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ENDOVASCULAR DEVASCULARIZATION OF HYPERVASCULAR TUMORS IN NEUROONCOLOGY

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Objective *— to investigate the results of endovascular devascularization of tumors to develop new approaches to the treatment of hypervascular neoplasms in neurooncology.*

Materials and methods. *There are 24 patients with diagnosis hypervascular intracranial tumors were operated in SO «Scientific Practical Center of Endovascular Neuroradiology of the NAMS of Ukraine» in the period 2002–2011. The features of thetumors blood supply were studied and the volume of hemorrhage during tumor sirgical removal after preliminary devascularization evaluated.*

Results. *It was determined that the tumor blood supply from the External Carotid Artery basin in 21 (87.5 %) cases, 66.7 % of the afferent artery was a.maxillaris internalis. During removal of the tumor after embolization, the average hemprrhage was about 230 ml.*

Conclusıon. *The results showed that the endovascular embolization of hypervascular intracranial tumors is safe and improves the results of microsurgical tumors removal by a significant reduction of the intraoperative hemorrhage, in some cases, embolization is the only treatment.*

Key words: hypervascular tumor, endovascular embolization, microsurgical removal.

The main method of hypervascular tumors (HVTs) treatment remains surgical. However, the complexity and invasiveness of surgical access, and a high risk of massive intraoperative bleeding, often make it impossible for radical removal of such lesions [25]. Traditional methods of intra- and postoperative bleedings prevention do not always provide the desirable effect. Endovascular techniques have been constantly improved, indications developed, possible difficulties and complications defined [5].

The first reports about the endovascular approach using in the treatment of tumors are dated 1904, when R.H. Dawbarn performed transcarotid embolization of face sarcoma by means of paraffin and gasoline mix [6]. In 1972 R.E. Heckster reported that preoperative embolization of the tumor eases its surgical removal and becomes effective, safe alternative to bandaging of external carotid artery (ECA) branches [12].

There is still no consensus on the indications for endovascular interventions before surgical treatment stage [8, 18]. Technical aspects of its performance are insufficiently developed, the problem of choosing the optimal quantity and quality of materials for embolization is not solved. Besides, have not been evaluated the effectiveness of endovascular treatment depending on morphology, location and stage of development of HVTs specifics and the use of permanent occlusion as an independent method of treatment of vascular anomalies [14, 16].

The objective — to investigate the results of endovascular devascularization of tumors to develop new approaches to the treatment of hypervascular neoplasms in neurooncology.

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Materials and methods

In the period of 2002–2011 we have operated 24 patients with a diagnosis of heads HVTs in Scientific and Practical Center of Endovascular Neuroradiology of the NAMS of Ukraine. Age of patients — 21–54 years, on average — (44 ± 1) year. There were 9 (37.5 %) men, 15 (62.5 %) women.

The study included patients with tumors with distinct afferent arteries. Indications for surgery stated on the basis of angiography (AG).

All patients underwent endovascular embolization of HVTs by means of transfemoral access. In one case the patient's endovascular cut off was completed with transcutaneous puncture and subsequent introduction of thrombosing composition in the vessels feeding the tumorunderfluoroscopy.

Histological structure of the HVTs was different, dominated meningioma — 16 (66.7 %) patients, other tumors were detected infrequently (Table 1).

All patients underwent a comprehensive examination at the hospital. Clinical symptoms differed depending on the type of tumor and its location. In case of intracranial tumors cerebral and focal symptoms, seizures have been detected. Hemangiomas were accompanied by the bleeding from the tumor, pain, swelling of the soft tissues. Paraganglioma in the jugular-tympanic fossa clinically were shown by swelling of soft tissues in the affected area. Shvanoma — hearing loss, osteoma — proptosis, vision disorders.

Laboratory studies: general and biochemical blood tests (platelet number, prothrombin time, partial thromboplastin time to define the bleeding diathesis), general analysis of urine to assess renal function (urea, creatinine) and exclusion of renal failure. Detailed neurological examination, neuroophthalmologist consultationwhen necessary.

Instrumental methods of examination. Magnetic resonance imaging (MRI) and computed tomography (CT) were performed to clarify the nature and the localization of the lesions. To clarify the concomitant somatic pathology additional checkups were undertaken.

AG — the main method of medical examination, it has been conducted to all patients under local anesthesia, 4.6 ml of 2 % lidocaine and neuroleptanalgesia. For selective AG of HVTs different catheters of various firms have been used.

