Research Article

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Results of Endoscopic and Open Removal of Hypertensive Subcortical Hematomas

V.G. Dashyan[1, 2], R.Y. Kryachev[1, 2] *, Y.A. Shesterikov[3], I.M. Godkov[2], S.V. Tsilina[3], V.V. Krylov[1]

Department of Emergency Neurosurgery
[1] A.I. Yevdokimov Moscow State University of Medicine and Dentistry of the Ministry of Health of Russian Federation
20, build. 1, Delegatskaya St., Moscow, 127473, Russian Federation
2 N.V. Sklifosovsky Research Institute for Emergency Medicine of the Moscow Health Department
3 Bolshaya Sukharevskaya Square, Moscow, 129090, Russian Federation
[3] Omsk Region City Clinical Emergency Hospital No. 1
9 Pereleta St., Omsk, 644112, Russian Federation

***Contacts:** Roman Yu. Kryachev, postgraduate student of the Department of Neurosurgery and Neuroresuscitation of A.I. Yevdokimov Moscow State University of Medicine and Dentistry of the Ministry. Email: roma.kryachev@mail.ru

AIM OF STUDY To compare the effectiveness of surgical treatment of patients with hypertensive intracerebral hematomas (ICHs) of subcortical location and methods of endoscopic aspiration and open removal.

MATERIAL AND METHODS The results of surgical treatment of 97 patients with hypertensive subcortical hematomas were analyzed. In group 1 (n=52), endoscopic aspiration of the ICH was performed using a frameless navigation station, in group 2 (n=45), open removal of the ICH was performed using a microsurgical method.

Results Mortality among patients in the age group over 71 years after endoscopic aspiration of ICH was significantly lower than after open removal (30.8% and 60%, respectively). With a decrease in the level of wakefulness to sopor, the mortality rate with endoscopic removal was 50%, and with open intervention — 66.7%, with a decrease to coma — 100% in both groups. Among patients of the 1st group with the volume of ICH less than 40 cm3, the lethality was 11.1%, while in the 2nd group this indicator was almost 2 times higher — 20%. With endoscopic removal of an intrauterine device with a volume of 40 to 60 cm3, the mortality rate reached 14.3%, and with an open removal of a hematoma of the same volume, this indicator reached 30%, while the mortality rate in both groups was similar with a volume of an intrauterine device from 61 to 100 cm3 and amounted to 23.1% and 21.4% in the 1st and 2nd groups, respectively. The radicality of hematoma removal in the 1st and 2nd groups was 86.4% and 86%, respectively.

CONCLUSION Endoscopic removal of hypertensive subcortical hematomas revealed a greater number of patients with good recovery, and postoperative mortality was 11.3% lower than with open removal, which, along with the simplicity of execution and minimally invasiveness, indicates the safety and efficiency of endoscopic aspiration for surgical treatment of patients with intracerebral hematomas of subcortical location.

Keywords: hemorrhagic stroke, hypertensive subcortical hematomas, endoscopic aspiration, craniotomy

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Affiliations

Vladimir G. Dashyan	Doctor of Medical Sciences, Professor of the Department of Neurosurgery and Neuroresuscitation of the A.I. Yevdokimov Moscow State University of Medicine and Dentistry of the Ministry of Health; https://orcid.org/0000-0002-5847-9435, v485@bk.ru; 25%, carrying out operations, developing the concept and design of the study, scientific editing of the article text
Roman Y. Kryachev	Neurosurgeon of the Department of Emergency Neurosurgery of N.V. Sklifosovsky Research Institute for Emergency Medicine, postgraduate student of the Department of Neurosurgery and Neuroresuscitation, A.I. Yevdokimov Moscow State University of Medicine and Dentistry of the Ministry of Health; https://orcid.org/0000-0003-4372-6648, roma.kryachev@mail.ru 25%, conducting operations, developing a study design, analyzing the data obtained, writing the text of the article
Yaroslav A. Shesterikov	Candidate of Medical Sciences, Head of the Neurosurgical Department of Omsk Region City Clinical Emergency Hospital No. 1; https://orcid.org/0000-0003-3095-6452, chest.slav@mail.ru; 20%, carrying out operations, obtaining data for analysis, analyzing the data obtained
Ivan M. Godkov	Candidate of Medical Sciences, Senior Researcher of the Department of Emergency Neurosurgery, N.V. Sklifosovsky Research Institute for Emergency Medicine;

