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. Hecker 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.
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 tumor under fluoroscopy.

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 consultation when 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 %) tumors have 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-
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 1. Histological structure and vascularization of HVTs

<table>
<thead>
<tr>
<th>№</th>
<th>Sex</th>
<th>Age, years</th>
<th>Tumor</th>
<th>Afferent pool</th>
<th>Result of embolization</th>
<th>Afferent artery</th>
<th>Blood loss, ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>М</td>
<td>30</td>
<td>Meningioma</td>
<td>ICA</td>
<td>Subtotal</td>
<td>a. ophtalmicus, a. maxillaris int.</td>
<td>200</td>
</tr>
<tr>
<td>2</td>
<td>W</td>
<td>46</td>
<td>Meningioma</td>
<td>ECA</td>
<td>Subtotal</td>
<td>a.maxillaris int.</td>
<td>230</td>
</tr>
<tr>
<td>3</td>
<td>W</td>
<td>45</td>
<td>Meningioma</td>
<td>ECA</td>
<td>Total</td>
<td>a. maxillaris int.</td>
<td>240</td>
</tr>
<tr>
<td>4</td>
<td>М</td>
<td>53</td>
<td>Meningioma</td>
<td>ECA</td>
<td>Total</td>
<td>a. maxillaris int.</td>
<td>190</td>
</tr>
<tr>
<td>5</td>
<td>W</td>
<td>21</td>
<td>Meningioma</td>
<td>ICA</td>
<td>Total</td>
<td>a. ophtalmicus, a. maxillaris int.</td>
<td>230</td>
</tr>
<tr>
<td>6</td>
<td>W</td>
<td>48</td>
<td>Meningioma</td>
<td>ECA</td>
<td>Total</td>
<td>a. maxillaris int.</td>
<td>210</td>
</tr>
<tr>
<td>7</td>
<td>W</td>
<td>51</td>
<td>Meningioma</td>
<td>ECA</td>
<td>Subtotal</td>
<td>a. maxillaris int., a. temporalis superficialis</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>М</td>
<td>48</td>
<td>Meningioma</td>
<td>ECA + ICA</td>
<td>Total</td>
<td>a. ophtalmicus, a. maxillaris int.</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>М</td>
<td>38</td>
<td>Meningioma</td>
<td>ECA + ICA</td>
<td>Total</td>
<td>a. ophtalmicus, a. maxillaris int.</td>
<td>230</td>
</tr>
<tr>
<td>10</td>
<td>W</td>
<td>46</td>
<td>Meningioma</td>
<td>ECA + ICA</td>
<td>Total</td>
<td>a. ophtalmicus, a. maxillaris int.</td>
<td>250</td>
</tr>
<tr>
<td>11</td>
<td>W</td>
<td>44</td>
<td>Meningioma</td>
<td>ECA</td>
<td>Total</td>
<td>a. maxillaris int.</td>
<td>220</td>
</tr>
<tr>
<td>12</td>
<td>W</td>
<td>48</td>
<td>Meningioma</td>
<td>ECA</td>
<td>Total</td>
<td>a. occipitalis</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>М</td>
<td>43</td>
<td>Meningioma</td>
<td>ECA</td>
<td>Total</td>
<td>a. occipitalis</td>
<td>230</td>
</tr>
<tr>
<td>14</td>
<td>W</td>
<td>43</td>
<td>Meningioma</td>
<td>ECA</td>
<td>Total</td>
<td>a. maxillaris int., a. temporalis superficialis</td>
<td>90</td>
</tr>
<tr>
<td>15</td>
<td>W</td>
<td>48</td>
<td>Meningioma</td>
<td>ECA</td>
<td>Total</td>
<td>a. maxillaris int.</td>
<td>160</td>
</tr>
<tr>
<td>16</td>
<td>W</td>
<td>49</td>
<td>Meningioma</td>
<td>ECA, ECA</td>
<td>Total</td>
<td>a. maxillaris int. dexter et sinister, a. temporalis superficialis</td>
<td>210</td>
</tr>
<tr>
<td>17</td>
<td>М</td>
<td>54</td>
<td>Osteoma</td>
<td>ECA + ICA</td>
<td>Total</td>
<td>a. maxillaris int., a. ophtalmicus</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>W</td>
<td>48</td>
<td>Paragan-glioma</td>
<td>ECA</td>
<td>Total</td>
<td>a. auricularis post.</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>М</td>
<td>52</td>
<td>Hemangio-blastoma</td>
<td>VA + ECA</td>
<td>Total</td>
<td>a. vertebralis, a. occipitalis</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>W</td>
<td>50</td>
<td>Hemangioma</td>
<td>ECA, ECA</td>
<td>Total</td>
<td>a. temporalis super., a. auricularis post.</td>
<td>360</td>
</tr>
<tr>
<td>21</td>
<td>W</td>
<td>46</td>
<td>Hemangio-pericitoma</td>
<td>ECA</td>
<td>Total</td>
<td>a. occipitalis, a. auricularis post.</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>М</td>
<td>28</td>
<td>Hemangioma</td>
<td>ECA, ECA</td>
<td>Subtotal</td>
<td>a. auricularis post. dexter et sinister, a. occipitalis dexter et sinister, a. maxillaris int.</td>
<td>400</td>
</tr>
<tr>
<td>23</td>
<td>W</td>
<td>43</td>
<td>Schwanoma</td>
<td>ECA</td>
<td>Subtotal</td>
<td>a. auricularis post.</td>
<td>280</td>
</tr>
<tr>
<td>24</td>
<td>М</td>
<td>51</td>
<td>Hemangio-blastoma</td>
<td>ECA</td>
<td>Total</td>
<td>a. occipitalis, a. auricularis post.</td>
<td></td>
</tr>
</tbody>
</table>

