RESULTS OF DIFFERENTIATED SURGICAL TREATMENT OF AGGRESSIVE VERTEBRAL HEMANGIOMAS

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Objective. To evaluate the outcomes of the differentiated surgical treatment in patients with aggressive vertebral hemangiomas.
Material and Methods. The study included 127 patients with aggressive vertebral hemangiomas operated on in 2013–2016. The tumor localization was cervical in 9.5% of cases, thoracic in 59.8 % and lumbar in 30.7 %. Patients were divided into two groups: Group I (n = 110) with type IIIA aggressive hemangiomas, and Group II (n = 17) with type IIIB aggressive hemangiomas. Preoperative assessment included clinical and neurological examination, VAS, ODI, JOA, Weinstein-Boriani-Biagini classification, and radiography; MSCT and MRI studies of the spine were performed before treatment and in 12 months after surgery.
Results. Patients in Group I underwent puncture vertebroplasty. Back pain was 6 VAS, after 12 months – 2 VAS. The average preoperative ODI score was 32 and decreased to 9 in 12 months after surgery. In Group II, patients underwent decompression and stabilization with intraoperative open vertebroplasty of the affected vertebra. Preoperative embolization of tumor vessels was performed in two of 17 patients to reduce intraoperative blood loss. Preoperative back pain was 6 VAS, in 12 months after surgery – 2 VAS. The ODI score showed the improvement in all patients as compared to preoperative values.
Conclusion. Puncture vertebroplasty ensures the achievement of good functional result in 95.4 % of cases of type IIIA aggressive hemangioma. Decompression and stabilization surgery with intraoperative open vertebroplasty provides good functional result in 93.4 % of cases of type IIIB aggressive hemangioma. The use of vertebroplasty in type IIIB aggressive hemangiomas allows for vertebral segment stabilization with a low risk of the tumor recurrence.
Key Words: aggressive vertebral hemangioma, myelopathy, vertebroplasty, embolization.

Please cite this paper as: *Klimov VS, Kosimshoev MA, Evsyukov AV, Kiselev VS, Voronina EI. Results of differentiated surgical treatment of aggressive vertebral hemangiomas. Hir. Pozvonoc. 2018;15(1):79–90. In Russian.*
DOI: http://dx.doi.org/10.14531/ss2018.1.79-90.

Spinal hemangioma is a vascular lesion of dysembryogenetic origin mainly found in the vertebral bodies. Hemangiomas are characterized by abundant vascularization, atrophy of the surrounding bone and remain asymptomatic for long periods [2, 4, 6, 10, 14, 24]. Hemangiomas are mostly encountered in the middle-aged women. In 30 % of cases, hemangioma affects several levels of the spine [5]. Vertebral hemangiomas are practically not detected in children in the first ten years of life, and the largest number of cases is revealed at the age of 30 to 60 years.Hemangiomas occur in all parts of the spine but the thoracic is the most frequent location [6, 17, 18]. Clinical symptoms include local pain that coincides with the level of hemangioma location in 54–94 % [4, 7, 36]. However, 0.9–4.0 % of hemangiomas can manifest as a vascular tumor that causes spinal cord injury [6, 16, 40]. Clinically, spinal cord compression occurs as slowly progressive myelopathy [7]. Spinal cord can be compressed by the epidural component of a highly vascularized tumor, epidural hematoma. Furthermore, hemangioma can affect the posterior supporting column of the spine, extends into the spinal canal and causes spinal cord compression. Compression of the anterior radiculomedullary artery by tumor causes circulatory disturbances of the spinal cord resulting in myelopathy [31, 32]. Expansive growth of the tumor with resorption of the adjacent bone and formation of an extra-vertebral soft tissue component in the anterolateral direction or into the vertebral canal associated with a risk of spinal cord compression, compressive fracture and vertebral body collapse have been observed [5, 6, 20, 35, 42]. Spinal hemangiomas with an intracanal component occur rarely in the lumbar spine. Lumbar vertebral hemangioma can cause cauda equina syndrome [14].

In 1986, Laredo et al. [33] proposed a definition for aggressive hemangiomas and regarded a hemangioma as aggressive when three or more of the seven radiographic signs are present:

1) location at T3–T9 vertebral level;

2) involvement of the entire vertebral body;
3) tumor extension to vertebral arch pedicle;
4) bone expansion with bulging of cortical layer with indistinct margins;
5) an irregular trabeculae pattern of hemangioma;
6) presence of an epidural or paravertebral mass of the tumor;
7) low T1-weighted signal and high T2-weighted signal on MRI, contrast agent enhancement on CT.

In 1989, Nguyen et al. [38] identified 5 topographic types: I – hemangioma affects the entire vertebra and can have paravertebral and intracanal extension; II – the lesion is limited to a vertebral body; III – isolated lesions of the posterior semi-ring; IV –involvement of a vertebral body with a partial involvement of the posterior semi-ring; V –only epidural location of the tumor.

In 2010, M.N. Kravtsov et al. [6] developed a scale of scores based on published data and own clinical observations for assessing the aggressiveness of vertebral hemangiomas (Table 1). According to this scale, hemangiomas were classified as follows: type I – small hemangiomas; II – non-aggressive; III– aggressive. The latter type is classified into IIIA and IIIB (Table 2). Type III aggressive hemangiomas have a score of more than 5 by clinical and radiographic signs. This classification is convenient for choosing the tactics of treatment and indications for surgery.