To simplify navigation in the tested vessel «Road-map» digital program has been implemented. For super selective catheterization microcatheters of different companies that are set up coaxially through a guide catheter have been utilized. Endovascular surgery was performed under X-ray control.

Non-absorbable liquid embolizing agents: 1–2 ml of n-Butyl Cyanoacrylate (n – BCA), concentration 1:2–1:8 have been injected to HVTs depending on its type of blood supply. Introduction of embolizing agent stopped after the devascularization of the tumor. As a rule, all endovascular surgeries end up with control AG of vascular beds.

After the surgery analgesics and broad-spectrum antibiotics have been prescribed (when indicated). The operations were performed under general anesthesia, using systemic heparinization (5.000–10.000 IU), and continuous monitoring of the vital organs and systems.

Follow-up care including AG, CT, and MRI examinations was performed at 6 months, 1 year, 3 and 5 years period with unremoved tumors.

The results

According to the AG quantitative characteristics all HVTs were divided into 4 groups: I group (17 (70.8 %)) patients — tumors, supplied from ECA; II group (4 (16.7 %)) patients — both from internal carotid artery (ICA) + ECA; III group (2 (8.3 %)) patients — ICA; IV group (1 (4.2 %)) patient — from the vertebral artery (VA) + ECA. Bilateral blood flow detected in 3 (12.5 %) patients, monolateral — in 21 (87.5 %). Arteries feeding HVTs are presented in Table 2.

Two types of blood supply identified: mixed and cavernous. 16 (66.7 %) tumorshave cavernous type of structure, with arterial blood supply that forms an extensive network in pathological tumor stroma. Mixed (diffuse) type of blood supply is characterized by a large number of afferents ICA, ECA, and VA that form «angiomotosis» network detected in 8 (33.3 %) cases.

The results of endovascular embolization were following: in 19 (79.2 %) cases the tumor was cut off from the blood totally, in 5 (20.8 %) — subto-

Table 1. *Histological structure and vascularization of HVTs*

№	Sex	Age, years	Tumor	Afferent pool	Result of embolization	Afferent artery	Blood loss, ml
1	M	30	Meningioma	ICA	Subtotal	a. ophtalmicus, a. maxillaris int.	200
2	W	46	Meningioma	ECA	Subtotal	a.maxillaris int.	230
3	W	45	Meningioma	ECA	Total	a. maxillaris int.	240
4	M	53	Meningioma	ECA	Total	a. maxillaris int.	190
5	W	21	Meningioma	ICA	Total	a. ophtalmicus, a. maxillaris int.	230
6	W	48	Meningioma	ECA	Total	a. maxillaris int.	210
7	W	51	Meningioma	ECA	Subtotal	a. maxillaris int., a. temporalis superficialis	
8	M	48	Meningioma	ECA + ICA	Total	a. ophtalmicus, a. maxillaris int.	
9	M	38	Meningioma	ECA + ICA	Total	a. ophtalmicus, a. maxillaris int.	230
10	W	46	Meningioma	ECA + ICA	Total	a. ophtalmicus, a. maxillaris int.	250
11	W	44	Meningioma	ECA	Total	a. maxillaris int.	220
12	W	48	Meningioma	ECA	Total	a. occipitalis	
13	M	43	Meningioma	ECA	Total	a. occipitalis	230
14	W	43	Meningioma	ECA	Total	a. maxillaris int., a. temporalis superficialis	90
15	W	48	Meningioma	ECA	Total	a. maxillaris int.	160
16	W	49	Meningioma	ECA, ECA	Total	a. maxillaris int. dex. et sin., a. temporalis superficialis	210
17	M	54	Osteoma	ECA + ICA	Total	a. maxillaris int., a. ophtalmicus	
18	W	48	Paraganglioma	ECA	Total	a. auricularis post.	
19	M	52	Hemangioblastoma	VA + ECA	Total	a. vertebralis, a. occipitalis	
20	W	50	Hemangioma	ECA, ECA	Total	a. temporalis super., a. auricularis post.	360
21	W	46	Hemangiopericitoma	ECA	Total	a. occipitalis, a. auricularis post.	
22	M	28	Hemangioma	ECA, ECA	Subtotal	a. auricularis post. dex. et sin., a. occipitalis dex. et sin., temporalis superficialis, a. maxillaris int.	400
23	W	43	Schwanoma	ECA	Subtotal	a. auricularis post.	280
24	M	51	Hemangioblastoma	ECA	Total	a. occipitalis, a. auricularis post.	

