South Russian Journal of Cancer 2022, Vol.3, No. 3, P. 6-14
https://doi.org/10.37748/2686-9039-2022-3-3-1
ORIGINAL ARTICLE

FEATURES OF REPLACEMENT OF EXTENSIVE POST-RESECTION BONE DEFECTS IN PELVIC AND SACRAL TUMORS

L. N. Vashchenko, P. V. Chernogorov, R. G. Luganskaya, A. A. Barashev, E. S. Bosenko, T. V. Ausheva, N. S. Saforyan✉

National Medical Research Centre for Oncology, Rostov-on-Don, Russian Federation
✉ saforyans@mail.ru

ABSTRACT

Purpose of the study. To represent the results of a two-stage surgical treatment in patients with extensive pelvic bone defects.
Materials and methods. Data on 7 patients who underwent surgery for pelvic and sacrum tumors at the National Medical Research Centre for Oncology from 2016 up to 2020 are presented. The average age of the patients was 36 years. Patients with massive tumors that required a major resection of the posterior pelvis and the formation of an extensive bone defect requiring reconstruction with massive allografts and implants were selected for the study. 5 patients underwent different variations of sacrectomies with the resection of the iliac bones; 2 patients – interiliac-abdominal resections. For all these patients, surgical treatment was split into 2 stages.
Results. At the first stage we performed: 5 surgical interventions (total or extended sacrectomy at L5–S1 with lumbar-iliac bilateral stabilization with an 8-screw pedicle system) in patients with sacral tumors. In 2 cases, an interilio-abdominal resection with the defect replacement with cement articulating spacer. Intraoperative blood loss on average was 1.8L. We used autohemotransfusion to compensate the intraoperative blood loss.
The 2nd (reconstructive) stage was completed on average after 3 months. The reconstructive stage was not accompanied by major trauma in all patients. The average blood loss was approximately 800 ml. There were no complications after the reconstructive surgical stage.
Conclusion. The described two-stage technique allowed to avoid severe infectious complications requiring removal of implants and grafts in all patients. Adequate spinal pelvic stabilization and/or spacing of the defect contributed to early functional rehabilitation of patients and the continuation of adequate adjuvant therapy in the interstage period. The delaying of the reconstruction allowed to reduce the duration and invasiveness of the main intervention without affecting the final result of treatment.

Keywords:
sacral tumors, sacrectomy, lumbar-pelvic stabilization, bone defects, infectious complications, augment

For correspondence:
Natalia S. Saforyan – Cand. Sci. (Med.), MD, surgeon at the department of tumors of bones, skin, soft tissues and breast, National Medical Research Centre for Oncology, Rostov-on-Don, Russian Federation.
Address: 63 14 line str., Rostov-on-Don 344037, Russian Federation
E-mail: saforyans@mail.ru
ORCID: https://orcid.org/0000-0002-7511-2715
SPIN: 1444-9003, AuthorID: 430648

Funding: this work was not funded.
Conflict of interest: authors report no conflict of interest.

For citation:
Vashchenko L. N., Chernogorov P. V., Luganskaya R. G., Barashev A. A., Bosenko E. S., Ausheva T. V., Saforyan N. S. Features of replacement of extensive post-resection bone defects in pelvic and sacral tumors. South Russian Journal of Cancer. 2022; 3(3): 6-14. (In Russ.).
https://doi.org/10.37748/2686-9039-2022-3-3-1

The article was submitted 25.02.2022; approved after reviewing 01.07.2022; accepted for publication 02.09.2022.

Южно-Российский онкологический журнал 2022, Т. 3, № 3, С. 6-14
https://doi.org/10.37748/2686-9039-2022-3-3-1
ОРИГИНАЛЬНАЯ СТАТЬЯ

ОПЫТ ДВУХЭТАПНОГО ХИРУРГИЧЕСКОГО ЛЕЧЕНИЯ БОЛЬНЫХ С ОБШИРНЫМИ ПОСТРЕЗЕКЦИОННЫМИ КОСТНЫМИ ДЕФЕКТАМИ ПРИ ОПУХОЛЯХ ТАЗА И КРЕСТЦА

Л. Н. Ващенко, П. В. Черногоров, Р. Г. Луганская, А. А. Барашев, Е. С. Босенко, Т. В. Аушева, Н. С. Сафорьян✉

НМИЦ онкологии, г. Ростов-на-Дону, Российская Федерация
✉ saforyans@mail.ru

РЕЗЮМЕ

Цель исследования. Представить результаты двухэтапного хирургического лечения больных с обширными костными дефектами таза.