Currently, percutaneous vertebroplasty is the most common treatment method for aggressive hemangiomas [1, 10, 22, 26]. When the spinal cord is compressed by soft tissue component of the tumor, vertebroplasty is performed in conjunction with removal of the extravertebral tumor component for spinal cord decompression [28]. Decompression and stabilization surgery is indicated for vertebral hemangiomas only when clinical symptoms of spinal cord compression are present [31]. The symptoms of the disease generally do not differ from other types of spinal tumors [35, 39]. It can be said that spinal hemangioma is a hormone-dependent tumor. According to modern concepts, during pregnancy venous outflow decreases and the effects of estrogens on vascular endothelium stimulate growth of hemangiomas [21, 32]. Pregnancy is a risk factor: normal blood flow is disturbed, venous pressure increases by 30–50 % due to pressure of the uterus on the vena cava in the third trimester. Venous obstruction and increased intra-abdominal pressure stimulate the development of asymptomatic hemangioma [21]. Back pain, radiculopathy, and compression of the spinal cord become symptomatic during pregnancy (most often in the third trimester) [32]. The course of the disease is influenced by many factors: location of spinal cord compression, period of pregnancy, rate of neurologic deficit development [32]. According to the literature data [24], hemangiomas do not become malignant but a single case of angiosarcoma developed from hemangioma after irradiation was reported.

The aim of the study was to analyze the results of differentiated surgical treatment of patients with aggressive vertebral hemangiomas.

Material and Methods

The study included 127 (33 men, 94 women) patients with aggressive spinal hemangiomas operated on at the Spinal Department of the Federal Center of Neurosurgery (Novosibirsk) in 2013–2016. The mean age was 54.3/57.0 (45; 64) years and ranged from 17 to 77 years. Hemangiomas were most frequently detected at the thoracic (59.8 %) and lumbar (30.7 %) spine. In 9.5 % of cases, the location was cervical. In 29 cases (22.8 %), hemangiomas occupied several levels.

The essential diagnostic protocol of preoperative examinations included anamnesis and clinical and neurological examination. The intensity of vertebral pain syndrome was assessed using VAS. Grade of functional adaptation was evaluated using the Oswestry questionnaire. Myelopathies were assessed using a scale of the Japanese Orthopedic Association – JOA [15, 25] with estimation of recovery rate by the Hirabajashi method using a formula: postoperative score –preoperative score/17 x 100 %. An 11-point scale is used for thoracic myelopathy to obtain more significant results [27]. The result

Table 1

Scored system for assessment of aggressiveness of vertebral hemangiomas [6]

Signs of aggressiveness	Score
Presence of extravertebral component of hemangioma	5
Compressive fracture or compressive deformation of the vertebral body due to hemangioma	5
Bone expansion with bulging cortex (swollen vertebra)	4
Hemangioma affecting more than 2/3 (6 %) volume of a vertebra	3
Injury (thinning and/or destruction) of the corical layer	3
Irregular trabeculae structure of hemangioma	2
Extension of hemangioma from vertebral body to vertebral arch	2
Absence of adipose tissue within hemangioma (low T1- and high T2-weighted image signal in the mode of fat signal suppression)	2
Local pain syndrome and other neurological signs (paresis, projection pain, sensitive disorders)	1

Table 2

Clinical classification of vertebral hemangiomas

Types of vertebral hemangiomas		Characterization of vertebral hemangioma
I. Small hemangiomas		Hemangiomas located in vertebral body affecting less than 1/3 volume of the body: total score <3
II. Non-aggressive hemangiomas		Total score <5
III. Aggressive hemangiomas	IIIA type	Total score >5 (without signs of neural structure compression)
	IIIB type	Total score >5 (with extra-vertebral extension, signs of compression of neural structures)

was excellent with 75 to 100 %, good – with 50 to 74 %, satisfactory – with 25 to 49 %, unchanged – with 0 to 24 %, and bad – with less than 0 %. Operative time, volume of blood loss and length of hospital stay were evaluated.

The treatment outcomes were analyzed in two groups of patients identified by the dominant clinical and neurological syndrome: I (n = 110) – aggressive IIIA type hemangiomas (without extra-vertebral extension), II (n = 17) – aggressive IIIB type hemangiomas (with extra-vertebral spread and clinical symptoms of myelopathy).

In the group I, preoperative radiography, CT, MRI of the affected spine were performed. Radiography and CT were conducted in the early postoperative period. In group II, radiography, CT, MRI of the affected spine were performed before surgery, in the early postoperative period and in 12 months. Selective angiography was performed in three patients before surgery because of a significant extra-vertebral tumor spread. Follow-up ranged from 12 to 48 months.

Tumor location, tumor spread in the vertebral tissues, and extension to paravertebral areas and inside the canal were assessed using the Weinstein–Boriani–Biagini (WBB) classification [19]. In 9 out of 17 cases, the soft tissue component of hemangioma was located in the anterior vertebral portion (4–9 according to the WBB classification), group A; in 5 – in the anterolateral portion (3–5; 8–10), group B; in 3 – in the posterolateral portion (1–3; 10–12), group C.