Notes: *ICA — internal carotid artery; ECA — external carotid artery; VA — vertebral artery.*

tally. Total devascularization of meningiomas was achieved in 13 patients, subtotal — in 3.

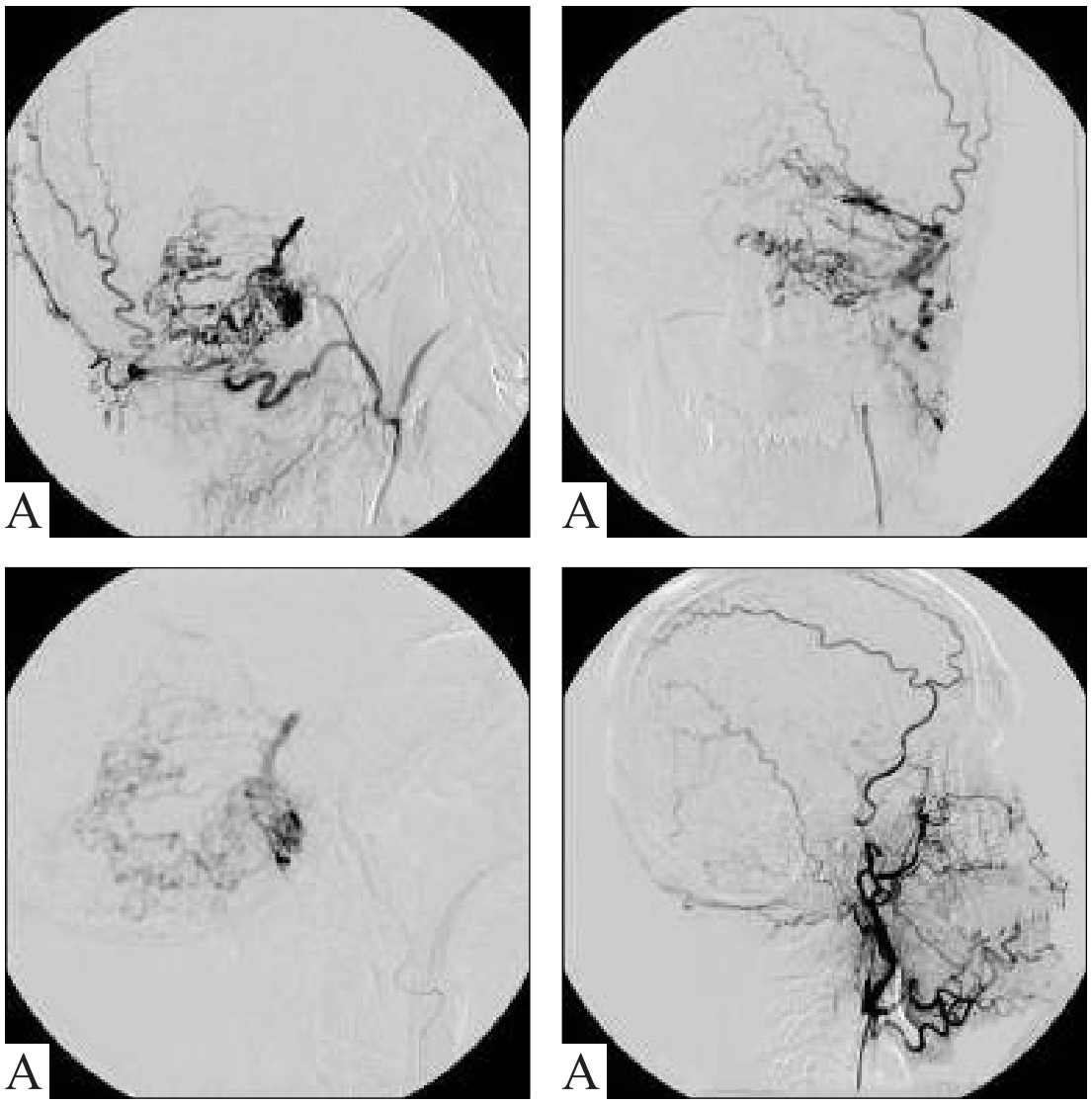
In 16 (66.7 %) patients on the 3–7th day after endovascular embolization microsurgical removal of HVTs was executed. Local changes (cyanosis, hyperemia, swelling of soft tissues,

Table 2. *Arteries feeding HVTs*

Artery	n	%
maxillaris internalis	16	66.7
ophtalmicus	6	25.0
occipitalis	6	25.0
auricularis posterior	6	25.0
temporalis superficialis	5	20.8
vertebralis	1	4.2

various protrusions) regressed after endovascular embolization in all patients in a period from several hours to several months; except for the patients with the second phase of treatment — tumor's surgical removal. After the HVTs total switch off local changes regression was the most significant. The mix of endovascular embolization radicalism and temporary regress of clinical implications, HVTs remote localization, patients' somatic status guided to the refusal of tumor surgical removal in 8 (33.3 %) cases.