Материалы и методы. Представлены данные о 7 пациентах, которым выполнены оперативные вмешательства по поводу опухолей таза и крестца в ФГБУ «НМИЦ онкологии» Минздрава России с 2016 по 2020 гг. Для анализа отобраны пациенты с местно-распространенным процессом, потребовавшим значительной по объему резекции задних отделов таза и с формированием обширного костного дефекта, требующим реконструкции массивными ауто- и аллотрансплантатами и имплантами. 5 пациентов – это сакрэктомии в разных вариантах с резекцией подвздошных костей и 2 пациента – межподвздошно-брюшные резекции. Всем пациентам хирургическое лечение разделено на 2 этапа.

Результаты. На 1 этапе было выполнено: 5 оперативных вмешательств у больных с опухолями крестца – тотальная или расширенная сакрэктомия на уровне L5–S1 с пояснично-подвздошной билатеральной стабилизацией 8 винтовой педикулярной системой, и в 2 случаях – межподвздошно-брюшная резекция с замещением дефекта цементным артикулирующим спейсором. Средняя кровопотеря составила 1,8 л. В качестве возмещения интраоперационной кровопотери нами использовалась методика аутогемотрансфузии.

2-й (реконструктивный) этап выполнен в среднем через 3 мес. У всех пациентов реконструктивный этап не сопровождался большой травматичностью. Кровопотеря в среднем 800 мл. Осложнений после реконструктивного этапа операции не было.

Заключение. Использование двухэтапной методики позволило избежать тяжелых инфекционных осложнений, требующих удаления имплантов и трансплантатов у всех пациентов. Адекватная позвоночно-тазовая стабилизация и (или) спейсирование дефекта способствует ранней функциональной реабилитации больных и продолжению адекватной адъювантной терапии в межэтапном периоде. Отсроченное выполнение реконструкции позволяет уменьшить продолжительность и травматичность основного вмешательства, не влияя на окончательный результат лечения.

Ключевые слова:
опухоли крестца, сакрэктомия, пояснично-тазовая стабилизация, дефекты костной ткани, инфекционные осложнения, трансплантат

Для корреспонденции:
Сафорьян Наталья Сергеевна – к.м.н., врач-хирург отделения опухолей костей, кожи, мягких тканей и молочной железы, ФГБУ «НМИЦ онкологии» Минздрава России, г. Ростов-на-Дону, Российская Федерация.
Адрес: 344037, Российская Федерация, г. Ростов-на-Дону, ул. 14-я линия, д. 63
E-mail: saforyans@mail.ru
ORCID: https://orcid.org/0000-0002-7511-2715
SPIN: 1444-9003, AuthorID: 430648

Финансирование: финансирование данной работы не проводилось.
Конфликт интересов: авторы заявляют об отсутствии конфликта интересов.

Для цитирования:
Ващенко Л. Н., Черногоров П. В., Луганская Р. Г., Барашев А. А., Босенко Е. С., Аушева Т. В., Сафорьян Н. С. Опыт двухэтапного хирургического лечения больных с обширными пострезекционными костными дефектами при опухолях таза и крестца. Южно-Российский онкологический журнал. 2022; 3(3): 6-14. https://doi.org/10.37748/2686-9039-2022-3-3-1

Статья поступила в редакцию 25.02.2022; одобрена после рецензирования 01.07.2022; принята к публикации 02.09.2022.

RELEVANCE

Pelvic bones are affected by tumors relatively often: these tumors make up 10–15 % in relation to tumors of other bones of the skeleton [1].

According to a number of authors, pelvic bones are most often affected by malignant tumors (about 50 %), the proportion of benign tumors is 15 %, dysplastic processes – 35 %. Among primary malignant tumors, chondrosarcomas, osteogenic sarcoma, malignant giant cell tumors are most common; among benign ones – chondromas, osteoid osteomas, giant cell tumors [1].

One of the main and distinctive features of malignant formations of the pelvic bones is a long asymptomatic course, this is due to anatomical and topographic features of the pelvis, as well as insufficient oncological alertness of doctors of the general network [2]. The main reason for the patient's visit to the doctor is a pronounced pain syndrome, when the tumor already reaches an impressive size, and sometimes internal organs and intra-phase structures germinate.

Surgical interventions for tumors of the pelvic and sacral bones are associated with a high risk of massive blood loss, damage to the main vessels, visceral organs, damage to nerve structures, as well as often secondary healing or deep suppuration of a postoperative wound [1; 2].

