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Experience of Endoscopic Removal of Hypertensive Intracerebral Hemorrhage

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This study focuses on our first experience (11 cases) of endoscopic removal of hypertensive intracerebral hemorrhage. The paper presents examples of endoscopic removal of hematomas located in the basal ganglia (9 cases) and hematomas located in the posterior fossa and causing occlusion at the fourth ventricle (2 cases). In 3 patients (27%) with intraventricular hemorrhage, the removal of acute hematomas from the ventricular system with simultaneous endoscopic third ventriculostomy (ETV) was performed. Intervention was carried out within the first 6 hours in patients with hemispheric hematomas (in 90% of cases) and within 3—5 hours, in patients with hematomas of the posterior cranial fossa. The article analyzes the functional outcomes in the early and late postoperative period. In our opinion, endoscopic removal of hypertensive intracerebral hemorrhage is a promising method that meets all the existing aspects of modern neurosurgery. The combination of rigid and flexible endoscopy provides new capabilities in surgery of patients with intraventricular hemorrhage.

Keywords: *endoscopy, 'chip-on-tip' flexible endoscopy, hypertensive hemorrhage, hemorrhagic stroke.*

Abbreviations

HICH — hypertensive intracerebral hemorrhage;
GCS — Glasgow Coma Scale;
IVH — intraventricular hemorrhage.

Since the disability and mortality rates of hemorrhagic stroke are rather high, surgical treatment of the acute forms of cerebral circulation disorders still remains a very topical issue [2, 5]. The contribution of hemorrhagic stroke to the total structure of mortality is 1.28 per 1,000 population per year, which is significantly higher than the characteristics of other forms of cerebral pathology. The rate of this pathology ranges from 10 to 20 cases per 100,000 population and corresponds to approximately 45,000 hemorrhages per year [1, 2]. Most of them require adequate surgical management within the early period after disease onset [6].

A vast body of new experience in surgical treatment of hypertensive intracerebral hemorrhages (HICHs) has been accrued, offering an opportunity to reconsider the existing conceptions of treating this pathology [4, 6—8]. The existing methods, such as microsurgical removal, aspiration of hematoma, and local fibrinolysis have demonstrated fair outcomes of surgical treatment of hemorrhagic stroke in patients of different age groups [3]. As indicated by numerous studies [4, 6—8], the minimally invasive procedures for surgical treatment of patients with cerebral pathology are now commonly available for neurosurgeons.

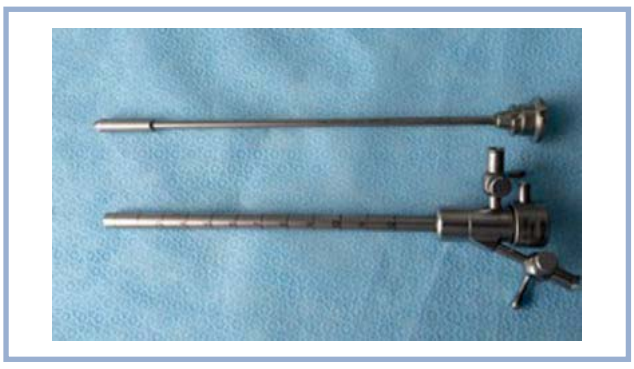


Fig. 1. **Appearance of the port (Gaab, 6 mm) for endoscopic interventions.**

The modern endoscopic systems meet all the key criteria that define minimally invasive surgeries, which undoubtedly is a significant breakthrough. Their development has made it possible to implement minimally invasive interventions in treatment of hypertensive intracerebral hemorrhages in actual practice [12].

L. Auer is the pioneer of endoscopic removal of intracerebral hematomas. In 1989, he demonstrated in a series of surgeries conducted in 100 patients that this method was preferred over conservative treatment of small and medium-sized hematomas (30—50 cm^3) provided that maximal radicality of their removal was achieved [10]. T. Nishihara [11] has demonstrated for 82 patients operated on that this method is promising when used early after stroke. C. Chen et al. [13] have also proved the effectiveness of endoscopic removal of hematomas of putaminal localization in 25 patients with GCS score of 3—12. The result of the surgical interventions performed by them consisted in reducing the mortality rate to 16%.