Pathomorphology of surgical material was analyzed. The tumor tissue was fixated in 10 % buffered formalin for 24 h, and tumor fragments 3–5 mm thick were cut. The specimen was processed in a standard histoprocessor. Sections of about 5 μm in thickness were made from paraffin-embedded specimens using a rotational microtome and then were stained with hematoxylin and eosin.

Numerical data are presented as the mean/median (lower; upper quartiles). Two independent samples were compared using two-sided Mann–Whitney test, dependent samples were compared using two-sided Wilcoxon test. Multiple comparisons were performed using the Holm correction (p_{corr}).

The results were illustrated by diagrams showing the median, interquartile range, the highest/lowest sample value within a distance of 1.5 interquartile range, and outlying cases.

The calculations were performed using software R version 3.3.1 [R: A language and environment for statistical computing. R Foundation

for Statistical Computing, Vienna, Austria.URL: https://www.R-project.org/; date accessed: 23.12.2016.

Results

In group I, vertebral pain was the dominant clinical and neurological syndrome. Percutaneous vertebroplasty of the affected vertebra with bone cement (polymethyl methacrylate) was performed in 62 (56.3 %) patients in the thoracic spine, in 37 (33.7 %) –in the lumbar spine, in 11 (10.0 %) –in the cervical spine, in 29 (22.8 %) – at several levels.

Preoperative VAS score of the intensity of vertebral pain was 6.7/7.0 (6.0; 7.8) s (Fig. 1a). In 3 months, approximately 2.6/2.0 (2; 3); in 6 months 2.1/2.0 (1; 3) scores, in 12 months 2.1/2.0 (1; 3. Pain syndrome after vertebroplasty remained in 5 (4.7 %) patients.

Functional adaptation after surgery according to Oswestry improved in all patients as compared to preoperative scores (Fig. 2a): in 3 months, average Oswestry score decreased from 32.8/34.5 (28; 37) to 18.2/19.0 (15; 20), in 6 months to 14.8/15.(12; 16), and in 12 months to 9.8/10.0 (8; 12). Average length of hospital stay was 3/3 (3; 3) days (2 to 7 days); blood loss was 6/5 (5;5) ml and varied from 5 to 30 ml. The operative time was 30.5/25.0 (20; 35), ranging from 10 to 150 min.

Complications associated with administration of bone cement according to postoperative CT were revealed in 23 patients: cement extrusion to the epidural space – in 9, to the intervertebral space veins – in 7, and extra-vertebral extrusion – in 6.

Cement extrusion into the spinal canal with spinal cord compression and development of neurological symptoms in form of left-sided hemiparesis up to grade 3 was noted in 1 patient. This patient underwent urgent hemilaminectomy at the left side of C2 vertebra, spinal cord decompression, and removal of bone cement. In 12 months, neurological deficit completely regressed.

Revision surgery was not required to other patients, since cement extrusion was asymptomatic. There were no infectious complications and allergic reactions.

Spinal cord compression was the dominant syndrome in group II. The patients underwent decompression and

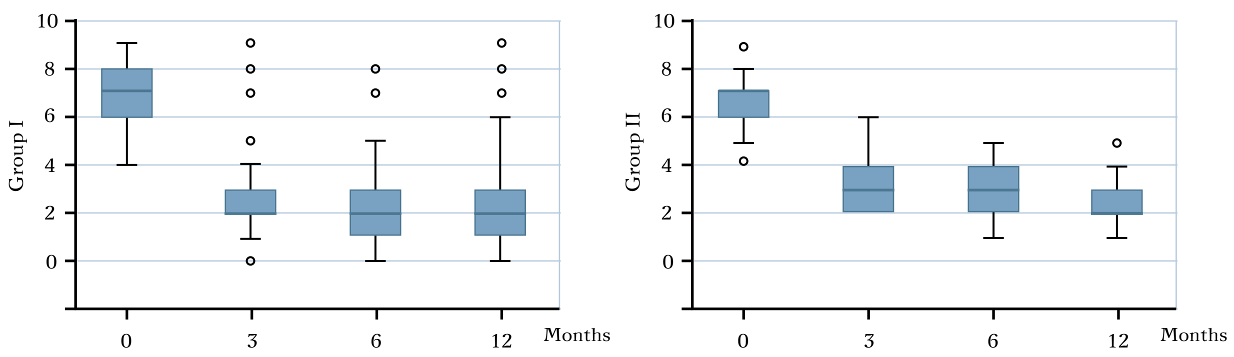

Fig. 1
Dynamics of VAS scores in study groups of patients

stabilization surgery with intraoperative open vertebroplasty of the affected vertebra: in 14 (82.4 %) patients – in the thoracic spine, in 2 (11.8 %) – in the lumbar spine, in 1 (5.8 %) – in the cervical spine.

Selective angiography was performed as the first surgical stage in three patients with a large soft tissue extra-vertebral component and a high risk of large blood loss; selective angiography showed that two patients had a highly vascularized tumor: early arteriovenous shunting, 2 or more of afferent tumor vessels (III grade on Nair et al. [37]). Intraoperative blood loss was reduced by transarterial embolization of tumor vessels through a transfemoral approach. Surgery was performed under general anesthesia. The primary embolization agent was liquid adhesive glue – cyanoacrylate (n-BCA). After embolization of the tumor blood vessels, neurological disorders were not observed. As recommended by Nair et al. [37], surgical intervention was performed on the first day after transarterial embolization of tumor vessels.