We analyzed blood loss during removal of the tumor after embolization in 16 patients. Blood loss was assessed visually, by weighing pads, control the volume of blood in the aspirator. During all surgical interventions for benign vascular lesionsand malignant HVTs after preoperative embolization the blood loss averaged 230 ml.



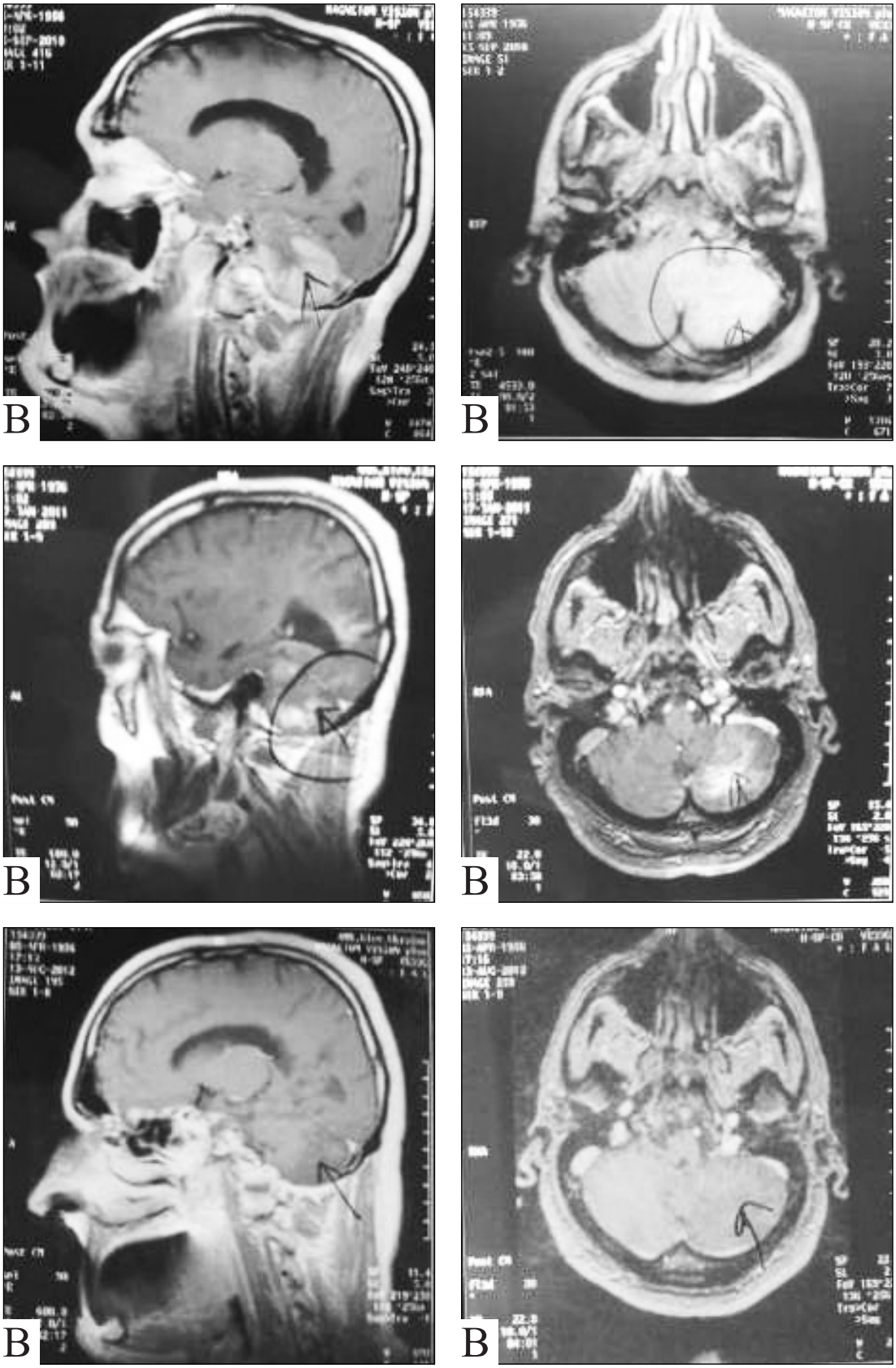


Fig. 1. *Male, 55 y.o. A — Digital subtraction: the lateral and anteroposterior projection. Cavernous hypervascular hemangioblastoma. Afferent — shell branch of ECA. Total ECA embolization. B — MRI. Regress of focal symptoms within 1 month after embolization. Within 2 years the patient has underwent 4 