THE RESULTS OF SURGICAL TREATMENT OF SACRAL SCHWANNOMAS WITH EXTENSION INTO PELVIC CAVITY

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ABSTRACT

The aim. *To analyze the results of surgical treatment of sacral schwannomas with their extension into lower pelvis.*

Materials and methods. *We analyzed the clinical results of surgical treatment of 25 patients with sacral schwannomas, including those with ventral extension and growth into pelvic cavity. All patients were operated at the Clinic of Neurosurgery of the Novosibirsk Research Institute of Traumatology and Orthopedics named after Ya.L. Tsivyan for a 10-year period. The analysis of literature describing prevalence, classification, diagnosis and surgical treatment of sacral tumors and schwannomas in particular was carried out. The features of the course, diagnosis and surgical treatment of sacral schwannomas and accepted surgical methods for their treatment are described.*

Results. *The average follow-up period of the patients in our study was 61.6 ± 2 months. Compared with the initial indicators of patients in the postoperative period (1 year after the surgery), a good clinical result with the regression of symptoms was registered in 17 (68 %) out of 25 patients, and 10 (40 %) of them had a significant regression of neurological disorders. 3 (12 %) operated patients had a deterioration of neurological disorders in the form of aggravation of sensitive disorders; one patient had an aggravation of pelvic organ dysfunction. Radical removal of the tumor was achieved in 24 (96 %) out of 25 cases; subtotal resection was performed in 1 (4 %) patient. The number of relapses and continued growth of tumors in our series was 12 % (3 out of 25 patients). The mortality rate was 0 %. The complications were registered in 3 (12 %) cases and manifested as wound liquorrhea in cases of using posterior approach.*

Conclusion. *The degree of radicality of tumor resection and clinical outcomes is directly related to the selected surgical approach.*

Key words: *sacral schwannomas, retroperitoneal space neurinoma, tumors of the retroperitoneal space of the pelvis and the anterior wall of the sacrum*

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РЕЗУЛЬТАТЫ ХИРУРГИЧЕСКОГО ЛЕЧЕНИЯ ШВАННОМ КРЕСТЦА С РАСПРОСТРАНЕНИЕМ В ПОЛОСТЬ МАЛОГО ТАЗА

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РЕЗЮМЕ

Цель исследования. *Анализ результатов хирургического лечения шванном крестца с распространением в малый таз.*

Материалы и методы. *Проведён анализ клинических результатов хирургического лечения 25 пациентов с шванномами крестцовой локализации, в том числе с вентральным распространением и ростом в полость малого таза, оперированных в клинике нейрохирургии Новосибирского НИИТО им. Я.Л. Цивьяна Минздрава России за 10 лет. Проведён анализ литературных данных, описывающих распространённость, классификации, диагностику и хирургическое лечение опухолей крестца и шванном в частности. Описаны особенности течения, диагностики и хирургического лечения опухолей данной локализации, принятые хирургические подходы.*

Результаты. *Период наблюдения за пациентами в нашем исследовании составил в среднем 61,6 ± 2 мес. По сравнению с исходными показателями больных в послеоперационном периоде (на сроке 1 год) хороший клинический результат с регрессом симптоматики отмечен у 17 (68 %) из 25 пациентов, причём у 10 (40 %) из них имелся значительный регресс неврологических нарушений. У 3 (12 %) оперированных отмечено усугубление неврологических нарушений в виде усугубления чувствительных нарушений, у одного пациента отмечено усугубление нарушений функции тазовых органов. Радикальное удаление новообразования достигнуто в 24 (96 %) из 25 случаев; субтотальная резекция проведена у 1 (4 %) пациента. Число рецидивов и продолженного роста новообразований составило в нашей серии 12 % (3 из 25 пациентов). Летальность составила 0 %. Осложнения, встречаемые в нашей группе, были отмечены в 3 (12 %) случаях и проявлялись в виде раневой ликвореи в случаях задних доступов.*

Заключение. *Степень радикальности резекции опухоли и клинических исходов напрямую связана с выбранным операционным доступом.*

Ключевые слова: *шванномы крестца, невринома забрюшинного пространства, опухоли забрюшинного пространства малого таза и передней стенки крестца*

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INTRODUCTION

Primary spinal cord tumors account for 5 % to 10 % of all spinal neoplasms in adults and 4.5 % of all central nervous system (CNS) tumors [1, 2]. Their incidence is 1.3 cases per 100,000 populations per year [2]. Extramedullary neoplasms occur in 70-80 % of all primary spinal cord tumors and in 53–68.5 % of all spinal cord neoplasms [2–4]. The most common histologic variants of extramedullary tumors are meningiomas (24.4 %), ependymomas (23.7 %), and neurinomas (21.2 %) [5–7]. Tumors of the sacrum account for 1–7 % among spinal tumors [1, 2, 4, 8]. Schwannomas account for about 25–29 % of all primary spinal tumors [8]. Retroperitoneal localization of schwannomas is quite rare and accounts for approximately 1 to 5 % of all retroperitoneal localization masses [1, 2, 4–6, 9]. Investigating the problem of sacral tumor treatment, especially in the case of ventral extension and their retroperitoneal localization, it should be noted the late detection of this pathology and sometimes asymptomatic course [2, 6, 10, 11]. There are many factors contributing to this, mainly the presence of sufficient reserve spaces in this area, atypical symptomatology indicated by patients, and difficulties in interpreting diagnostic results [11].

It is believed that the earliest symptom is local pain in the sacral region, and later, with the progression of tumor growth, radicular symptoms appear, and, as a consequence, sciatic manifestations, pelvic disorders, and radicular pain syndrome appear [4, 12, 13].