There are very few Russian studies focusing on endoscopic surgery of HICHs. One of those, the work by V.G. Dash'yan [7] reports management of 35 patients. According to findings obtained by A.B. Gekhtman [9] on the basis of the original prognostic scale of postoperative mortality among patients with HICH that he had developed, the endoscopic method proves to be most effective in patients with lateral hematomas if their volume is less than 50 cm^3. The mortality was 9% among the patients with the GCS level of consciousness score no less than 10. An analysis of the recent literature shows an increasing

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Table 1. **Characteristics of the patients who had undergone surgical treatment**

No.	Localization of HICH	Hematoma volume excluding IVH, cm^3	IVH, yes/no	Occlusive hydrocephalus, yes/no	For patients with IVH (Graeb scale), score	Time when the hemorrhage occurred, days ago
1	Putaminal	30	Yes	No	2	1
2	Thalamocapsular	36	Yes	Yes	5	1
3	Putaminal-capsular	34	No	No	—	14
4	Thalamo-putaminal-capsular	46	Yes	Yes	7	1
5	Thalamocapsular	23	Yes	No	3	1
6	Putaminal-capsular	26	No	No	—	1
7	Thalamocapsular	32	No	No	—	1
8	Putaminal	50	Yes	No	—	1
9	Thalamo-putaminal-capsular	54	Yes	Yes	8	1
10	PCF	27	No	Yes	—	5
11	PCF	24	No	Yes	—	3

Footnote. PCF — posterior cranial fossa.

Table 2. **Key neurologic symptoms before and after surgical treatment**

No.	Neurological symptoms prior to surgery	Neurological symptoms after 7 days	Neurological symptoms after 30 days
1	Obtundation, hemiparesis up to score 3, right horizontal gaze paresis	Hemiparesis (score 4), gaze paresis	Complete regression of all symptoms
2	Obtundation, hemiplegia, gaze paresis, motor aphasia	Leg paresis — score 2, arm paresis — score 0	Arm paresis — score 2, leg paresis — score 3
3	Obtundation, dysarthria, hemiplegia	Leg paresis — score 2, arm paresis — score 0	Complete regression
4	Sopor, hemisyndrome, dysarthria, gaze limitation	Leg paresis — score 1, arm paresis — score 0, gaze limitation and paresis	Leg paresis — score 3, arm paresis — score 2
5	Obtundation, hemiparesis up to score 3, gaze paresis	Leg paresis — score 5, arm paresis — score 4	Complete regression of all symptoms
6	Obtundation, hemiplegia, gaze paresis, sensorimotor aphasia	Leg paresis — score 1, arm paresis — score 0	Leg paresis — score 3, arm paresis — score 3
7	Symptoms of occlusive disease, dysarthria	Dysarthria	No neurologic deficit
8	Obtundation, hemiparesis up to score 3, right horizontal gaze paresis	Hemiparesis — score 4, gaze paresis	Complete regression of all symptoms
9	Sopor, hemisyndrome, dysarthria, gaze limitation	Leg paresis — score 1, leg paresis — score 0, gaze limitation and paresis	Leg paresis — score 3, arm paresis — score 2
10	Symptoms of occlusive disease, dysarthria, mild hemiparesis	Complete regression	No neurologic deficit
11	Symptoms of occlusive disease, hemisyndrome	Complete regression	No neurologic deficit

interest in endoscopic surgery of HICHs due to the generally improved outcomes of treating this disease.

In this study, we have demonstrated the results of employing the endoscopic method in treating patients with HICHs using rigid and flexible endoscopes.

The study was aimed at assessing the effectiveness of the endoscopic method in surgery of hypertensive intracerebral hemorrhages.

Material and Methods

The outcomes of surgical management of 11 patients with hypertensive hemorrhages aged 53—68 years and operated on during the period between March 2013 and December 2014 are reported. The patients were admitted to the Burdenko Neurosurgical Institute or transferred there from other neurological in-patient clinics; 8 (73%) patients were managed within day 1 since the onset of the disease; 3 (27%) patients were treated on day 3 or later.

All the patients were either in compensated or subcompensated condition according to GCS: 2 (18%) patients, score 14; 6 (55%) patients, score 1; 1 (9%) patient, score 11; and 2 (18%) patients, score 10.