Preoperative VAS score of the intensity of vertebral pain was 6.5/7.0 (6; 7) (Fig. 1b), in 3 months – 3.2/3.0 (2; 4), in 6 months – 2.9/3.0 (2; 4), in 12 months – 2.4/2.0 (2; 3).

Functional adaptation after surgery according to Oswestry questionnaire improved in all patients compared to preoperative values (Fig. 2b). In 3 months, average ODI score decreased from 37.4/38.0 (37; 40) to 24.0/21.0 (20; 24), in 6 months to 19.5/18.0 (16; 20), in 12 months to 16.5/15.0 (12; 20).

The dynamics of neurological disorders is presented in Table 3. The data are described as the mean/median; minimum and maximum values are given in square brackets. Preoperative score in group A was lower than in other groups. The dynamics for all cases is positive and in 12 months tends to JOA score of 10–11. However, a small size of the available sample does not allow making statistically significant conclusions. The dependence of neurological disorders (JOA scale) on tumor location according to the WBB classification was not revealed after surgery.

According to the JOA scale, average score of neurological status in the preoperative period was 7.2/7.0 (5; 9). Postoperatively, it improved to 10.0/10.0 (9; 11). By the recovery rate, the patients were distributed as follows: 12 (70.5 %) –excellent results, 4 (23.6 %) –good, and 1 (5.9 %) – satisfactory (Fig. 3).

Surgery lasted approximately 225.3/245.0 (180; 260) min, ranging from 65 to 320 min, average intraoperative blood loss was 960/700 (400; 1500) ml, range from 50 to 2100 ml. Blood transfusion was required for 7 patients, 4 of them – autohemotransfusion. Average length of hospital stay was 16.2/14.0 (10.8; 20.0) days, ranging from 5 to 41 days.

Complications were noted in two patients in group II. One patient developed CSF leakage after surgery, lumbar drainage was installed and bed rest was recommended. CT revealed medial malposition of the screw in T5 vertebra on the left side, grade II, type C according to Abul-Kasim et al. [13]. MRI revealed fluid accumulation in the area of intervention. Conservative treatment was not effective. On 10th day, revision surgery was performed. No signs of injury to the dura mater in the area of resected tumor were found during surgery. CSF leakage was caused by injury to the dura mater with the screw that passed intracanally. A transpedicular screw was inserted into T5 vertebral body on the left side along a new trajectory under control of O-arm. Control MRI detected no fluid accumulation in the surgical area; lumbar drainage was removed on the 7th day after surgery. The patient was discharged on day 17. Deep infection in the surgical area and abscess were revealed in one patient in 3 months after surgery. Revision, debridement, excision of necrotic tissues, and insertion of drainage were conducted.

VAS scores did not differ between groups I and II. Scores of all question-

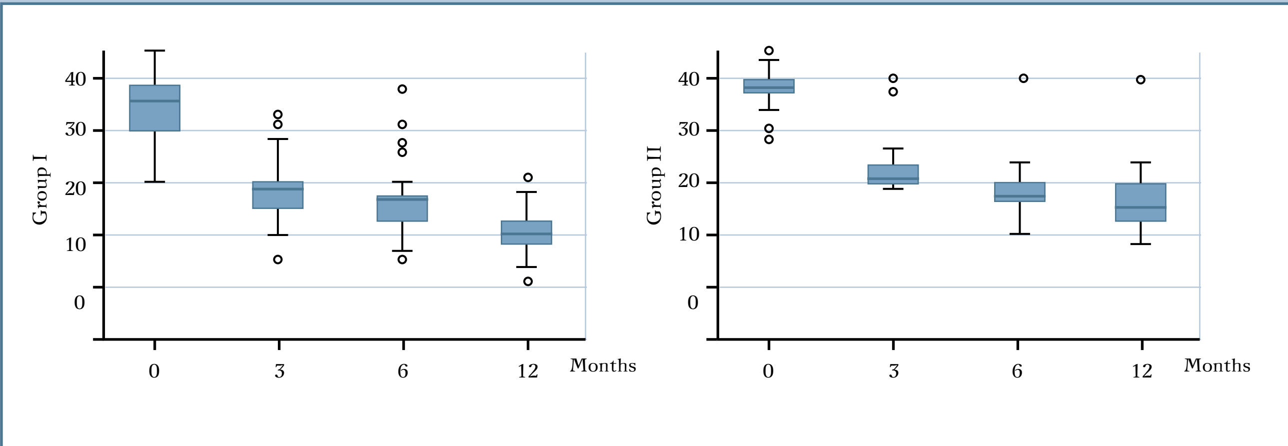

Fig. 2
Dynamics of Oswestry scores in study groups of patients

naires before and after surgery (after 3 months) in each group were significant, $p_{corr} < 0.01$. Differences in Oswestry score were observed before and after surgery and in a year ($p_{corr} < 0.01$). It is noted that during a year after surgery, the indicators improved in both groups ($p_{corr} < 0.05$). However, postoperative recovery was longer in patients of group II.

Case report. Patient A., 55 years old, was admitted on February 26, 2015 with complaints of pain at the thoracic spine (VAS score 7), numbness in the legs. Conservative treatment over 4 months did not lead to noticeable relief. Local pain was revealed in the interscapular region by palpation; neurological status –impaired sensitivity after T8 segment. JOA score – 7. ODI score of functional adaptation is 45.