Currently, there is no single universally accepted classification of sacral tumors due to their great diversity and genetic origin. The two most common classifications described in the current literature are Enneking classification, based on tumor grade, and Weinstein – Boriani – Biagini (WBB) classification [8]. These classifications help to evaluate treatment tactics, also from the oncologic side [8]. K. Sridhar developed a classification of tumors based on magnetic resonance imaging (MRI) [14]. In 2003, P. Klimo proposed a classification scheme of cauda equina tumors at the sacral level depending on the direction of growth and distinguished three types: first – limited to the sacrum (in this case, the tumor can be excised from the posterior approach); second – tumors adhering to/destroying the posterior and anterior walls of the sacrum (in this case, a combined approach is required for tumor excision – anterior and posterior); third – tumors within the presacral space on the anterior wall of the sacrum (in this case, anterior approach is required for excision) [14].

Due to the available topographic-anatomical features of the small pelvis, in some cases surgical treatment can be performed in one or several stages – removal of the intracanalicular portion first, and then the portion from the pelvic cavity. The main problem of tumors extending from the sacral canal into the pelvic cavity, and in our case schwannomas, is the need to make approach to the pelvis.

Despite the improvement of diagnostic methods, the development of new surgical approaches using microsurgical and endoscopic techniques, and the improvement of anesthesia, it has become possible to perform one-stage operations or surgical approaches – both posterior and anterior – to excise tumors of sacral localization [10]. However, even today, the problem of sparing surgical approach to neoplasms of this type, one-stage excise of the entire tumor and minimizing the number of relapses has not been completely solved [4, 15, 16].

The choice of adequate approach in order to obtain a good clinical effect and a high degree of radicality of tumor excision will depend on proper, careful preoperative planning based on imaging the interaction of the tumor with adjacent organs and great vessels [12, 15]. In the case of schwannomas, it is common to adhere to surgical tactics of treatment with maximum radical excision of the tumor substrate in order to obtain a favorable prognosis due to the fact that these tumors are not sensitive to chemo- and X-ray therapy [2, 3, 12, 16, 17].

THE AIM OF THE STUDY

Retrospective analysis of clinical outcomes of sacral schwannoma surgical treatment, including those with extension into lower pelvis.

MATERIALS AND METHODS

An open (non-blind), uncontrolled, non-randomized, single-center, retrospective study of clinical results of surgical treatment of patients with schwannomas in the sacrum, including those with ventral extension and retroperitoneal localization in the pelvis, operated at the Clinic of Neurosurgery of the Novosibirsk Research Institute of Traumatology and Orthopedics named after Ya.L. Tsivyan for a 10-year period was conducted. Inclusion criteria: the presence of schwannomas localized at the level of the sacrum with a confirmed pathomorphologic diagnosis; surgical intervention in accordance with the standard protocol. Exclusion criterion: severe concomitant somatic pathology in decompensation stage.

During this period, the Clinic of Neurosurgery has gathered the experience of surgical treatment of 69 patients with tumors of sacral localization having different histological structure. Among them 25 (36.2 %) were diagnosed with schwannomas of the sacrum; and according to the histopathological classification adopted by the World Health Organization, the neoplasms of all patients were of the I degree of malignancy. There were 16 (64 %) females and 9 (36 %) males; mean age was 49.6 ± 3 years.

The diagnosis of sacral neoplasms, the degree of schwannoma resection, and confirmation of the presence of relapses or continued tumor growth, adhering to the adopted standards, were performed using MRI studies of the spine and spinal cord on ExcelartVantage MR tomographs (Toshiba, Japan) with intravenous injection of contrast agent. Magnetic field strength was 1.5 T, slice thickness – up to 3 mm in T1, T2, FLAIR, DWI modes

(in three projections). If clinical signs that could be accompanied by structural changes of the spine were detected, the patients underwent additional computed tomography (CT) of the spine on Aquilion 64 multislice spiral computed tomography scanner (Toshiba, Japan); slice thickness was 1 mm. Ultrasound diagnostics was also used when necessary [3, 15].

According to P. Klimo's classification, schwannomas were divided into three groups depending on the localization and direction of growth according to MRI and CT data: 16 (64 %) subjects had tumors limited to the sacrum; 6 (24 %) – intracanalicular, with destruction of the anterior wall of the sacrum and with extension into the pelvic cavity; 3 (12 %) patients had tumors that were localized presacral, directly in the retroperitoneal space in the area of the anterior wall of the sacrum, in the pelvic cavity, without extending into the sacral canal (Table 1).

TABLE 1

DISTRIBUTION OF TUMORS BY THE DIRECTION OF GROWTH

Characteristics of growth direction	Number of patients	
	abs.	%
Tumor limited to the sacrum	16	64
Tumor with extension into the pelvic cavity	6	24
Tumor directly in the retroperitoneal space	3	12
Total	25	100

Intradural tumor growth was noted in 12 (48 %) cases, intra-/extradural – in 8 (32 %), and extradural – in 5 (20 %) cases.

The mean tumor volume was 32.6 ± 0.9 cm^3. In this case, the smallest tumor size was 1.2 cm^3 and the largest was 100.6 cm^3. The follow-up of patients in our study series averaged 61.6 ± 2 months.

The clinical picture of the disease in 21 (84 %) patients consisted of pain syndrome, neurological symptoms and pelvic organ dysfunction. In 4 (16 %) patients, the tumor was diagnosed by MRI as an incidental finding. The distribution of clinical manifestations is summarized in Table 2.

Pain syndrome of varying severity in the sacral region occurred in 16 (64 %) cases. Absence of pain symptoms was noted in 9 (36 %) patients. Mild pain degree according to Visual Analogue Scales (VAS) was noted in 12 (75 %) patients, moderate pain – in 3 (18.7 %) cases, in one case (6.3 %) the pain was severe. Irritation of the pelvic organs, in particular the rectum, expressed in frequent urges to defecate, was noted in 2 (8 %) patients with tumors localized directly in the retroperitoneum of the pelvis. Irritative symptoms along the sacral roots were noted in 20 (80 %) cases. Sensitive disorders were noted in 12 (48 %) cases.

TABLE 2

DISTRIBUTION OF CLINICAL SYMPTOMS

Symptoms	Number of patients	
	abs.	%
Pain syndrome in the sacrum	16	64
Pelvic irritation	2	8
Irritation of the sacral roots	20	80
Sensitive disorders	12	48
POD	3	12
No manifestations	4	16

Note. POD – pelvic organ dysfunction.