The following parameters were analyzed in all cases to determine the tactics of surgical treatment:

— level of consciousness and the presence of neurological deficit;

— time when the hemorrhage occurred;

— hematoma characteristics (volume, density, localization);

— Degree of IVH (according to the Graeb score) and severity of acute occlusive hydrocephalus, VCR II;

—presence of the dislocation syndrome and perifocal edema.

The main objective of endoscopic interventions was to improve the functional outcome and reduce the total mortality rate in the group of patients. We took into account the data of the prognostic scale of postoperative mortality among patients

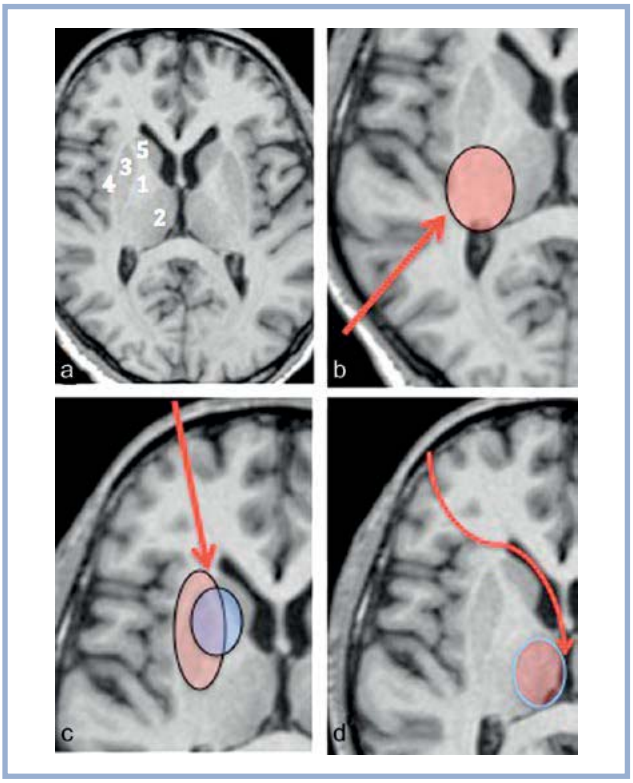


Fig. 2. **Anatomy of the basal ganglia according to A. Rhoton. The anatomical and topographic justification of the endoscopic approaches being used.**

a — the anatomy of basal ganglia. The anatomical and topographic justification of the endoscopic approaches being used; b — the endoscopic approach used in patients with putaminal-thalamic hematomas; c — the endoscopic approach used in patients with putaminal and putaminal-capsular hematomas; d — the endoscopic approach used in patients with thalamic hematomas with a rupture (to perform ETV and remove blood from the ventricular system).
Arrows denote projections of the endoscopic approaches.

with hypertensive intracerebral hemorrhages proposed by A.B. Gekhtman [9].

In terms of their localization, hematomas were subdivided according to the classification proposed by A.S. Saribekyan [6]. **Table 1** shows the distribution of patients over hematoma characteristics.

The clinical symptoms and the dynamics of their changes during the postoperative period are listed in **Table 2**.

All patients underwent endoscopic surgeries using rigid and flexible optical devices. Karl Storz endoscopes, the GAAB systems, and a 'chip-on-tip' flexible endoscope were used. Diameters of working ports through which surgical interventions were carried out were 6 and 8 mm **(Fig. 1)**.

In patients who did not need to have blood removed from the ventricular system, the port was installed with allowance for minimal traumatization of associative conductors **(Fig. 2)**. In all the patients with IVH accompanied by hemo-tamponade of ventricles, the port was installed from the standard site for third ventriculostomy. Flexible optical device that has a number of benefits was used to remove blood clots from the ventricular system and to perform endoscopic third ventriculostomy.

Compression and dislocation syndromes were indications for surgical treatment in the acute phase: aggravation of the degree of occlusion in patients with IVH and low effectiveness of conservative treatment accompanied by persistent neurologic deficit in patients in the delayed phase.

Intracranial pressure (ICP) monitoring was performed in all patients with IVH using the Liquo Gard system. Monitoring was stopped and the ventricular drainage was removed only within 24 h after ICP had normalized and the patient had undergone a test for closure of CSF drainage.