Contrast-enhanced MRI of the thoracic spine revealed a space-occupying lesion at the level of T7–T8 vertebrae that intensively accumulates contrast agent. Size of the lesion: intracanal – 13 x 11 x 22 mm, extravertebral – 36 x 24 x 26 mm (Fig. 4). CT of the thoracic spine revealed destructive changes in the T7 vertebral body and T7 left pedicle. The lesion was classified according to M.N. Kravstov et al. [6] as aggressive type IIIB hemangioma of the T7 vertebra.

Selective angiography was performed taking into account the presence of the soft tissue extravertebral tumor component, size of tumor, destructive changes of the vertebral body and left pedicle of the T7 vertebra, extent of the planned surgical intervention, and risk of large blood loss. A highly vascularized tumor with arteriovenous shunting and three afferent vessels was revealed. Thus, on February 28, 2015, endovascular embolization of tumor arteries at T7–T8 of vertebral level was performed (Fig. 5).

On February 29, 2015, a space-occupying tumor at T7–T8 vertebral level was removed. After hemilaminectomy at T7–T8 and left-sided costotransversectomy, we detected a space-occupying neoplasm in epidural space that was dark gray, dense in consistency, caused ventral and dorsal compression of the spinal cord, extended to the thoracic cavity and displaced the parietal pleura. Supply and drainage vessels of the lesion were coagulated, the tumor was reduced in size and resected en block (Fig. 6a). Five ml of bone cement was loaded into T7 vertebral body, transpedicular fixation was performed. Intraoperative blood loss was 600 ml. Surgery lasted 4 h 20 min.

Microscopically, the lesion represents accumulation of a large number of different-size capillary vessels, most

Table 3
Dynamics of neurological disorders, direction of spinal cord compression is indicated

Location of spinal cord compression	Patients, n	Preoperative	In 3 months	In 6 months	In 12 months
A	10	6.2/6.0 [3; 9]	9.8/10.0 [7; 11]	9.8/10.0 [7; 11]	9.8/10.0 [7; 11]
Б	4	7.8/8.0 [5; 10]	9.8/10.0 [8; 11]	9.8/10.0 [8; 11]	10.2/10.0 [9; 11]
B	3	9.0/10.0 [7; 10]	10.3/11.0 [9; 11]	10.3/11.0 [9; 11]	10.3/11.0 [9; 11]

A – anterior portion of a vertebra (4–9 on WBB classification); B – anterolateral portion (3–5; 8–10); C – posterolateral portion (1–3;10–12).

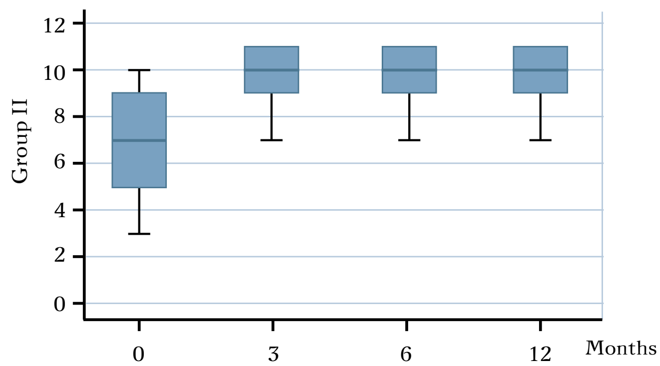

Fig. 3
Dynamics of JOA scores in group II

of which have thin walls and expanded lumen (Fig. 6b). The morphology of this lesion corresponds to capillary hemangioma [23].

Postoperative period was without complications, severe back pain – VAS score 4. Control MRI of the thoracic spine in the early postoperative period did not detect a space-occupying lesion (Fig. 7a, b, c). CT of the thoracic spine visualized bone cement in the T7 vertebral body (Fig. 7d). Length of hospital stay was 11 days. In 3 months, the score of intensity of vertebrogenic pain syndrome was 4. In 6-12 months, pain reduced to the score of 2. Grade of functional adaptation after surgery according to Oswestry improved versus preoperative value. In 3 months, average score reduced from 45 to 30, in 6-12 months – to 12. There was a positive dynamics in neurologic status the JOA scale score was 11 in 3, 6, 12 months. By recovery rate, the outcome was estimated as excellent. MRI, CT of the thoracic spine revealed no tumor recurrence in 12 months.

Discussion

Percutaneous vertebroplasty is a safe and effective minimally invasive treatment for aggressive type IIIA hemangiomas of [1, 3, 9, 36]. The main goals of vertebroplasty are to restore the supporting ability of the affected vertebra and achieve analgesic and antitumor effects [5, 6].

In group I, all patients underwent only percutaneous vertebroplasty of the affected vertebra. In our series, pain syndrome regressed in 105 (95.4 %) patients with aggressive type IIIA vertebral hemangiomas.

No recurrence or pathological fractures after vertebroplasty were detected during follow-up. In 2007, V.E. Parfyonov et al. [9] analyzed the results of surgical treatment of aggressive type IIIA hemangiomas in 50 patients. All patients underwent only percutaneous vertebroplasty of the affected vertebra. Pain syndrome regression was noted in 43 (86 %) cases. In 2015, V.V. Zaretskov et al. [3] evaluated treatment outcomes for 88 patients with aggressive hemangiomas IIIA type, who underwent percutaneous vertebroplasty only. Regression of pain syndrome was achieved in 74 (84.5 %) patients.