Pelvic organ dysfunction (POD) was noted in 3 (12 %) cases, with one patient having dysuric disorders associated with mechanical impact of a large-sized tumor located in the retroperitoneum on the pelvic organs.

All patients were operated using microsurgical instruments, OPMI Vario/NC33 microscope of Carl Zeiss company (Germany). Magnification from 10 to 20 times was used. High-speed drills supplied by Aesculap (USA) and Synthes (USA) were used for approach. A Sonoca 300 ultrasonic dissector/aspirator (Söring, Germany) was used at the stages of excision, allowing, if necessary, to perform internal decompression of the tumor for its further mobilization and minimize the impact on the adjacent neural structures.

Two types of approaches were used in the patient group. The first one was a posterior approach with resection of the posterior wall of the sacrum; performed in 22 patients. Posterior approach allows a fairly clear identification of the nerve structures that are located directly in the sacral canal. In case of tumor localization within the sacral canal, it is limited to trepanation of its posterior wall and skeletonization of the anterior wall of the canal and intervertebral foramen zones. All posterior approaches done were performed

with the patient in the abdominal position on the operating table. In this type of approach, opening and resection of the anterior wall of the sacrum from behind (or enlargement of the already existing enlarged intervertebral foramen) was performed if necessary in order to remove the fragment extending ventrally, which was performed in 6 cases. In 2 of these 6 cases, the posterior and anterior walls of the sacrum were resected and a large ventral component located in the pelvis was removed. Posterior approaches are quite typical, they are widely described in the literature, so there is no point in dwelling on them in more detail.

The second approach was an anterior retroperitoneal approach to excise tumors mainly localized on the anterior wall of the sacrum in the pelvis. It was performed in 3 cases in the supine position of the patient on the operating table. Retroperitoneal approach consists of making an oblique paramedian incision of the anterior abdominal wall. The peritoneum is peeled off the pelvic surface along with the intestine and displaced from the iliac vessels and ureters; the peritoneum is pushed medially. During the tumor approach phases, it is important to assess the risk of injury to the great vessel and ureter. On the lateral side, the iliac neurovascular bundle was mobilized and withdrawn. Bipolar coagulation is used retroperitoneally to enter the pelvis and approach the tumor mass. Subsequently, tumor mobilization with internal decompression using an ultrasonic disintegrator was performed. As the volume of the tumor node decreased after its internal decompression, we separated the schwannoma capsule from the anterior wall of the sacrum and important anatomical formations (peritoneum, vessels, nerves, ureters). After its intracapsular removal and its separation from the pelvic organs, the sacral intervertebral foramen was examined, the site of tumor growth (spinal root) was identified, and after preliminary coagulation it was cut off from the root. The operation ended with hemostasis, layer-by-layer sutures on the wound with drainage in the retroperitoneal space for 1–2 days.

In all 3 cases of purely anteriorly localized tumors excised from anterior approach, the surgical team included a vascular surgeon, but we did not experience any complications or difficulties during excision. The tumors were localized retroperitoneally and were not intimate with the great vessels.

In order to assess the results of surgical treatment and quality of life, we used the McCormick Scale, and to assess the pain syndrome and its dynamics – VAS. It should be noted that microsurgical interventions mostly did not cause a marked worsening of the patients' condition and deepening of the existing focal symptoms in the group of our patients, as well as any significant change in the patients' quality of life index in the postoperative period and transfer of patients from one group to another.

The conducted studies comply with the ethical standards developed on the basis of the Declaration of Helsinki of the World Medical Association (WMA) "Ethical Principles for Medical Research Involving Human Subjects", as amended in 2000, and the Rules for Good Clinical Practice approved by the Order No. 200n dated April 01, 2016 of the Ministry of Health of the Russian Federation. The study was approved by the Biomedical Ethics Committee of Novosibirsk Research Institute of Traumatology and Orthopedics named after Ya.L. Tsivyan of the Russian Ministry of Health. All data were depersonalized.

RESULTS

Compared to the initial parameters of patients in the postoperative period at 1 year, a good clinical result with regression of symptoms was noted in 17 out of 25 patients, which amounted to 68 % ($p < 0.01$) – this corresponded to class I according to the McCormick Scale (1999), – and 10 (5,8 %) of them had significant regression of neurology, expressed in a clear reduction of pain syndrome (from 64 % to 24 %), irritative symptoms on sacral roots, irritation of pelvic organs, restoration of sensitive disorders. In 6 (24 %) individuals the symptoms corresponded to grade II as per the McCormick Scale ($p = 0.291$), in 2 (8 %) cases – to grade III ($p = 0.027$). There were no patients with gross neurological disorders of persistent nature (grade IV) in the group. Positive symptoms noted at 1 year were not significant at later dates.

Regarding POD, we can say that of the three patients with POD in the preoperative period, regression of the disorders was noted in 2 (8 %) patients; 1 (4 %) patient retained POD with gradual incomplete regression during the following 1.5 years. In addition, in one patient who did not have POD preoperatively, this type of disorder appeared in the postoperative period.

Operation radically was achieved in 24 out of 25 cases (96 %), subtotal resection was performed in 1 (4 %) patient.

The number of relapses and continued growth of neoplasms amounted to 12 % in our series (3 out of 25 patients, which was confirmed by clinical and tomographic data). Analysis of neoplasm recurrences revealed that they recurred at 18 and 26 months, after primary surgery and total tumor excision, and in one case continued growth was noted 11 months after subtotal tumor excision. Patients were reoperated without worsening neurologic deficits or relapse during the remaining follow-up period.

Long-term (more than 5 years) treatment results were traced in 10 (40 %) of our operated patients. In 3 (12 %) patients, long-term results could not be followed up due to loss of contact with them. There were no fatal long-term outcomes in the group of patients available for catamnesis collection during the postoperative follow-up period.