When performing radical oncoresections on the anterior semicircle of the pelvis, including branches of the pubic and sciatic bones, restoration of the integrity of the pelvic ring is not required even in advanced cases [1].

In the area of the acetabulum, reconstruction is usually and quite successfully performed with modular or individual prostheses with a small number of complications.

One of the main and most dangerous complications of extensive oncoresections is infection. In orthopedic operations, the frequency of infectious complications after endoprosthetics is 1.5–2.5 %, but in oncological patients this indicator is significantly higher, according to literature data from 10.0 to 66.0 % [3–5]. And if the issue of two-stage tactics of prosthetics of bones and joints in peri-implant infection is beyond doubt, then the defects of bone tissue obtained during the removal of infected implants, after resection of bone tumors, represent a significant problem of modern orthopedics. With diaphyseal and articular traumatic and oncological defects, we are completely satisfied with the available modular and individual megaprostheses. The replacement of extensive defects of the iliac bones with the hip complex and sacrum does not always lead to the desired satisfactory results. A large percentage of complications (up to 40 %) [4; 6–8]. it

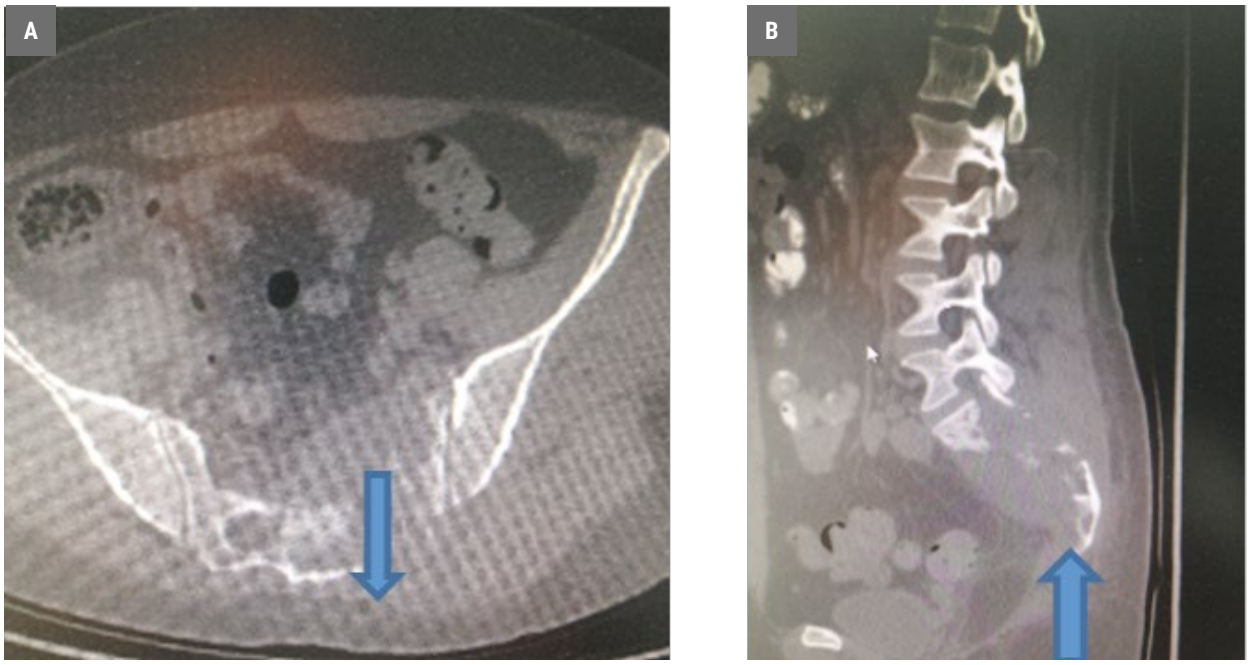

Fig. 1. Pelvic SCT, sacral liposarcoma (arrows showing the tumor).

requires analysis, individual correction of tactics and search for new solutions. The main problem is infectious complications due to the duration of the operation, the volume of surgical intervention, intraoperative blood loss, traumatization of the altered surrounding soft tissues, the presence of extensive metal structures and often allografts [4; 6, 7, 9–12]. Also, in the postoperative period, lymphorrhea is possible, which can last from several days to several weeks, which is supported by the presence of allografts and massive implants installed in the defect. The risk of deep suppuration increases significantly. After a number of similar complications, we began to separate (if possible) the stage of extensive pelvic resection and stabilization (if necessary, with the spacing of the defect with cement with antibiotics) and the reconstructive stage using auto- and allografts, the final vertebral-pelvic stabilization. The time between the stages depends on the specific clinical situation, ranging from one to several months. During this period, it is possible to carefully prepare for reconstruction, prepare implants, if necessary, perform modeling and an individual prosthesis exactly according to the shape of the resulting defect.