	https://orcid.org/0000-0001-8651-9986, i.godkov@yandex.ru; 15%, conducting operations, obtaining data for analysis
Svetlana V. Tsilina	Candidate of Medical Sciences, Anesthesiologist-resuscitator of Omsk Region City Clinical Emergency Hospital No. 1; https://orcid.org/0000-0002-6322-2095, thsilina_sv@rambler.ru; 10%, conducting operations, obtaining data for analysis, analyzing the data obtained
Vladimir V. Krylov	Doctor of Medical Sciences, Professor, Member of the Russian Academy of Sciences, Head of the Department of Neurosurgery and Neuroresuscitation, A.I. Yevdokimov Moscow State University of Medicine and Dentistry of the Ministry of Health, Chief Scientific Officer of the Department of Emergency Neurosurgery of the N.V. Sklifosovsky Research Institute for Emergency Medicine, Chief external neurosurgeon, Ministry of Health of the Russian Federation; https://orcid.org/0000-0001-7206-8926, manuscript@inbox.ru; 5%, operations, research concept development

IVH – intraventricular hemorrhage
ICH – intracerebral hematoma
HS – hemorrhagic stroke
CT – computed tomography
CAG – cerebral angiography
GOS – Glasgow Outcome Scale
GCS – Glasgow Coma Scale

INTRODUCTION

The problem of treating hemorrhagic stroke (HS) remains relevant, since despite the success of modern neurosurgery, this pathology is accompanied by high rates of mortality (from 40 to 90%) and disability (from 70 to 75%), mainly among people of working age. [1]. The share of intracerebral hypertensive hematomas (ICHs) accounts for 10-15% of all forms of acute cerebrovascular accident, of which, according to various researchers, in 15-47% of patients the hematoma has subcortical localization [2]. The effectiveness of surgical treatment of HS compared with conservative therapy was studied in the large multicenter international randomized study STICH I conducted by A.D. Mendelow et al. (2005). There were no obvious benefits of surgery. In a later study, STICH II, conducted by the same authors, the prevalence of the surgical method of treatment over the conservative method was proved in patients with hematomas of subcortical localization, not complicated by ventricular hemorrhage. In both studies, open surgery was the main surgical treatment [3, 4]. It is known that open removal of subcortical hematomas is accompanied by minor brain injury. Hypertensive subcortical hematomas are operated most often among all supratentorial ICHs. This is due to the superficial location of the hemorrhage and more favorable results of surgical treatment. The development of new surgical technologies, as well as intraoperative monitoring of the performance of the intervention (neuroendoscopy, frameless neuronavigation) contributed to the revision of the ideology of surgical interventions in different variants of the localization of the IHCs. The main trend in HS surgery in recent years has been a decrease in the invasiveness of surgical intervention while maintaining its radicality.

Purpose of the study — to compare the effectiveness of surgical treatment of patients with hypertensive subcortical IHCs using endoscopic aspiration and open removal.

MATERIAL AND METHODS

The results of surgical treatment of 97 patients with hypertensive subcortical hematomas hospitalized in the neurosurgical departments of the N.V. Sklifosovskiy and BUZ OO "GC BSMP No. 1" of the City of Omsk in the period from January 1, 2014 to December 31, 2018 were analysed. In the etiology of the formation of ICHs, the leading role was played by arterial hypertension.

Depending on the chosen method of surgical treatment, the patients were divided into two groups. In patients of the 1st group (n = 52), the method of surgical intervention was endoscopic aspiration of the ICH using a frameless navigation station. Among them there were 36 men (69.2%) and 16 women (30.8%), whose

average age was 60.7 years and 61.8 years, respectively. In the age group under 50, there were 11 patients (22%), 51-60 years old - 12 (24%), 61-70 years old - 16 (32%), over 71 years old - 13 patients (26%). On the 1st day after the hemorrhage, 19 patients (36.5%) were hospitalized in the hospital, on the 2-4th day - 31 (59.6%), on the 6-8th day - 0, on the 9-10th day - 2 patients (3.9%). The level of wakefulness was assessed according to the Glasgow Coma Scale (GCS) and at the time of admission to the hospital it corresponded to clear consciousness in 23 patients (44.2%), stunning - in 22 (42.3%), stupor - in 6 (11.5%)) and coma - in 1 patient (1.9%) (Fig. 1).