Complications observed in our group were noted in 3 (12 %) cases and manifested as wound liquorrhea. All of them are noted in cases of posterior approaches. In all three cases, the liquorrhea was controlled by secondary suturing with placement of lumbar drainage. In cases

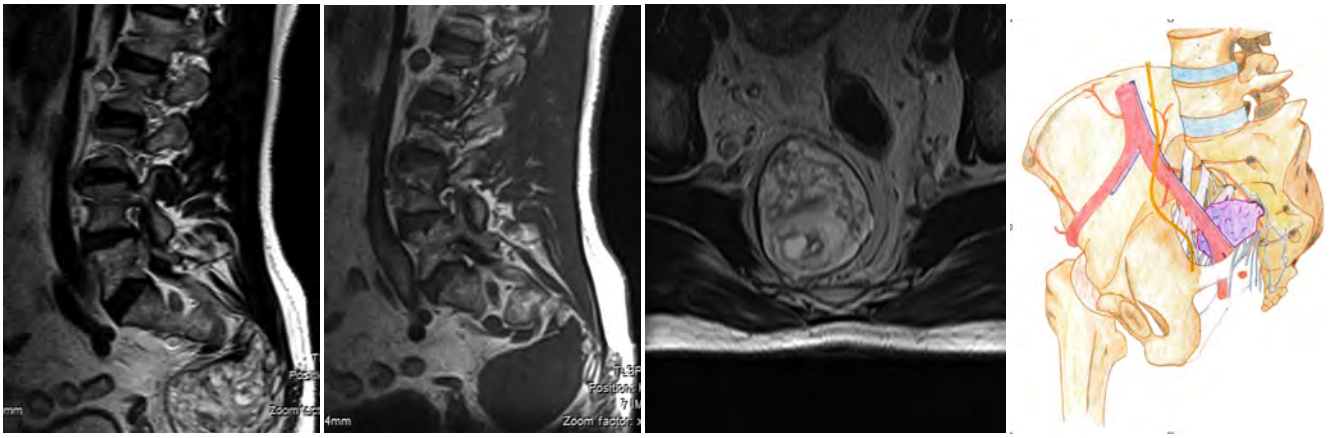
of anterior, retroperitoneal approach, there were no complications. Infections of the surgical area as well as inflammatory changes from the subarachnoid space did not occur among the patients.

CLINICAL CASE STUDY

Patient R., born in 1957, complains of weakness in the left foot and fingers. Intermittent moderate pain in the lumbosacral region, in recent months – fecal urgency. Dx: Giant-sized volumetric mass (schwannoma?) of intraforaminal localization at the level of S3 on the right with ventral extension into the pelvic cavity. The diagnosis was confirmed by contrast-enhanced MRI of the lumbosacral spine, which revealed a giant presacral, contrast-enhanced mass at the S3 level on the right with an intraforaminal component totaling 51 × 52.6 × 65.3 mm, with the intraforaminal component measuring 10 × 11 × 12 mm (Fig. 1).

Surgical treatment was performed routinely: trepanation of the posterior and anterior walls of the sacrum in the projection of tumor growth at the level of S3–S4 segments on the right, microsurgical excision of the tumor.

Among the surgical peculiarities, we would like to emphasize the fact that the tumor was completely excised from the posterior approach without damaging the peritoneum; the resulting postoperative cavity of the posterior wall of the sacrum was filled with autogyre; con-



a ***b*** ***c*** ***d***

FIG. 1.

Patient R., MRI of the lumbosacral spine in 2 projections with contrast enhancement, before the surgery. Giant presacral tumor of retroperitoneal localization at the S3 level on the right, with intraforaminal component. ***a***, ***b*** *– sagittal sections;* ***c*** *– axial section;* ***d*** *– scheme of topographic and anatomical features of the tumor localization.*

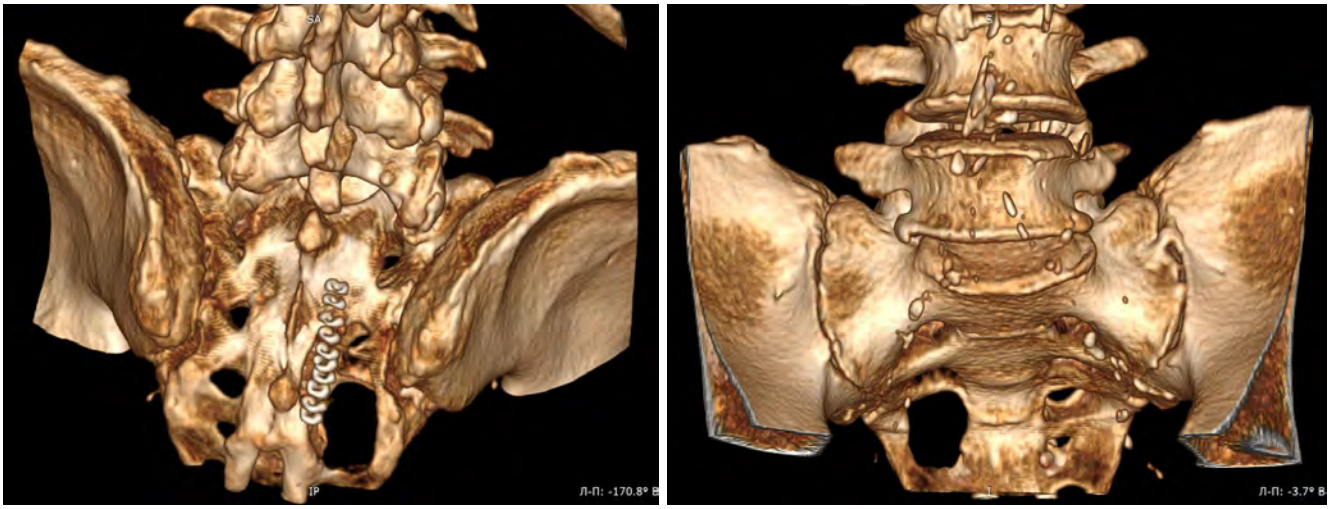


FIG. 2.