According to the literature [6, 8, 11], complications of percutaneous vertebroplasty occur in 0.5–25.0 % of cases, with clinical symptoms occurring up to 2.6 %. In our patients, complications associated with insertion of bone cement were revealed on CT after surgery in 23 (20.9 %) cases. In 1 (0.9 %) patient, cement extrusion into the spinal canal caused spinal cord compression.

Open surgery for spinal hemangiomas in most cases is accompanied by extensive blood loss [24]. In 2013, Nair et al. [37] conducted a retrospective analysis of 228 angiograms of patients with spinal tumors and identified 4 degrees of tumor blood supply: blood supply is the same in all vertebrae – grade 0 (Fig. 8a); a darker area of the affected vertebra compared to the normal vertebral body is detected – grade I (Fig. 8b); segmental artery with significantly darker area of the tumor without arteriovenous shunting – grade II (Fig. 8c); dark tumor staining and early arteriovenous shunting – grade III (Fig. 8d). Some authors suggest using preoperative embolization as the first stage of surgical treatment to reduce blood loss [29, 37]. However, currently, there are no clearly defined indications and contraindications to preoperative embolization of tumor vessels in aggressive hemangiomas (type IIIB). Some authors [17, 29, 31, 37] conduct embolization in case of spinal cord compression by soft tissue component of the tumor, when a large intraoperative blood loss is predicted, and the lesion affects several spinal levels. Preoperative embolization should be used reasonably, based on general condition of the patient, neurological status, volume of spinal lesions on MRI, CT and angiography [32, 39].

E.I. Slin'ko [12] reports blood loss from 600 to 3900 ml (average 1800 ml) with partial tumor resection. In the early postoperative period, the mortality rate was 18 %. Ogawa et al. [39] published clinical case of a patient with thoracic myelopathy and lower paraparesis who underwent total spondylectomy at T8, T9 vertebrae. Preoperative embolization of tumor vessels was performed, intraoperative blood loss was 2232 ml. After surgery, neurological symptoms were relieved for 2.5 years. Kato et al. [31] reported five cases of aggressive hemangiomas treated with preoperative embolization of tumor vessels and total resection of vertebrae. The average intraoperative blood loss was 2424 ml. Patients did not undergo radiation therapy after surgery. During the follow-up period (135.2 months), there was no tumor recurrence.

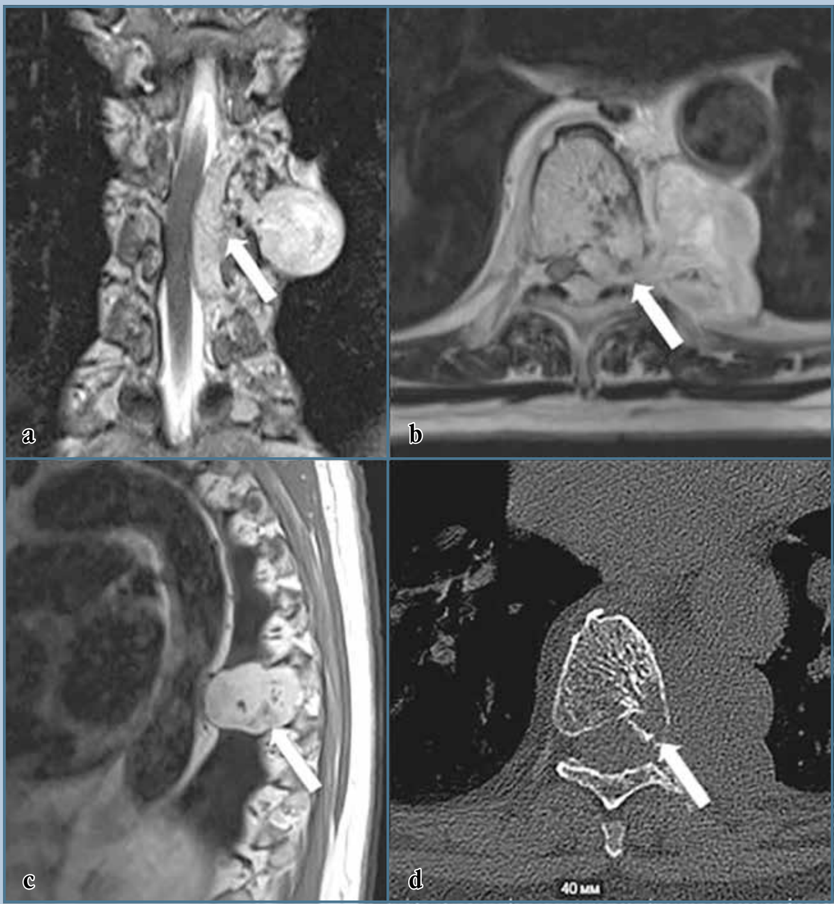

Fig. 4
MRI of the thoracic spine (T2-weighted image), patient A. aged 55 years, a space-occupying lesion is detected at T7–T8 vertebral level, which grows inside the canal, at the level of intervertebral foramen and extra-vertebral extension into the thoracic cavity **(a, c)**; intense contrast agent enhancement **(b)**; CT of the thoracic spine shows destructive changes in the left half of the T7 vertebral body, with spread to the left vertebral arch pedicle, articular and transverse processes, with thinning of the cortical layer, swelling, narrowing of the spinal canal **(d)**

Our patients had intraoperative blood loss of approximately 1200 ml. In two patients, a preoperative embolization of tumor vessels was performed resulting in blood loss of 600; 800 ml. Thus, the use of preoperative embolization reduces intraoperative blood loss.