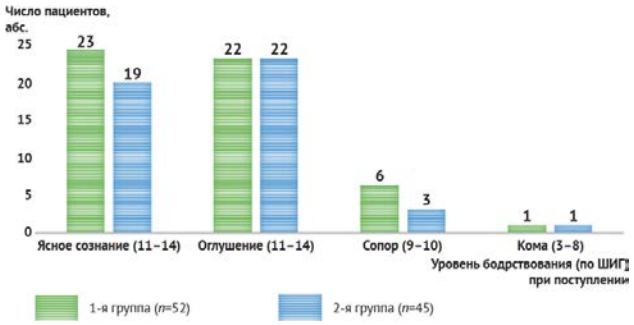

Fig. 1. The distribution of patients depending on the degree of inhibition of the level of wakefulness upon admission to the hospital (n=97), abs. (%)

Fourteen patients (26.9%) had no neurological impairments on admission, another 38 (73.1%) had moderate or severe neurological deficits (speech impairments, paresis / plegia in the limbs). On admission, all patients underwent computed tomography (CT) of the brain, in which the average volume of hematoma was 49.4 cm3. The volume of the ICH was less than 40 cm3 in 18 patients (34.6%), from 41 to 60 cm3 - in 21 (40.4%), from 61 to 100 cm3 - in 12 patients (25%) (Fig.2).

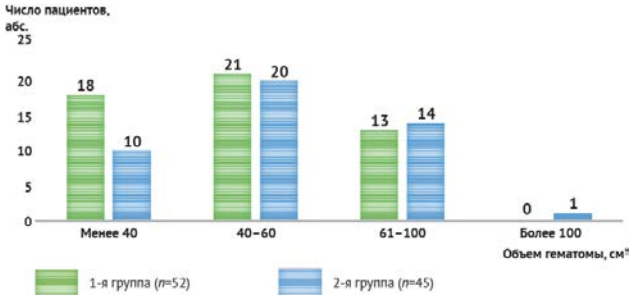

Fig. 2. The distribution of patients depending on the volume of the ICH according to the CT scan of the brain, performed upon admission to the hospital (n=97), abs. (%)

In 21 patients (40.4%), a breakthrough of blood into the ventricular system of the brain was revealed. In order to exclude arteriovenous malformation, all patients underwent cerebral angiography (CAG). Not a single patient was operated on the 1st day after the hemorrhage. The overwhelming majority of patients (38 (73.1%)) were operated on 2-4 days from the onset of the disease.

Patients of the 2nd group (n = 45) underwent open removal of the ICH using microsurgical technique. Of these, there were 31 men (68.8%) and 14 women (31.2%), whose average age was 55.1 years and 62.3 years, respectively. In the age group under 50, there were 10 patients (22.2%), 51-60 years old - 20 (44.4%), 61-70 years old - 10 (22.2%), over 71 years old - 5 (11%). On the 1st day after the hemorrhage, 31 patients (68.9%) were hospitalized, on the 2-4th day - 10 (22.2%), on the 6-8th day - 4 (8.9%), on 9-10th day — 0. 19 patients (42.2%) were admitted with a clear consciousness, 22 (48.9%) were stunned, 3 (6.7%) were dissociable, 1 (2.2%) were in a coma (see Fig. 1). Eight patients (17.8%) had no neurological disorders at the time of admission to the hospital, 37 (82.2%) had moderate or severe neurological deficit. The average hematoma

volume was 54.8 cm3. The volume of the ICH was less than 40 cm3 in 10 patients (22.2%), from 41 to 60 cm3 - in 20 (44.4%), from 61 to 100 cm3 - in 14 (31.1%), in another 1 patient (2%) hematoma was 144 cm3 (see Fig. 2). Intraventricular hemorrhage (IVH) was detected in 10 cases (22.2%). CAG or CT angiography of the brain were performed in 33 patients (73.3%). Most patients (22 (48.9%) were operated on the 1st day after hemorrhage.

Patients with non-hypertensive ICH (hemorrhage into the tumor, hemorrhage due to rupture of an arterial aneurysm or vascular malformation) were excluded from the study.

Preoperative preparation (stabilization of hemodynamic parameters, correction of homeostasis and vital functions) of patients for surgery was performed in the neurosurgical intensive care unit.

During the evacuation of the ICH, data from the navigation station (Brainlab, Germany) were used to determine the access trajectory and the puncture point of the brain, taking into account the shape of the hematoma, the location of the latter in relation to the functionally significant areas of the brain, and the shortest path to hemorrhage was chosen.