Patient R., 3D reconstruction of the MSCT image of the sacrum, after the surgery. Defect of lateral sacral masses in the area of surgical intervention

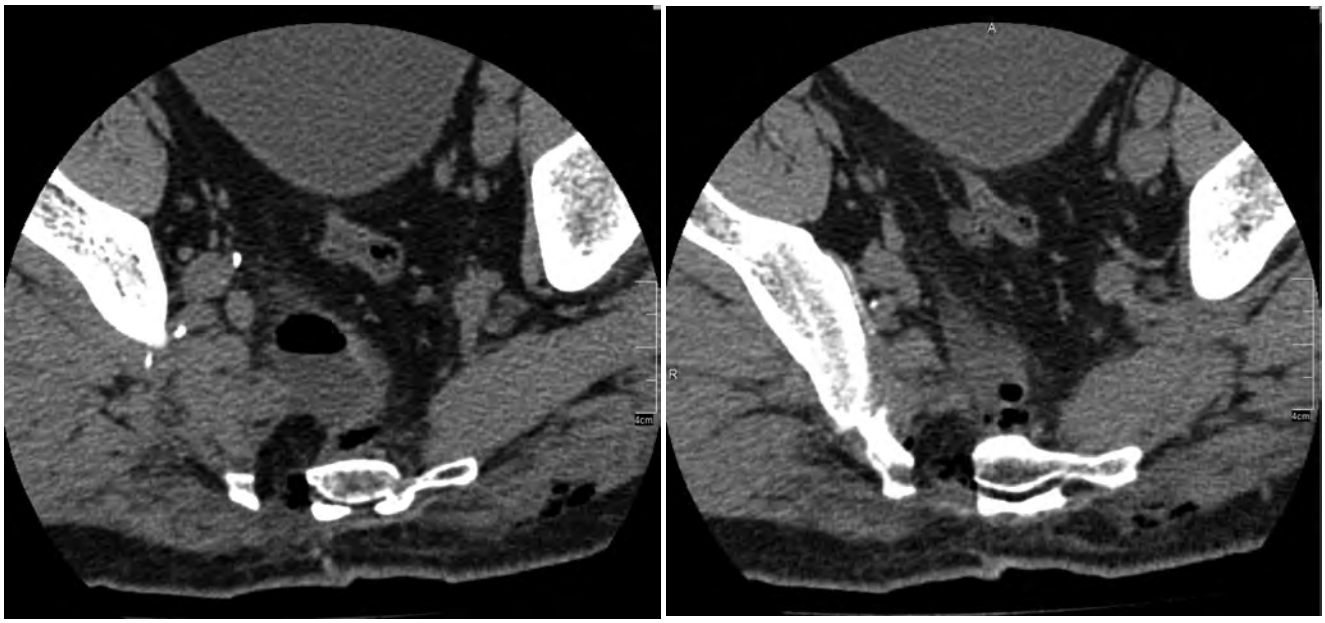
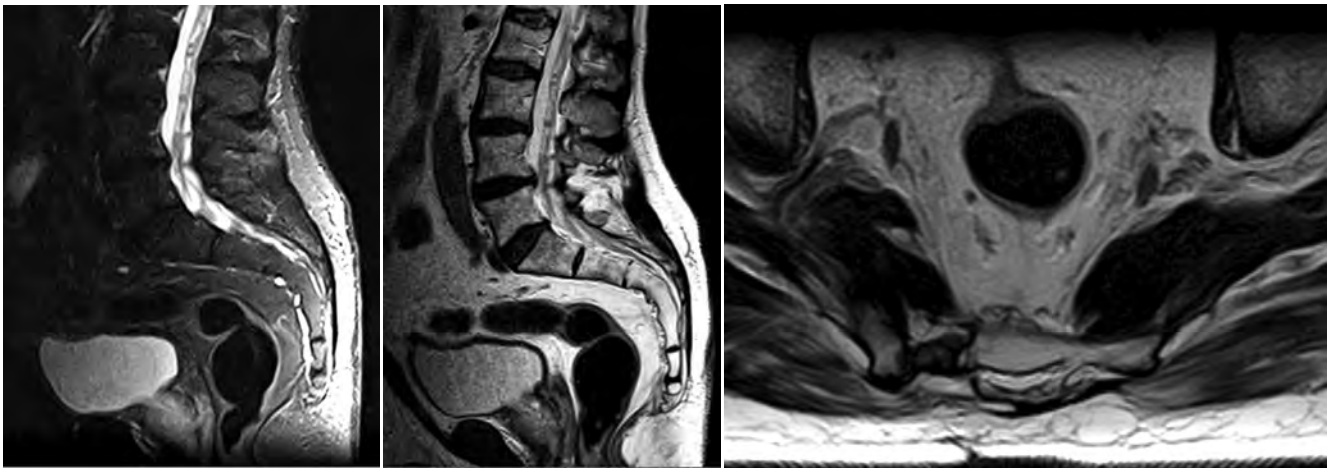


FIG. 3.

Patient R., MSCT images of the sacral spine and the pelvis with contrast enhancement, 1 day after the surgery. No signs of the tumor tissue



a ***b*** ***c***

FIG. 4.