Results

On postoperative day 14, after the patients had either been discharged from the neurosurgical department or transferred to further rehabilitation, all patients showed regression of neurologic symptoms to some extent (**Table 2**).

Complete regression of neurologic symptoms was achieved in 4 (36%) patients; the remaining 7 (64%) patients had a

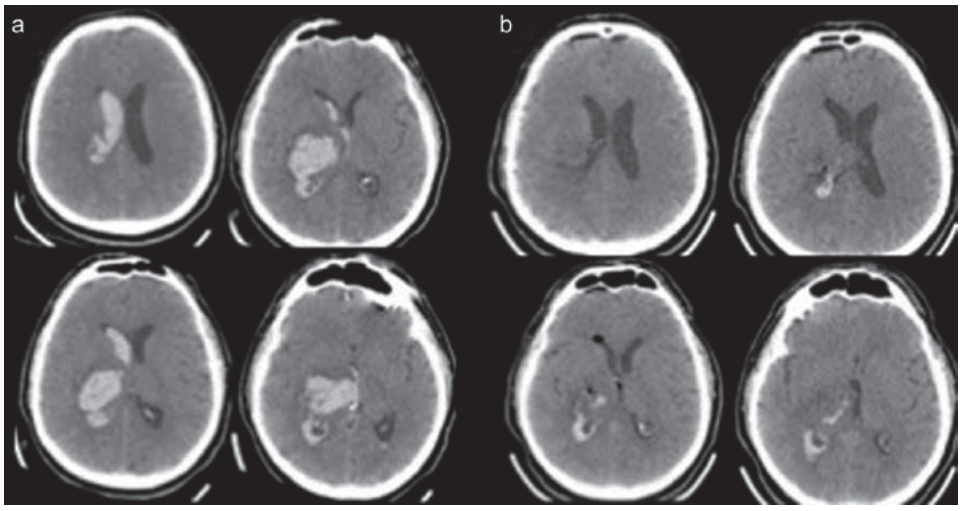


Fig. 3. **hCT of the patient with a thalamocapsular hematoma and breakthrough of blood into the ventricular system.**

a — 6 h after the onset of the disease; b – hCT after endoscopic removal of the hematoma.

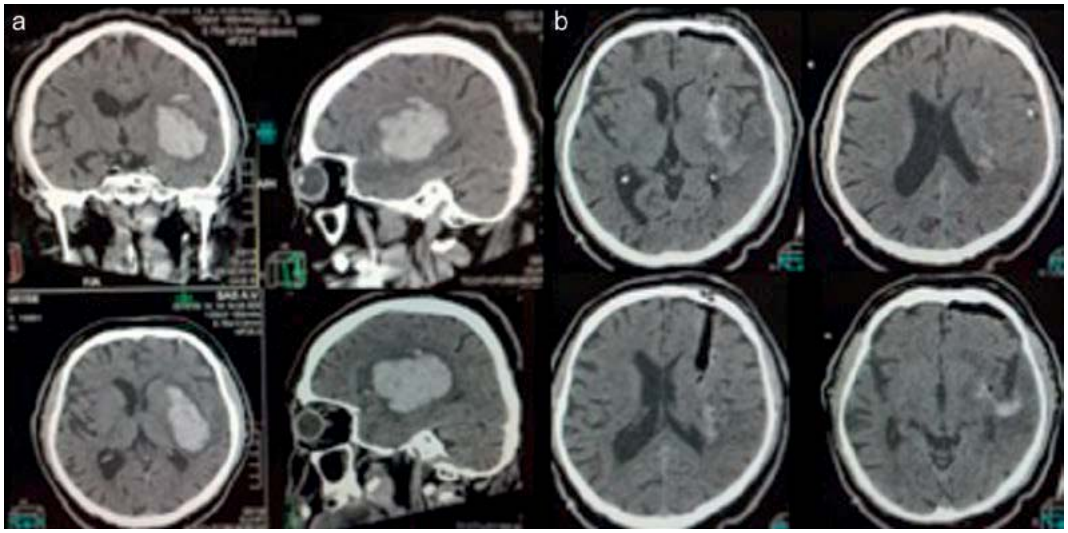


Fig. 4. **hCT of the patient with a putaminal hematoma.**
a — 10 h after the onset of the disease; b — hCT after endoscopic removal of the hematoma.

moderate disability by the time they were transferred, which allowed 5 (45%) of them to be able to independently support themselves within the room after a course of rehabilitation therapy.