For endoscopic aspiration of hematoma, a Hopkins II ventriculoscope (Karl Storz, Germany) with a working channel diameter of 5.5 mm, an opening area of the working channel of the tube 20 mm2, and thin optics, an observation angle of 6° was used.

Immediately after the operation, a control CT scan of the brain was performed, the results of which were used to assess the residual volume of the ICH, the degree of displacement of the midline structures of the brain and the presence / absence of recurrent hemorrhage, and the ventricular system of the brain was assessed. Treatment outcomes were assessed using the Glasgow Outcome Scale (GOS) at discharge.

RESULTS

Both groups of patients turned out to be comparable in size, frequency of history of arterial hypertension, severity of the condition upon admission to the hospital and the volume of hematoma according to CT of the brain performed upon admission to the hospital (the average volume of hematoma was 49.4 cm3 and 54.8 cm3 in 1st and 2nd groups, respectively).

The endoscopy group was dominated by patients in the age group from 61 to 70 years (20 patients), in the craniotomy group - from 51 to 60 years (16 patients), over the age of 71, more patients were in the endoscopy group (13 patients compared with 5 in the craniotomy group). In both groups, the majority of patients had a hematoma volume of 40 to 60 cm3. The incidence of IVH almost doubled in the endoscopy group (40.4% versus 22.2% in the craniotomy group).).

The use of neuronavigation in both groups optimized preoperative planning, made it possible to monitor more reliably and safely the course of surgery.

The average duration of endoscopic aspiration was 80 minutes, while the duration of open surgery using microsurgical techniques was 175 minutes, with an average intraoperative blood loss of 245 ml in group 2 and minimal blood loss in group 1.

Radical removal of hematoma in groups 1 and 2 was 86.4% and 86%, respectively (Fig. 3, 4). Relapse of hemorrhage was noted in 2 cases (3.8%) in group 1 and in 1 case (2.2%) in group 2.

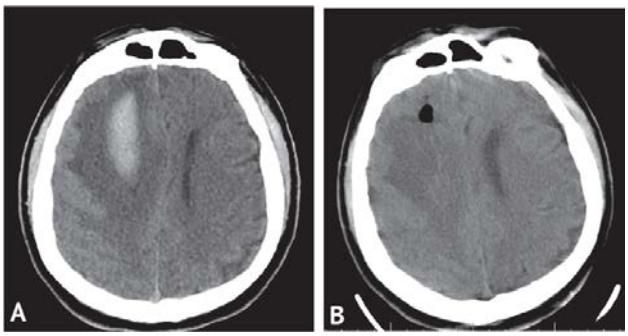

Fig. 3. CT scan of the brain, axial projection: A — before surgery; subacute subcortical hematoma of the right frontal lobe with a volume of 33 ml, transverse dislocation to the left up to 6 mm; B — 1 hour after endoscopic aspiration of the ICH; the hematoma is removed completely, the transverse dislocation to the left up to 2 mm, a small amount of gas in the bed of the removed hematoma

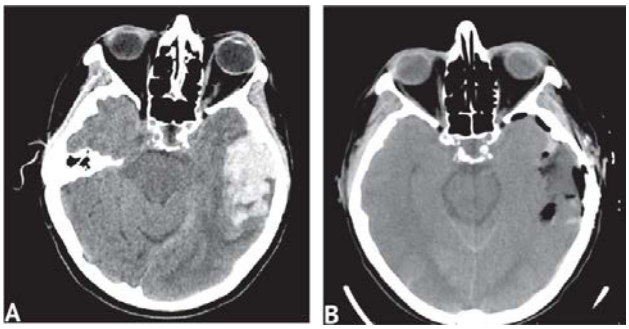

Fig. 4. CT scan of the brain, axial projection: A — before surgery; acute subcortical hematoma of the left temporal lobe with a volume of 39 cm3, transverse dislocation to the right up to 10 mm; B — 1 hour after microsurgical removal of the ICH; the hematoma is removed completely, the transverse dislocation to the right up to 3 mm, the gas in the bed of the removed hematoma

In the endoscopy group a good outcome (5 points according to GIS) was observed in 32 patients (61.5%), in the craniotomy group there were 18 patients (40%), with moderate disability there were 5 (9.6%) and 5 patients (11, 1%), respectively, with deep disability - 7 (13.5%) and 9 patients (20%), respectively. In group 2, in 1 patient (2.2%) the outcome of the disease corresponded to the vegetative state. Postoperative mortality (1 point according to GIS) was 15.4% (8 patients) in the endoscopy group and 26.7% (12 patients) in the microsurgery group (Fig. 5).