In our series of clinical cases, factors of spinal cord compression were eliminated in all patients without vertebral body removal. Decompression and stabilization surgery with intraoperative open vertebroplasty of the affected vertebra is a safe and effective treatment for aggressive vertebral type IIIB hemangioma. In 2016, Vasudeva et al. [41] published data on surgical treatment of aggressive type IIIB hemangiomas. Neurological symptoms regressed in 80 % of cases after surgery. In 94.1 % of our patients, neurological status improved after spinal cord decompression. In one patient, aggravation of neurological deficit in form of lower paraparesis (3 points) was observed after surgery. In 12 months, upon conservative treatment, neurological deficit completely regressed.

Some researchers [24, 30, 40] recommend decompression of the spinal cord in conjunction with radiotherapy after surgery. Jiang et al. [30] analyzed the results of surgical treatment of 29 patients with aggressive spinal hemangiomas. In 12 cases, spinal cord decompression was performed without vertebroplasty of the affected vertebra; average blood loss was 1900 ml. In 8 cases, decompression was combined with vertebroplasty of the affected vertebra; average blood loss was 1039 ml. When combined with radiotherapy, no recurrences were observed, except for 6 cases of local relapses after decompression alone [30]. Our patients were not treated with radiotherapy after surgery. According to MRI and CT of the spine, no tumor recurrence occurred during follow-up from 12 to 48 months.

In group II, complications were observed in 11.7 % of cases: 1 patient – medial screw malposition; 1 – deep infection of the surgical area and abscess in the long-term postoperative period. Luksanapruksa et al. [34] noted that the incidence of complications in spinal surgery increased from 5.3 to 76.2 %. The reoperation rate is 10.7 %. This is due to risk factors, which include the elderly age, multilevel spinal metastases, preoperative radiation and concomitant diseases.

Conclusions

1. In 95.4% of cases, percutaneous vertebroplasty provides a good functional result in aggressive hemangiomas of IIIA type.
2. Decompression and stabilization surgery with intraoperative open vertebroplasty provides a good functional outcome in aggressive type IIIB hemangiomas in 94.1% of patients, and 11.7% of these patients needed preoperative embolization of tumor vessels to reduce blood loss.
3. The use of vertebroplasty in aggressive type IIIB hemangiomas allows achieving stabilization of the spinal segment at a low risk of tumor recurrence.

The study was not sponsored. The authors declare no conflict of interest.

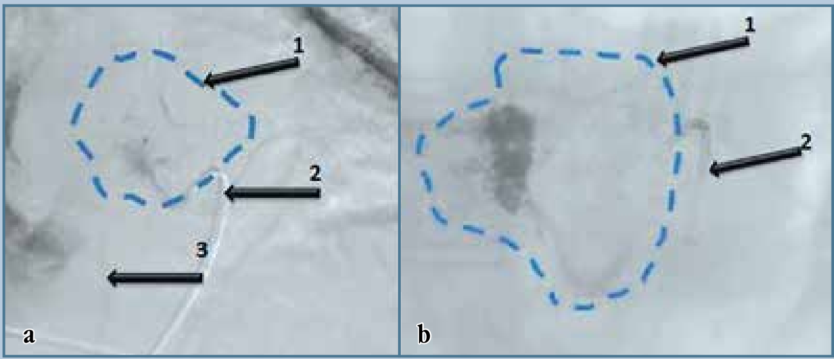

Fig. 5
Selective angiography of patient A., 55 years old: **a** – prior to embolization of tumor vessels: vascular network of the tumor (*1*), catheter (*2*), venous outflow (*3*); **b** – after embolization of tumor vessels: embolizate in tumor stroma (*1*), catheter (*2*)

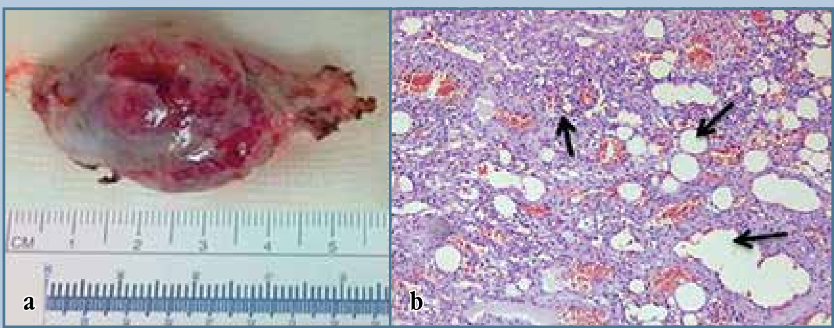

Fig. 6
A lesion of dense elastic texture is detected macroscopically on the spine of a patient A., 55 years, 4 x 3 cm in size,gray-brown color **(a)**; microscopy of resected lesion **(b)**: hematoxylin and eosin stain x 100, arrowheads point to capillaries of different sizes