Notes: ICA — internal carotid artery; ECA — external carotid artery; VA — vertebral artery.
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 lesions and malignant HVTs after preoperative embolization the blood loss averaged 230 ml.

Table 2. Arteries feeding HVTs

<table>
<thead>
<tr>
<th>Artery</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>maxillaris internalis</td>
<td>16</td>
<td>66.7</td>
</tr>
<tr>
<td>ophtalmicus</td>
<td>6</td>
<td>25.0</td>
</tr>
<tr>
<td>occipitalis</td>
<td>6</td>
<td>25.0</td>
</tr>
<tr>
<td>auricularis posterior</td>
<td>6</td>
<td>25.0</td>
</tr>
<tr>
<td>temporalis superficialis</td>
<td>5</td>
<td>20.8</td>
</tr>
<tr>
<td>vertebralis</td>
<td>1</td>
<td>4.2</td>
</tr>
</tbody>
</table>
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 were not 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 hystoacrylin jecction 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 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 loss reduction. 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.

References

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.


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 кровопотері дорівнював 230 мл.

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

Ключові слова: рясноваскулярная пухлина, ендоваскулярная эмболизация, мікрохірургічне видалення.

ЕНДОВАСКУЛЯРНА ДЕВАСКУЛЯРИЗАЦІЯ ОБИЛЬНОВАСКУЛЯРИЗОВАНИХ ОПУХОЛЕЙ В НЕЙРООНКОЛОГІЇ

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

Материалы и методы. В ГУ «Научно-практический Центр эндоваскулярной нейрорентгенокохирurgии НАМН Украины» в 2002–2011 гг. прооперировано 24 пациента с диагнозом «обильноваскуляризованная 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 % аферентных артерий составляла a. maxillaris internalis. Во время удаления опухоли после эмболизации средняя кровопотеря составила 230 мл.

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

Ключевые слова: обильноваскулярная опухоль, эндоваскулярная эмболизация, мікрохірургічне видалення.