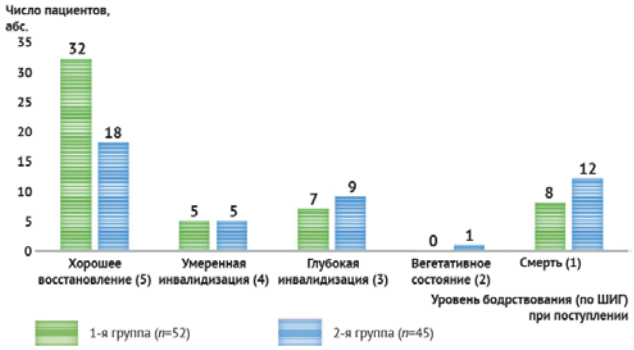

Fig. 5. The outcomes of surgical treatment of hypertensive subcortical hematomas with endoscopic aspiration and microsurgery (n=97)

Comparison of the levels of postoperative mortality in the study groups depending on age, level of wakefulness, volume of hematoma, presence of IVH, dislocation syndrome, movement disorders, timing of surgery from the onset of the disease and the presence of recurrent hemorrhage are given in Table 1.

Table 1

Mortality rates after open and endoscopic removal of intracerebral hematoma

Factor	1st group (n=52)			2nd group (n=45)		
	Number of patients abs.	Number of deaths (n=8)		Number of patients abs.	Number of deaths (n=12)	
		абс.	%		абс.	%
Age:						
less than 50 years	11	2	18,2	10	1	10,0
51-60 years old	12	0	0	20	6	30,0
61-70 years old	16	2	12,5	10	2	20,0
more than 71 years	13	4	30,8	5	3	60,0
Wakefulness level:						
clear mind	23	1	4,3	19	1	5,3
stunning	22	3	13,6	22	8	36,4
sopor	6	3	50,0	3	2	66,7
coma	1	1	100,0	1	1	100,0

Hematoma volume:						
less than 40 cm3	18	2	11,1	10	2	20,0
40-60 cm3	21	3	14,3	20	6	30,0
61-100 cm3	13	3	23,1	14	3	21,4
more than 100 cm3	0	0	0	1	1	100,0
Intraventricular hemorrhage	21	2	9,5	10	4	40,0
Dislocation syndrome:						
yes	34	6	17,6	34	12	35,3
no	18	2	11,1	12	0	0
Movement disorders:						
no violations	18	2	11,2	10	0	0
paresis	21	1	4,8	27	6	22,2
plegia	13	5	38,5	8	6	75,0
Terms of operation:						
1st day	0	0	0	22	10	45,4
2nd day	7	1	14,3	5	0	0
3rd day	17	4	23,5	5	1	20,0
4-5th day	20	1	5,0	7	0	0
6-7th day	4	1	25,0	1	0	0
later than 7 days	4	1	25,0	5	1	20,0
Recurrent hemorrhage	2	1	50,0	1	1	100,0

As a result of the analysis of the outcomes of surgical treatment, depending on individual indicators, it was found that as the age of the patients increased, the rate of postoperative mortality increased too. It was the highest among patients over 71 years old: 30.8% in group 1 and 60% in group 2. It should be noted that poor outcomes in patients of this age were noted much less frequently after endoscopic aspiration of ICH than after craniotomy.

The degree of inhibition of wakefulness also influenced the rate of postoperative mortality. In patients with a decrease in the level of wakefulness to sopor, the postoperative mortality with endoscopic intervention was 50%, and with open removal – 66.7%. Postoperative mortality with depression of consciousness to coma was 100% in both groups. Among the deceased in the endoscopy group, one patient (4.3%) admitted with a clear consciousness, and the cause of his death was the dislocation of the brain due to recurrent hemorrhage. In the craniotomy group, one patient (5.3%) was also clearly conscious before the operation, whose cause of death was respiratory failure. Three patients (13.6%) in the endoscopy group and 8 patients (36.4%) in the craniotomy group before surgery were in moderate (13-14 points on the GCS) or deep (11-12 points on the GCS) stunning. In the endoscopy group, the causes of death in these patients were somatic complications. Out of eight patients in the craniotomy group, five died from postponed dislocation of the brain, three more died from somatic complications. All patients, with the exception of one in the craniotomy group (the cause of death was intoxication against the background of pseudomembranous colitis), who were admitted with a decrease in the level of wakefulness to 10 points on the GCS or less, died from the postponed dislocation of the brain.