follow-up MRI. Reduction of tumor's size. The tumor is not contrasted; in its place scar tissue is found*

The clinical case 1

The patient with a subtentorial hemangioblastoma is under observation for more than 3 years. After embolization ataxic symptoms appeared. Control MRI images shows reduction in tumor size. The tumor is not contrasted, in its place scar tissue is found. Monitoring process of these patients continues (Fig. 1).

The clinical case 2

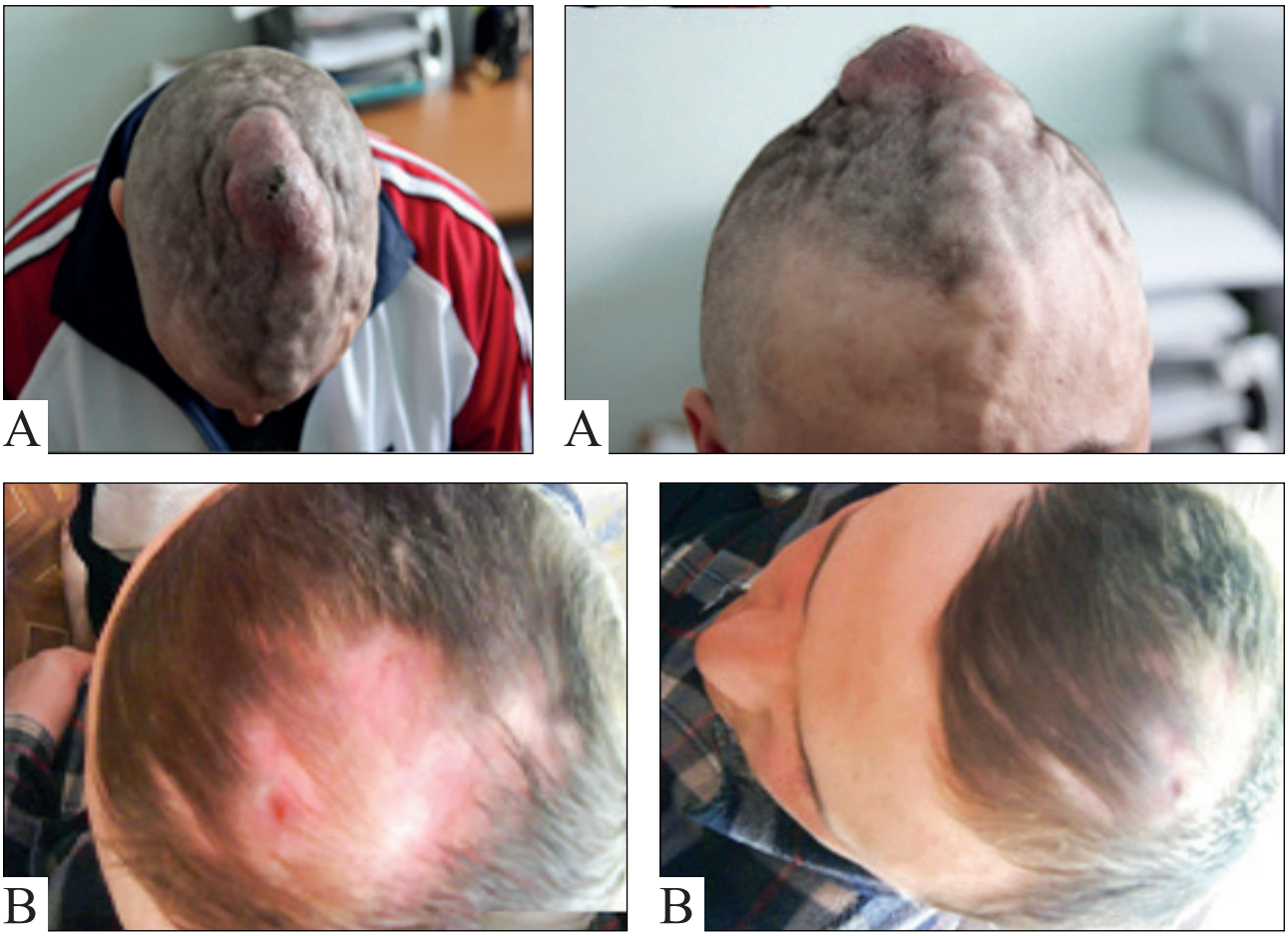
A patient with a giant hemangioma in the fronto-parietal region.In course of checkup, bleeding tumor and swelling in the fronto-parietal region were visually identified (Fig. 2).