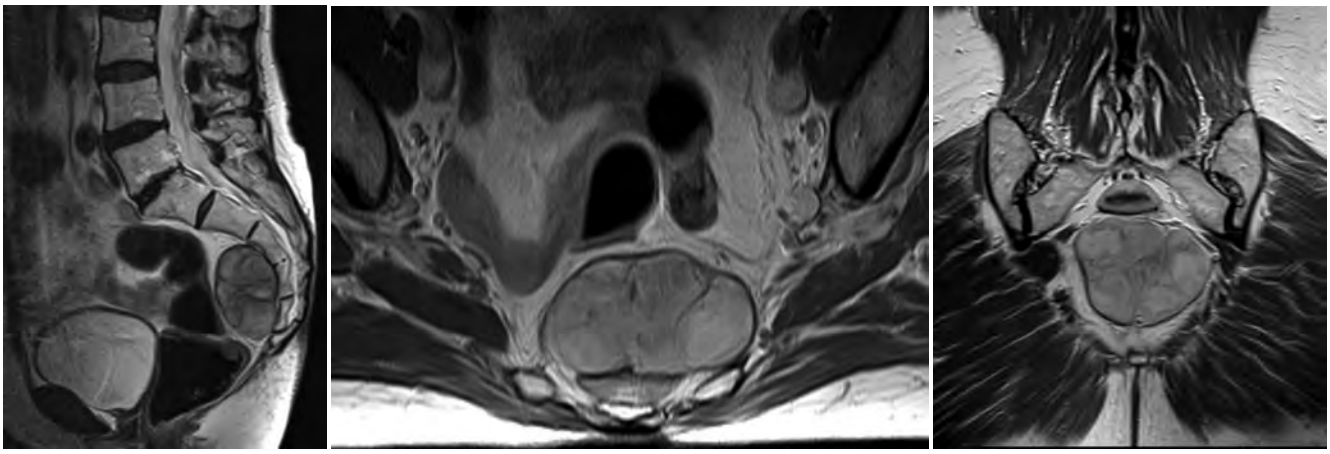
Patient R., MRI of the lumbosacral spine with contrast enhancement, 34 months after the surgery. No signs of recurrence of tumor in the sacrum. ***a***, ***b*** *– sagittal sections;* ***c*** *– axial section.*

sidering adequate hemostasis, no drainage systems were placed in the wound. The resection volume of the sacrum (in the area of the enlarged intervertebral foramen) is represented by a small defect (35.0 × 25.0 mm) that does not compromise the orthopedic integrity of the pelvic ring (Fig. 2).

Intraoperative blood loss amounted to 320 ml. The volume of the excised tumor was 100.6 cm^3. Histologic and immunohistochemical diagnosis: Schwannoma, stage 1 (ICD-O: 9560/0). Based on the results of Multislice Computed Tomography (MSCT) 24 hours after surgery, there were no signs of tumorigenesis (Fig. 3).

The postoperative period was uneventful. Wound healing is primary. In neurologic status – without aggravation of neurologic symptoms, and the urgencies regressed. The patient was discharged from the clinic on the day 12 in stable, satisfactory condition. The patient is on outpatient follow-up at the clinic. The results of control MRI after 34 months showed no signs of recurrence of the mass at the operated level (S3–S4) (Fig. 4)

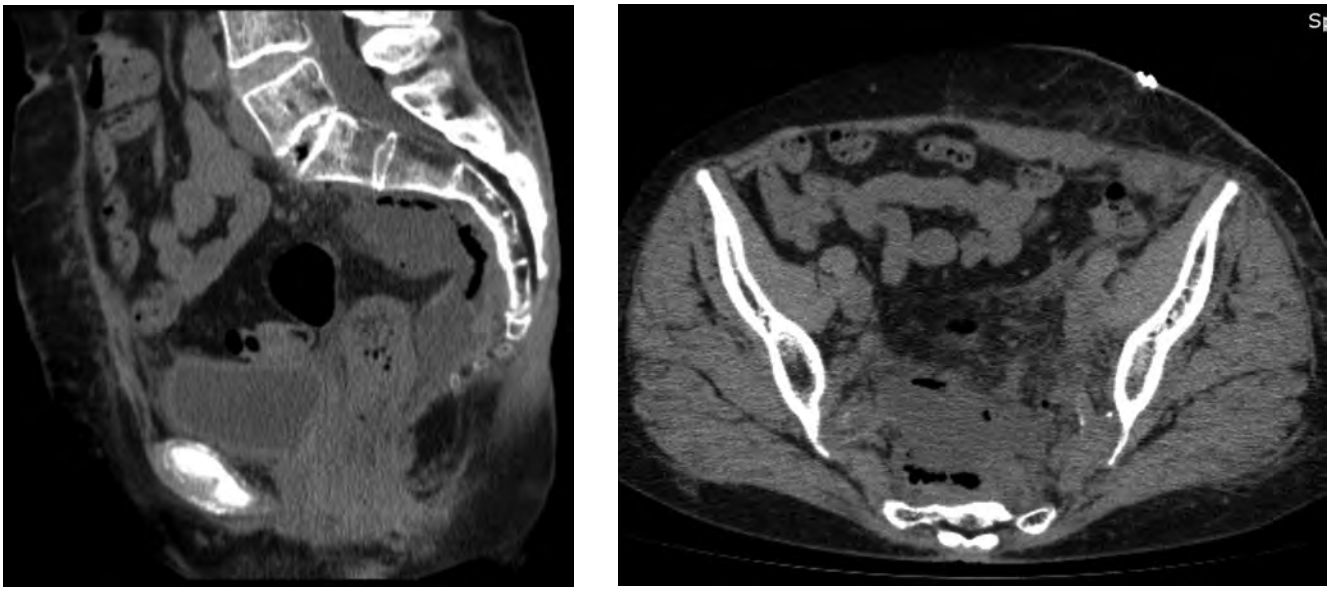
Patient N., born in 1946. Complaints of periodic moderate painful sensations ("feeling of discomfort") in the pelvic area. The results of ultrasound (U/S) re-



a *b* *c*

FIG. 5.

*Patient N., MRI of the lumbosacral spine in 2 projections with contrast enhancement, before the surgery: **a** – sagittal section; **b**, **c** – axial sections.*