The volume of hematoma turned out to be a significant factor determining the results of treatment: mortality increased with the increase in the volume of the ICH. Among patients of the 1st group with a volume of ICH less than 40 cm3, the mortality rate was 11.1%, while in the 2nd group this indicator was almost 2 times higher — 20%. With endoscopic removal of a hematoma with a volume of 40 to 60 cm3, the mortality rate reached 14.3%, and with open removal of a hematoma of a similar volume, this figure reached 30%, while the mortality rate in both groups was similar with the removal of an ICH with a volume of 61 to 100 cm3, and amounted to 23.1% and 21.4% in the 1st and 2nd groups, respectively. In the craniotomy group, a patient with an ICH volume of more than 100 cm3 died, and in the endoscopy group, there were no patients with a similar volume of an ICH.

According to the results obtained, in patients with concomitant IVH after endoscopic removal, mortality was 4 times less than after open surgery - 9.5% and 40%, respectively.

The presence of dislocation syndrome before surgery also determined the outcome of treatment. Postoperative mortality in the presence of dislocation syndrome in group 1 was 1.5 times higher than in its

absence of dislocation - 17.6% and 11.1%, respectively. In group 2, the mortality rate was 35.3% in the presence of dislocation syndrome (all 12 patients who died before the operation had dislocation syndrome). There was no significant effect on the frequency of good outcome of the absence or presence of dislocation syndrome.

The presence or absence of neurological deficit was a significant factor in relation to the outcome of the disease. In the endoscopy group, mortality among patients with preoperative neurological deficit in the form of hemiplegia was 3.5 times higher than without it - 38.5% and 11.2%, respectively. In the microsurgery group, postoperative mortality in patients with preoperative hemiplegia reached 75%, while in the same group, in patients without neurological deficit, no deaths were recorded. In the endoscopy group, the frequency of good outcomes in patients with hemiplegia was 3 times lower than in patients without neurological deficit - 30.8% and 88.9%, respectively. In the microsurgery group, 10 out of 10 (100%) patients without movement disorders had a good functional outcome, while in two patients (25%) with preoperative hemiplegia, the disease outcome corresponded to profound disability.

It is extremely difficult to unequivocally answer the question about the optimal timing of endoscopic aspiration, according to the data obtained, but it should be noted that out of 20 patients operated on days 4–5 from the onset of the disease, only 1 (5%) died, which emphasizes the advantage using the endoscopic method within the above terms. In the group of patients who underwent craniotomy (7) on the 4-5th day, no deaths were recorded with extremely high mortality in patients operated on the 1st day after the hemorrhage — 45.4%.

Relapse of hemorrhage was noted in two cases (3.8%) in group 1 and in one (2.2%) in group 2. The patient undergoing open surgery died. Of the two patients who had a relapse in group 1, one survived, but no favorable outcome was observed. Both patients in the endoscopy group relapsed within the first 2 hours after surgery, and both were reoperated on. The cause of death of the deceased patient was edema and dislocation of the brain.

Comparison of the results of treatment with two surgical methods showed that with endoscopic removal of hypertensive subcortical hematomas, postoperative mortality was 11.3% less, and the number of patients with good recovery was 2 times greater.

DISCUSSION

Endoscopic aspiration of ICH in recent years has become increasingly widespread due to its effectiveness and low invasiveness. It should be noted that endoscopic removal of stroke hematomas of putamenial localization has been performed for 35 years, and the work devoted to this variant of surgical treatment in recent years has been aimed at clarifying the indications and improving the technical aspects of the method, information on the safety and effectiveness of using the latter is reflected as in works of the founder of this direction L.M. Auer et al. (1985), as well as in modern publications (J.A. Dye et al. (2012), X. Jianhua et al. (2019) and etc.) [5–8].

The first description of the successful evacuation of hypertensive subcortical hematomas belongs to L.M. Auer et al. (1989). The researchers compared the results of endoscopic aspiration of hemorrhage and conservative treatment. The group of operated patients with subcortical hematomas (24 patients) showed significantly lower mortality (30%) in comparison with the group of conservative treatment (70%). More than 40% of these patients had a good functional outcome compared to 25% in the conservative treatment group. The study included a small number of patients for detailed analysis of individual factors, but the authors demonstrated a significant effect of endoscopic removal of subcortical hematomas [9].