Serious neuropsychiatric complications after embolization werenot examined. In the 1st day after surgery, 17 (70.8 %) patients reported headaches, 1 patient (4 %) — nausea. Narcotic analgesics in order to relieve intense headaches were administered to 3 (12.5 %) patients in the 1st postoperative day. In the remaining patients headaches were stopped by introducing non-narcotic analgesics. Increase in blood pressure above 30–50 mm Hg compared to initial was noted in 2 (8 %) patients, it required an additional prescription of antihypertensive drugs. Significant increase in body temperature (above 37,5 °C) after endovascular embolization was not specified in any patient. In 6 (25 %) patients body temperature was subfebrile in the 1st day after surgery.

Discussion

HVTs treatment — a complex problem due to the nature of the morphology and localization. Life-threatening tumor bleeding, facial skull deformity, dysfunction of other organs and systems determine the relevance of the study of this problem.

Previously, endovascular surgery of such tumors was used only in clinical researches that studied the introduction of chemotherapy drugs directly into the arteries feeding the tumor. These studies were based on the assumption that the intra-arterial route of administration of the drug significantly increases its concentration in the tumor, with reduced side effects of its systemic use. Some of these studies have not confirmed the intended effect [2].



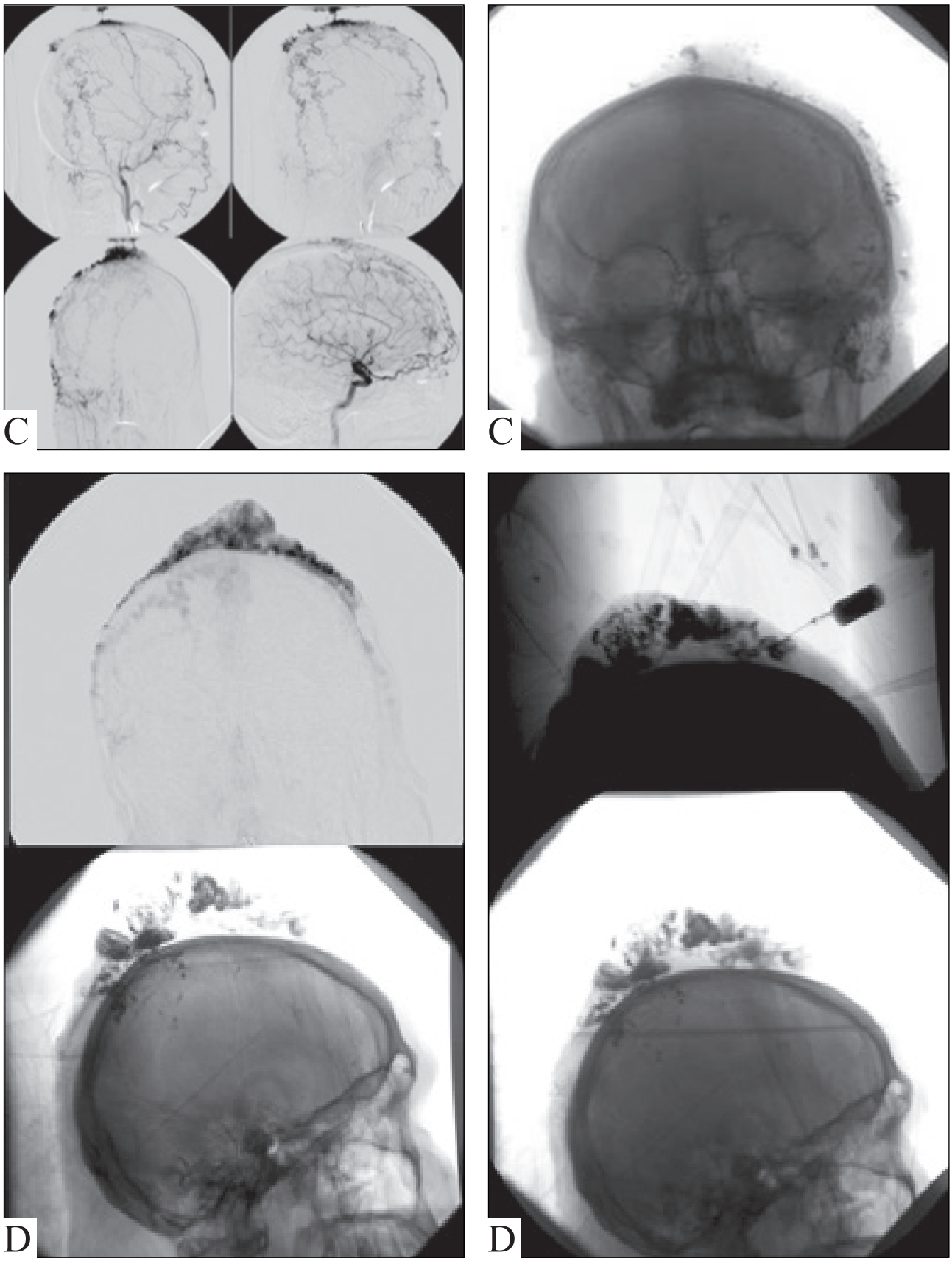


Fig. 2. *Male, 26 y.o. Hemangioma of frontoparietal area: A — Local changes before surgery: swelling, hyperemia, tumor bleeding. B — Patient's appearance after surgery. C — AG before surgery. Tumor's bilateral, mixed blood supply. D — Controlled embolization with additional percutaneous hysto-acrylin jection in tumor's stroma: digital subtraction before hystoacryl being inserted, introduction embolic agent. Bottom row — X-rays images in the lateral projection showing the distribution of embolic agent in the structure of the tumor*

In 2001, the Accreditation Council for Medical Education (USA) has developed and published main provisions of tumor embolization. They reflect eight main criteria as indicators for embolization of tumors of head and neck:

1) access to arteries feeding the tumor that can not be operated by open surgery method;

2) decrease in surgical complications risks as a result blood loss diminution in course of operation;

3) cutback of surgical intervention duration;