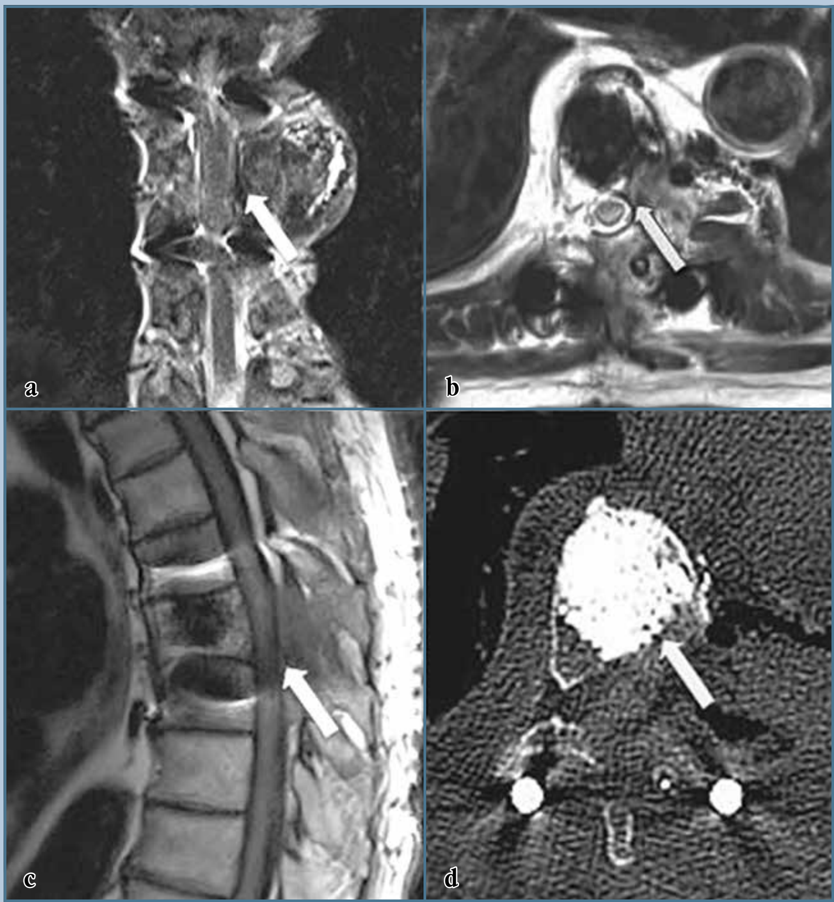

Fig. 7
MRI and CT of the thoracic spine, patient A., 55 years: **a** – coronal view (T2-weighted image); **b** – axial view (T2-weighted image); **c** – sagittal view (T1-weighted image); **d** – postoperative control

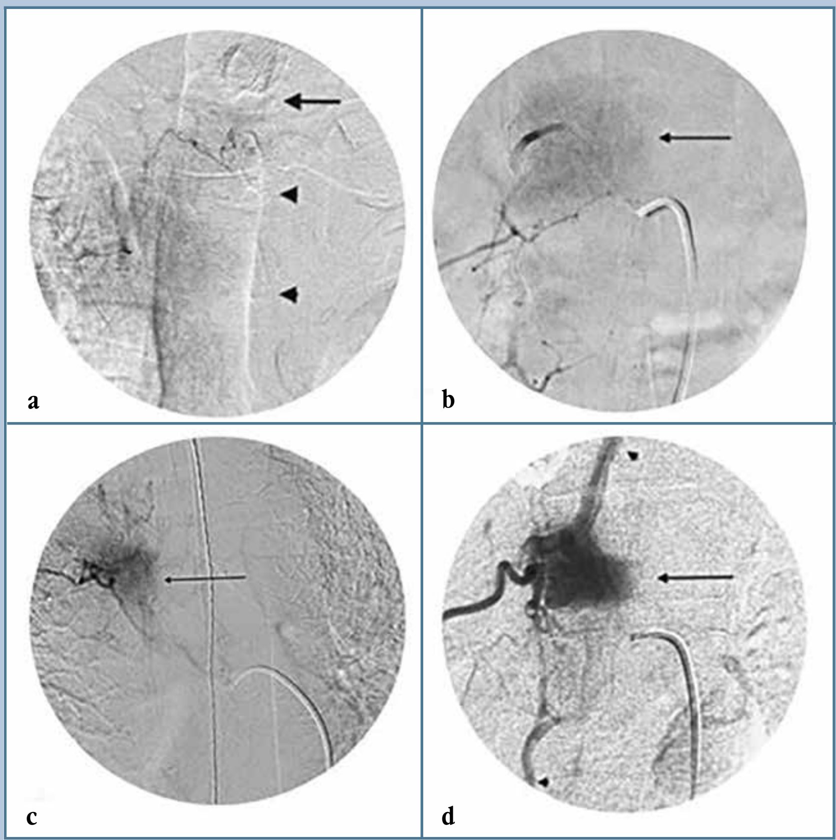

Fig. 8
Angiograms of patient A. aged 55 years: **a** – blood supply is similar in vertebrae T2,T3, T4; **b** – a darker region of T12 compared to normal vertebral body; **c** – segmental artery at T5 with a significantly more darker region of tumor without arteriovenous shunting; **d** – dark staining of the tumor and early arteriovenous shunting

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Received 22.06.2017
Review completed 03.08.2017
Passed for printing 10.08.2017

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