a *b*

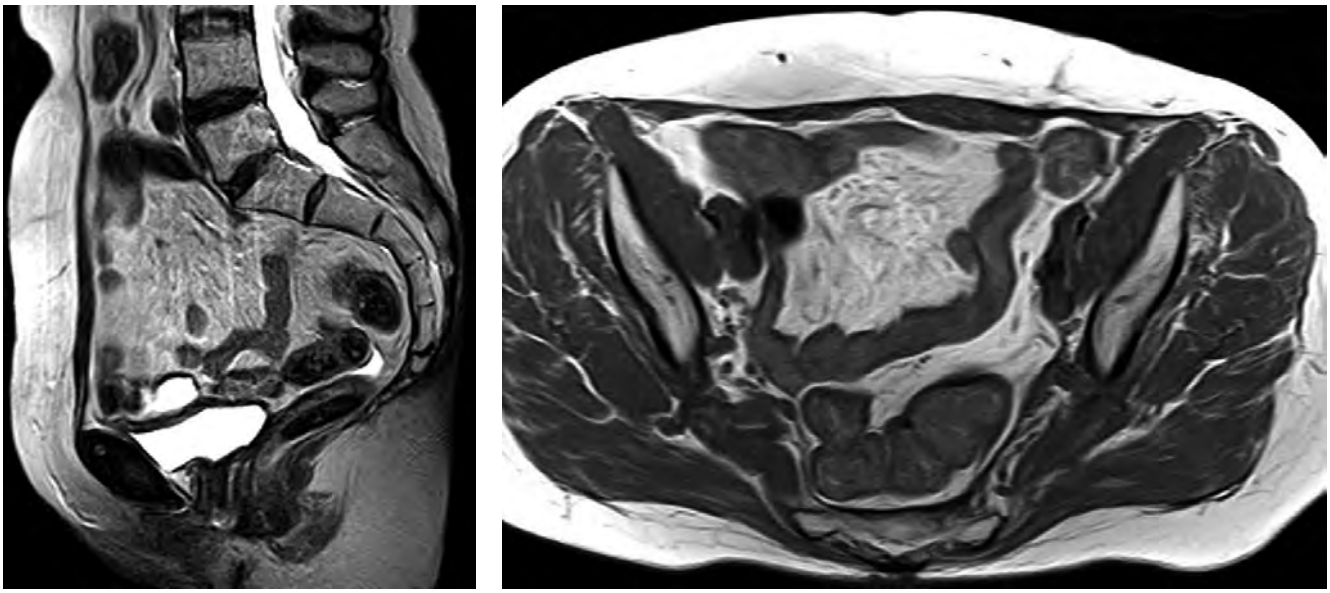
FIG. 6.

*Patient N., MSCT images of the lumbosacral spine, spinal cord and the pelvis with contrast enhancement, 1 day after the surgery: no signs of tumor. **a** – sagittal section; **b** – axial section.*

vealed a mass in the pelvic area, and the patient was referred to an oncologist. In neurologic status at examination: without focal neurologic deficit; no pelvic organ dysfunction. The diagnosis was clarified by contrast-enhanced MRI, which revealed a volumetric contrast-enhanced mass measuring 60.3 × 38.7 × 72 mm in the presacral region, on the ventral surface of the S3–S5 vertebrae (Fig. 5).

The patient underwent a planned surgical intervention: microsurgical removal of a volumetric mass at the level of S3–S5 segments of the sacrum in the pelvic area by left-sided retroperitoneal approach. The tumor was excised total, and a small tumor fragment extending into the intervertebral foramen of the sacrum was also removed. Intraoperative blood loss amounted to 150 ml. The volume of tumor excised was 96.5 cm^3. Histologic and immunohistochemical diagnosis: Schwannoma, stage I (ICD-O: 9560/0). Based on the results of postoperative MSCT control 1 day after surgery, no signs of residual tumor tissue were detected (Fig. 6).

The postoperative period was satisfactory, wound healing was by primary intention. The sutures were removed on the day 10. The patient was activated on the day 2. She was discharged from the clinic in satis-



a ***b***

FIG. 7.

Patient N., MRI of the lumbosacral spine in 2 projections with contrast enhancement, 62 months after the surgery. No signs of relapse of tumor. ***a*** *– sagittal section;* ***b*** *– axial section.*

factory condition with improvement on the day 10 after surgery. In neurologic status – without focal symptoms and increasing neurologic deficit. POD in normal state.

Based on the results of the most recent contrast-enhanced MRI of the pelvis and sacrum 62 months after surgery, there was no evidence of tumor relapse (Fig. 7).

DISCUSSION

The necessary set of diagnostic measures for surgical treatment, in addition to clinical and neurological data, should include the results of MRI and MSCT with contrast enhancement, and if necessary, MSCT with angioprogram and ultrasound examination of the pelvic region.

The priority in the treatment of schwannomas of sacral localization should be surgical treatment with complete excision of the tumor process. This ensures minimized and recurrence-free, continued good quality of life for patients, sparing them from reoperations and other treatments to target residual tumor tissue. However, we should not forget that in the pursuit of radical surgery, it is necessary to clearly plan the surgical approach, its features and volume, taking into account the topographic-anatomical features of the area. Despite the fact that the most applicable in neurosurgical practice is the posterior approach, which allows the most radical removal of voluminous masses, mainly intracanalicular localization, in cases of ventral extension, it is also possible to use the posterior approach to remove a ventrally extending tumor node (as presented in the clinical case study), and in this case it is possible to do with minimal, clinically insignificant blood loss, a small resection of bone structures of the sacrum and achieve radicality of removal. Currently, there is no clear algorithm regulating the choice of surgical approach [11]. Some authors are of the opinion that posterior approaches should be chosen when excising giant neurogenic tumors of the sacrum [16, 18]. The anterior retroperitoneal approach we used in several cases also allowed us to excise tumors of ventral localization in the pelvis radically and minimally traumatically.

However, based on our own experience, it is clear that excision of anterior sacral wall tumors at lower sacral levels from anterior retroperitoneal approach will be very difficult due to the formation of a longer operative approach to the tumor, which will reduce the view and angle of surgical attack. Taking this into account, as well as analyzing the peculiarities of the extension of some tumors in our group, the presence of a sufficiently deep surgical approach in the ventral direction at posterior approaches, we would like to note the possibility and expediency of using endovideo-assistance during excision, which, in our opinion, will allow to visualize more fully the removed tumor bed and contact with anatomical formations in the depth of the wound.