4) increasing probability of tumor's total surgical resection;

5) decreasing risk of surrounding intact tissue damage;

6) pain intensity reduction;

7) tumor's recurrence risk reduction;

8) improvement of surgical field visualization, and as a result — complications risk diminution [1].

Endovascular methods of diagnosis and treatment are constantly being improved, the range of indications for their use is growing gradually, potential difficulties and complications in their use identified [5]. Our results show the prostate and safety of endovascular embolization HVTs. Modern endovascular techniques allows you to perform these operations.

Application of the methods in the diagnosis of AG and endovascular surgery in the preoperative preparation of patients with different types of major vascular neoplasms HVTs in recent years, seen as an important stage in the treatment of such patients. Except for the purpose of endovascular interventions — the pain, they are more adjuvant methods, that is additional to the main surgery. Some patients may not be appropriate candidates for surgical treatment, because of existing brain tumor, severe comorbidity, advanced stages of cancer, tumor's remote localization not available for surgery. In these patients, endovascular surgery may be the only way of treatment [3]. If there is no possibility of the tumor radical removal, palliative embolization is performed [10, 19, 21].

Some of the vascular nature of the blood supply to HVTs very similar to the arteriovenous malformation and it is difficult to localize surgery can be a life threatening patient. Endovascular embolization is the only treatment option for these patients. Seen from above the clinical sample (hemangioblastom) for such cases.

In order to raise the radicality of endovascular embolization transarterial, transvenous access is explored andused in practice [4, 15, 20, 26]. Many authors recommend the use of embolization through direct transcutaneous puncture [11]. The possibilities of endovascular treatment of capillary and venous tumor with slow blood flow are under consideration [13]. According to the literature, all vascular tumors can be embolized before surgery thus reducing intraoperative blood loss [10].

Our data confirm that HVTs presence in many cases is an indication to their endovascular cut off from blood flow(endovascular treatment for devascularization as possible). Thus, the results obtained in the study justify the role of endovascular techniques in HVTs and treatment.