In a study by L. Kuo et al. (2011), where 68 patients with spontaneous intracerebral hemorrhages were operated on by endoscopic aspiration, in 9 patients the hematoma was located subcortically. The authors removed the ICH through the transparent port from its distal part, which is the most distant from the surgeon. There were no deaths or recurrences of hemorrhage in the group of patients with subcortical hematomas (with a general rate of postoperative mortality — 5.9%). The radicality of hematoma removal was 98%. Despite the promising data obtained as a result of the study in comparison with microsurgical removal, the authors themselves recognized the limitations of the results associated with a small number of patients, however, these preliminary results served as a substantive basis for further study and implementation of the method of endoscopic aspiration of ICH. [10].

Ya. A. Shesterikov et al. (2018) compared the results of open and endoscopic removal of hypertensive ICHs. The study included 132 patients. The group of patients who underwent craniotomy included 72 patients (in 22 cases, the hematoma was located subcortically), the group of endoscopy included 60 patients (subcortically, the ICH was located in 10 patients). The authors performed endoscopic aspiration using frameless neuronavigation and a ventriculoscope with a 6.5 mm tube, 13 cm working length, 20 mm2 working channel opening area, and fine optics, 6° viewing angle. In case of subcortical ICH after endoscopic aspiration, no deaths were recorded in comparison with 5 cases (22.7%) during open microsurgical intervention. The authors were able to establish that the use of endoscopic aspiration of hypertensive ICHs (putamenal, thalamic, subcortical) under neuronavigation control made it possible to achieve better results in comparison with open intervention by craniotomy and microsurgical evacuation of ICHs due to lower mortality (by 19%) and improved functional outcomes of the disease (with endoscopic removal of ICH, the number of patients with good recovery was 3 times more) [11].

X. Xu et al. (2018) retrospectively analyzed the results of surgical treatment of 151 patients with hypertensive ICH. The endoscopy group consisted of 82 patients, in 17 of whom the hematoma had subcortical localization. The craniotomy group consisted of 69 patients, where also in 17 patients the ICH was located subcortically. The results of the study determined a greater percentage of hematoma evacuation (90.5%) in comparison with open intervention (82.3%), as well as significant differences in the average duration of surgery (100 minutes and 320 minutes in the endoscopy and craniotomy groups, respectively) and intraoperative blood loss (90 ml and 600 ml in endoscopy and craniotomy groups, respectively). In terms of postoperative mortality, functional outcomes (in the early and late periods), the method of endoscopic aspiration again showed a more than 2-fold superiority over open surgery [12].

In our study, a comparison of the results of treatment with two surgical methods showed that with endoscopic removal of hypertensive subcortical hematomas, postoperative mortality was 11.3% less than with microsurgery, and the number of patients with good recovery increased by 2 times.

The number of publications devoted to endoscopic aspiration of subcortical ICH is small, studies include a small number of patients, and information on the use of the method is contradictory. According to our data, the risk factors for an unfavorable outcome of surgical treatment of hypertensive subcortical hematomas (level of consciousness before surgery, hematoma volume, the presence and severity of motor disorders, transverse dislocation of the brain, IVH, recurrent hemorrhage) do not differ from those in the surgical treatment of hypertensive ICHs of other localization and are reflected in many modern publications. Objective difficulties in the approach to the selection of patients, the timing of the intervention, surgical technique, the surgeon's experience and further restorative treatment are currently the subject of discussion. In our opinion, the suspicion regarding endoscopic surgery of subcortical hematomas is associated with the possibility of encountering an angiographically negative vascular malformation during surgery, the cases of which were not detected in the demonstrated group of patients. On the other hand, the superficial location of the ICH is also considered favorable for open surgery, in connection with which endoscopic surgery of these hematomas is currently not undergoing sufficient development, however, the method seems promising in terms of less invasiveness of the intervention.

CONCLUSION

The use of endoscopic aspiration in the removal of hypertensive subcortical hematomas made it possible to achieve better results in comparison with open intervention due to lower postoperative mortality and better functional outcomes of the disease, which, along with low invasiveness, indicates the safety and effectiveness of the neuroendoscopy method in the surgical treatment of patients with intracerebral hematoma of this localization.

The incidence of angiographically negative malformations in subcortical hematomas requires further study.

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