We would like to note that in the group of operated patients we did not have to use two-stage (ventral, dorsal) surgical intervention, as well as transperitoneal approach. At the same time it was possible to excise tumors radically enough in almost all cases when correctly chosen posterior or anterior approach was performed. The orthopedic integrity of the spine and pelvic ring was not compromised in all 25 cases and, accordingly, no stabilizing systems

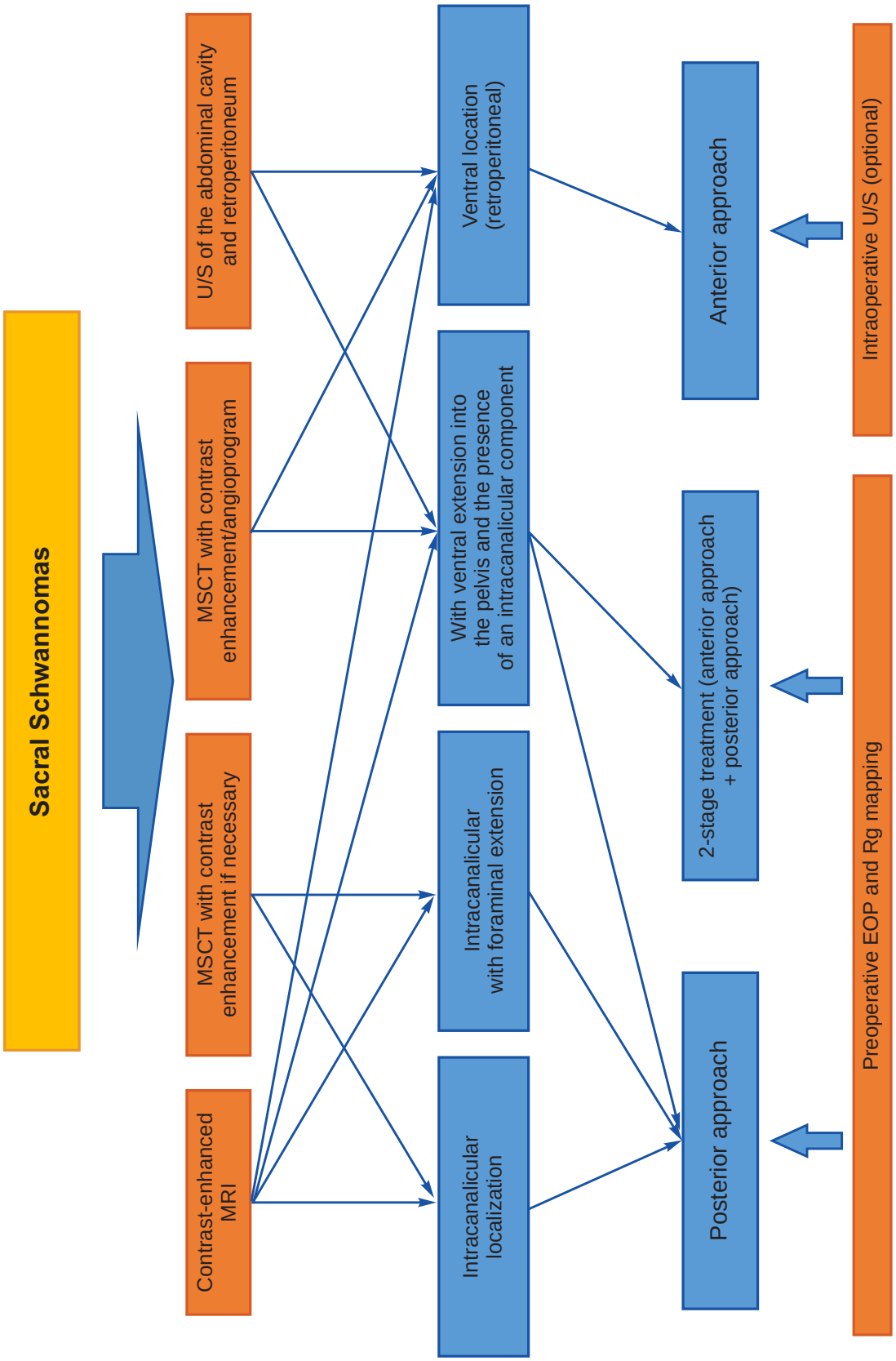


FIG. 8.
Algorithm of surgical and diagnostic approaches in the treatment of sacral schwannomas

were required. Good clinical results with analysis of the dynamics of neurological status, pain syndrome and pelvic organ function confirm the correct choice of surgical approach in each case.

In case of significant ventral extension of the tumor and its large volume, anterior approach or two-stage intervention is preferred. However, our experience and literature data show that sufficiently large sacral schwannomas extending predominantly into the retroperitoneum can be removed from the posterior approach, minimally traumatically and with a good clinical outcome [15, 18]. In this case, it is necessary to carry out an individual approach to the patient, focusing on the localization, extension of the tumor, as well as on the constitutional features of the patient.

The paradigm used in our clinic in treatment and diagnostic approaches in sacral schwannoma surgery is detailed in the flowchart (Fig. 8).

When analyzing complications, taking into account schwannoma localization area at the level of the sacral canal and interaction with the roots of the cauda equina, perhaps the most significant postoperative disorders, significantly worsening the quality of life of patients, are pelvic organ dysfunctions. Therefore, in our opinion, starting from preoperative planning, it is necessary to assess possible risks of postoperative disorders, including POD, together with urologists or neurourologists, and, if such complications are present, to develop and apply a rehabilitation program for them, starting from the early postoperative period. Complications in the form of wound liquorrhea are associated with the particular structure of the terminal portions of the dural sac in the form of thinning of the dura mater, therefore, in order to control this complication, as our experience shows, it is optimal to use biological glue and fat autograft for additional sealing of the dura mater.

CONCLUSIONS

As our experience shows and literature data confirm, the overwhelming number of tumors of sacral localization were schwannomas with gender distribution towards the female sex.

Radical surgical excision of schwannomas, including those with extracanalicular (ventral) extension, is an effective way to treat them, with a favorable prognosis, including using a single approach, even in large-sized schwannomas.

The choice of adequate approach is directly related to the degree of radicality of tumor excision. An individualized approach and planning are required for each case. Furthermore, it is necessary to clearly understand the possibilities of all existing surgical approaches, and the main goal should be, of course, the patient's quality of life.

Conflict of interest

The authors of this article declare the absence of a conflict of interest.

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Kopylov I.S. – participation in the operation (first/second assistant, illustrative material formation).