Lately, the use of angiographic diagnosis and low-invasive endovascular surgery for preoperative preparation of patients with different types of major vascular tumors of the head and neck consider as an important stage of their treatment. Most authors insist on the need of selective AG for patients with HVTs, since it provides precise «vascular scheme» and perfect «panorama» of the tumor to clarify its location, size and distribution. They insist that AG was one of the basic methods of research on pre-operative stage [7, 9, 17]. In the presence of HVTs AG can estimate precisely participation of ECA branches, and ICA as well and also, the carotid system in the opposite side of the tumor's vascularization [17, 23, 24].

One of the most significant advantages of preoperative embolization is an intraoperative blood lossreduction. HVTs devascularization enables extending opportunities for the radical surgical removal of such tumors. Our study shows the possibility of endovascular interventions use avoiding the risk of serious complications in patients with HVTs.

The results of our study show that preoperative HVTs embolization allows the surgical removal of the tumor with minimal trauma and blood loss. Good visualization of the surgical field due to devascularization promotes such tumors excision. Modern techniques of interventional neuroradiology allow conducting endovascular surgery with minimal risk.

Conclusion

Total and selective angiography reveals major vascular afferents, providing HVTs vascularization, as well as chooses the tactics of blood vessels preoperative embolization that reduces blood loss during surgery and makes open surgery safer and more radical HVTs endovascular devascularization is relatively simple, very safe and efficient procedure that reduces the risk of bleeding during further tumor removal.

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ЕНДОВАСКУЛЯРНА ДЕВАСКУЛЯРИЗАЦІЯ РЯСНОВАСКУЛЯРИЗОВАНИХ ПУХЛИН У НЕЙРООНКОЛОГІЇ

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Мета роботи — вивчити результати ендоваскулярної деваскуляризації пухлин для розробки нових підходів до лікування рясноваскуляризованих утворень у нейроонкології.

Матеріали та методи. У ДУ «Науково-практичний Центр ендоваскулярної нейрорентгенохірургії НАМН України» у 2002–2011 рр. було прооперовано 24 пацієнти з діагнозом «рясноваскуляризована пухлина інтракраніальної локалізації». Вивчено особливості кровопостачання пухлин та оцінено об'єм крововтрати під час хірургічного видалення пухлин після попередньої їхньої деваскуляризації.

Результати. Установлено, що пухлини кровопостачалися з басейну зовнішньої сонної артерії у 21 (87,5 %) випадку, 66,7 % аферентних артерій становила *a. maxillaris internalis*. Під час хірургічного видалення пухлин після емболізації середній об'єм крововтрати дорівнював 230 мл.

Висновки. Ендоваскулярна емболізація рясноваскуляризованих пухлин є безпечною та поліпшує результати їх мікрохірургічного видалення, значно зменшуючи об'єм інтраопераційної крововтрати. У деяких випадках це єдиний спосіб лікування.

Ключові слова: рясноваскуляризована пухлина, ендоваскулярна емболізація, мікрохірургічне видалення.

ЭНДОВАСКУЛЯРНАЯ ДЕВАСКУЛЯРИЗАЦИЯ ОБИЛЬНОВАСКУЛЯРИЗИРОВАННЫХ ОПУХОЛЕЙ В НЕЙРООНКОЛОГИИ

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Цель работы — изучить результаты эндоваскулярной деваскуляризации опухолей для разработки новых подходов к лечению обильноваскуляризированных образований в нейроонкологии.

Материалы и методы. В ГУ «Научно-практический Центр эндоваскулярной нейрорентгенохирургии НАМН Украины» в 2002–2011 гг. прооперированы 24 пациента с диагнозом «обильноваскуляризированная опухоль интракраниальной локализации». Изучены особенности кровоснабжения опухолей и оценен объем кровопотери при удалении опухолей после предварительной их деваскуляризации.

Результаты. Установлено, что опухоли кровоснабжались из бассейна наружной сонной артерии в 21 (87,5 %) случае, 66,7 % афферентных артерий составляла *a. maxillaris internalis*. Во время удаления опухоли после эмболизации средняя кровопотеря составила 230 мл.

Выводы. Эндоваскулярная эмболизация обильноваскуляризированных опухолей является безопасной и улучшает результаты микрохирургического удаления опухолей, значительно снижая объем интраоперационной кровопотери. В некоторых случаях это единственный метод лечения.

Ключевые слова: обильноваскуляризированная опухоль, эндоваскулярная эмболизация, микрохирургическое удаление.