascular treatment of intracranial aneurysm combined with endoscopic surgery offers new strategy: endovascular elimination of aneurysm as a first step and subsequent treatment of parenchymal haematoma and haematocephalus as a second step. Moreover, it is possible to reduce the amount of blood in the basal cisterns during the endoscopic surgery.

Results

The clinical condition of the patient after the intervention for intraventricular bleeding depends on the concomittant comorbidities and risks. In the group of primary haematocephalus, the patients were conscious both before surgery and afterwards, and their general medical condition was satisfactory. The presurgical clinical picture was heralded by headaches, unsteadiness, vomiting and occasionally transient alterations of consciousness were described. There was an exceptional case of posttraumatic haematocephalus requiring controlled ventilation. After uneventfull surgery the patient regained consciousness, but the cooperation was insufficient due to traumatic injury affecting both frontal lobes, as suspected on ventriculoscopy. Subdural blod clots were irrigated during the same endoscopic surgery.

In the group of secondary haematocephalus, the preoperative clinical findings were determined by the degree of initial brain injury caused by the intracerebral haematoma. The patient with brainstem haematoma suffered massive lung aspiration due to disturbance of consciousness and coughing reflexes. Subarachnoidal blood was detected on the initial CT, but subsequent investigations failed to reveal the source of bleeding. The clinical condition did not improve after otherwise smooth surgery and he expired due to ARDS.

In another patient with less extensive brainstem haematoma it was possible to save his life.

Disturbance of consciousness were rarely observed in the clinical picture of basal ganglionic haematoma cases with intraventricular penetration, the dominant feature was dense hemiparesis with or without speech disturbances. There was a tendency towards some functional improvement after surgery.

After initial transitory alteration the patients with thalamic haemorrhage were fully conscious, however they complained of severe motor disturbance affecting the contralateral side of the body. There was also tendency towards some improvement after surgical treatment.

In the case of extensive intraparenchymatous bleeding into the parietal lobe there was marked shift of the midline structures and dense hemiparesis remained.

Massive intracerebral bleeding located in temporal lobe caused tentorial herniation together with ventricular tamponade in one patient. Even after emergency surgery via open craniotomy and subsequent endoscopic surgery the patient did not regain consciousness and the outcome was dismal.

Intracerebellar haematoma, affecting the third and fourth ventricles caused obstructive hydrocephalus with marked distension of the lateral ventricles. The posterior fossa haematoma was removed by the microsurgical approach, and endoscopic surgery solved the ventricular tamponade after transient emergency external ventricular drainage. This combined surgery rescued this patient's life after initially threatening course.

In the case of aneurysmal bleeding (A Comm Ant aneurysm) penetrating to the left lateral ventricle the bleeding caused serious damage to both frontal lobes, therefore the final outcome was unfavourable (vegetative state). Similar clinical course was observed in another reported case.

In another case, when two aneurysms were verified in an unconscious patients requiring controlled ventilation, combination of various treatment methods saved the life of the patient. In one case, endovascular coiling of the aneurysm preceeded endoscopic treatment of haematocephalus.

Generally speaking no need arose for ventriculoperitoneal shunt in the chronic period. Conclusions can be drawn from the overview, that the haematocephalus as an isolated entity doesnot present a serious threat to the patient's life. The life is endangered by the cause of the bleeding.

The role of endoscopic surgery in the treatment of hematocephalus is twofold. Blood clots and degradation product of blood are eliminated from the ventricular system and from intraparenchymal haematomas and cerebrospinal fluid circulation pathways were deliberated to prevent the late consequencies of bleeding, always impeding after another surgical intervention, no matter if conservative or radical.

Discussion

Endoscopic treatment of hydrocephalus is being more frequently considered (3, 4, 5), therefore the paper presents the first experience from the author's department. So far microsurgical or stereotactic interventions, including drainage surgeries were the most frequently reported methods of treatment.

Haematocephalus was the topic of work of Beneš (6). This author considered only the rise of intracranial pressure in the case of primary or purely intraventricular bleeding, and did not considered this finding to be decisive for surgical indication. Intracerebral bleeding to the deep brain structures together with the shift of these structures and brainstem compression were considered to be the truly offending lesion.

The advent of imaging techniques proved that both mechanisms of intraventricular bleeding, primary as well as secondary, can elicit acute hydrocephalus, and in the chronic stage of disease late hydrocephalus with the adverse effect on brain functions forms. Therefore the most diverse shunt systems (7) were implanted to cope with this situation and some less usual were employed in the management of treatment resistant ventricular infection (8).

The advantageous properties of endoscopic surgery to reestablish the patency of the cerebrospinal fluid circulation were recognised during the same period of time and the trend to use endoscope for therapeutic purposes in the acute and delayed consequencies of intraventricular bleeding cases became more and more pronounced.

Endoscopic system enables perfect evacuation of blood clots from inside the cerebral ventricles and septostomy enables the surgeon to clean blood from both lateral ventricles (9) without the need for biportal approach (10). Addition of endoscopic ventriculocisternoanastomosis is a precondition for the reduction of the amount of blood clots in the basal cisterns, especially after aneurysmal bleeding. Endoscopic aspiration and washing out of blood clots facilitates resorption of blood degradation products capable of causing plastic productive changes affecting not only the ventricular system. Therefore endoscopic treatment of haematocephalus meets two objectives – both therapeutic and preventive. As a result more favourable surgical outcomes can be achieved.

Minimally invasive stereotactically navigated endoscopy was used in the treatment of patients with haematocephalus. The success rate was gratifying in these risky patients and there were no surgical complications even in polymorbid patients.

The benefit of the endoscopic surgery is evident both in acute phase, when the main advantage is immediate deliberation of cerebrospinal fluid circulation pathways, and in the subsequent period, when the incidence of posthaemorrhagic hydrocephalus requiring shunting is substantially reduced, because the endoscopic removal of blood is supplemented with endoscopic third ventriculostomy.

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