In 9 (82%), hematomas were completely removed. Two (18%) patients underwent partial removal (in the group of medial hematomas with blood breakthrough into the ventricular system).

No recurrent hemorrhages were observed.

In 2 (18%) patients, after ETV and hematoma removal using a flexible endoscope, ICP monitoring showed that it normalized within 24 h, which enabled removing the ventricular drain 48 h after the surgery. In the patient who had undergone ETV and had had blood removed from the ventricular system but the hematoma had not been removed, the ICP normalized only on day 7 of follow-up.

Figures 3 and **4** show two examples of hematoma removal.

Discussion

According to [7, 13], endoscopic removal of HICHs is mostly used in patients with putaminal and lobar hematomas. Endoscopy significantly reduces mortality in this group of patients; however, if patients had not been properly selected, it may increase the number of patients with severe neurologic deficit because of inextricable problems associated with radical removal of hematomas. Foreign authors [11, 13] believe that the procedure substantially reduces the duration of surgeries and postoperative mortality rate; it is comparable with microsurgical treatment in terms of its effectiveness.

This method is known to be characterized by minimal invasiveness and traumatization; however, the fact that radical removal of hematomas in some cases and the challenges associated with intraoperative hemostasis significantly limit its application. Most publications are based on small series and the main focus is placed on the features of the technique and the available tools.

We realize that it is too early to draw conclusions. It is difficult to compare the series of endoscopic interventions performed by us to other ones because there is no single scale and interpretation of the previously published studies is challenging. In particular, based on the findings of the only article published in 2014 [7], patients with deep hematomas were subdivided into the putaminal and thalamic groups only, which limits the possibility of comparing the groups and conducting a more thorough analysis.

In the scientific community, there still is no shared vision regarding how the time and sufficient effectiveness of surgical treatment for patients with hemorrhagic stroke compared to conservative therapy. The fourth randomized study (STICH 2) is currently being carried out, which includes comparing the conservative and surgical treatments in patients with subcortical hemorrhages. However, we believe that comparing patients based on treatment method only, without taking into account its effectiveness it each particular group, may result in uncertain inference.

The outcomes for our series of patients are promising; however, we realize that the procedure needs to be tested for a greater number of patients in order to obtain statistically significant data.

Authors declare no conflict of interest.

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Commentary

The study focuses on an important issue, surgical treatment of hypertensive intracerebral hemorrhages.

It is known that the question regarding indications for surgical intervention and selection of the method for hematoma evacuation that would be optimal for a specific patient remains most complex in managing patients with hypertensive intracerebral hematomas.

The authors have analyzed the initial experience of endoscopic removal of deep hematomas with supratentorial localization in 9 patients and cerebellar hematomas in 2 patients.

The absence of complications and the positive neurological dynamics in all patients attest to the fact that the authors have performed proper preoperative selection of patients and have mastered the surgical endoscopy procedure.

Unfortunately, no technical details of surgeries were mentioned in the article, namely: 1) how did the authors overcome the challenges associated with navigation in the hematoma cavity in medium being the non-transparent due to the presence of blood and in the pockets being inaccessible for visualization? and 2) how did the authors achieve reliable hemostasis?

It is noteworthy that in most patients (67%), hematomas were removed within 24 h after the hemorrhage; no recurrent hemorrhages were observed in these patients. Meanwhile, it is known for sure that the risk of postoperative recurrent hemorrhage and spontaneous hematoma expansion is the highest within 24 h after hemorrhagic stroke, primarily due because of the hemodynamic instability and a tendency towards arterial hypertension in this cohort of patients. In many clinics, this circumstance, provided that the patient's condition is stable, is the reason for refusing surgery on day 1 of hypertensive intracerebral hemorrhage in order to correct high blood pressure.

In general, taking into account the fewness of publications focused on endoscopic removal of intracerebral hematomas, there is no doubt that this article is relevant today.

Further studies are required in order to select more patients to have a representative group, compare the endoscopic method of hematoma removal to other procedures, and draw more reliable conclusions.

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