The purpose of the study: to analyze the results of two-stage surgical treatment of patients with extensive bone defects of the pelvis.

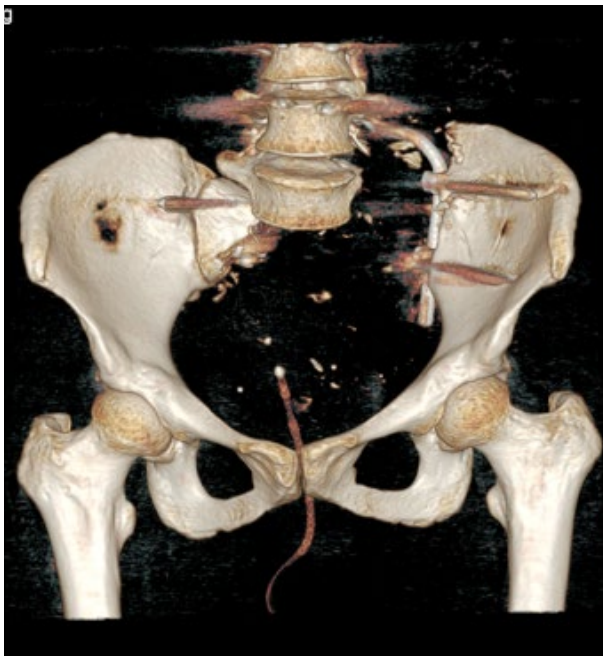

Fig. 2. 3D SCT pelvic reconstruction after the 1st stage.

MATERIALS AND METHODS

Data on 7 patients who underwent surgical interventions for pelvic and sacral tumors at the National Medical Research Centre for Oncology of the Ministry of Health of Russia from 2016 to 2020 are presented. For this analysis, patients were selected with a locally widespread process that required a significant volume of resection of the posterior parts of the pelvis and with the formation of an extensive bone defect requiring reconstruction with massive auto- and allografts and implants. The average age of the patients was 36 years, all women.

All patients at the prehospital stage underwent spiral computed tomography (CT), magnetic resonance imaging (MRI), trepanobiopsy. All patients have given informed consent for this type of surgical intervention, for the study.

Five patients underwent sacrectomy in different variants with resection of the iliac bones (1 patient had sacral liposarcoma, G3T3N0M0, 1 patient had malignant chordoma, G2T3N0M0, 2 patients had sacral chondrosarcoma, T3N0M0.

Two patients underwent ilio-abdominal resections, one patient had iliac fibrosarcoma, G3T2N0M0, and one patient had Ewing's sarcoma, T3N0M0.

The group did not include patients with sacral resection below the S2 level and paraarticular resection of the hip joint, when the reconstructive-stabilizing stage was performed immediately. Surgical treatment is divided into 2 stages for all patients.

At the 1st stage, we performed: 5 surgical interventions in patients with sacral tumors – total or extended sacrectomy at the level of L5–S1 vertebrae with lumbo-iliac bilateral stabilization by an eight-screw pedicular system. In 2 cases, ileo-abdominal resection was performed with replacement of the defect with a cement articulating spacer (2–3 doses of polymethylmethacrylate) with vancomycin. The spacer was manufactured in the operating room and installed on spongy 6.5–7.0 screws inserted into the remains of the pubic, sciatic bones and sacrum from the sawdust side.

In order to reduce the volume of blood loss, an intraoperative system was used to return autologous blood with Cell-Saver Sorin, thanks to which it was possible to significantly improve the quality of infusion-transfusion therapy and obtain an acceptable level of hematocrit. As compensation for

intraoperative blood loss, we used the autohemotransfusion technique. In the preoperative period, autologous blood components were harvested in one or two stages, which had a pronounced positive effect on the course of the postoperative period, and also allowed to reduce the number of allogeneic (donor) blood transfusions and related complications. In order to reduce intraoperative blood loss, three patients underwent angiography with superselective embolization of tumor vessels before surgery.

The reconstructive stage was completed in an average of 3 months. In 1 case, a massive individual prosthesis of half of the pelvis with a hip joint. In other cases, combined auto- and alloplasty. Additional stabilization (installation, rewiring) of the vertebral-pelvic pedicular system was required in 4 patients.

Patients (according to indications) received adjuvant chemo-radiation therapy according to clinical recommendations [13].

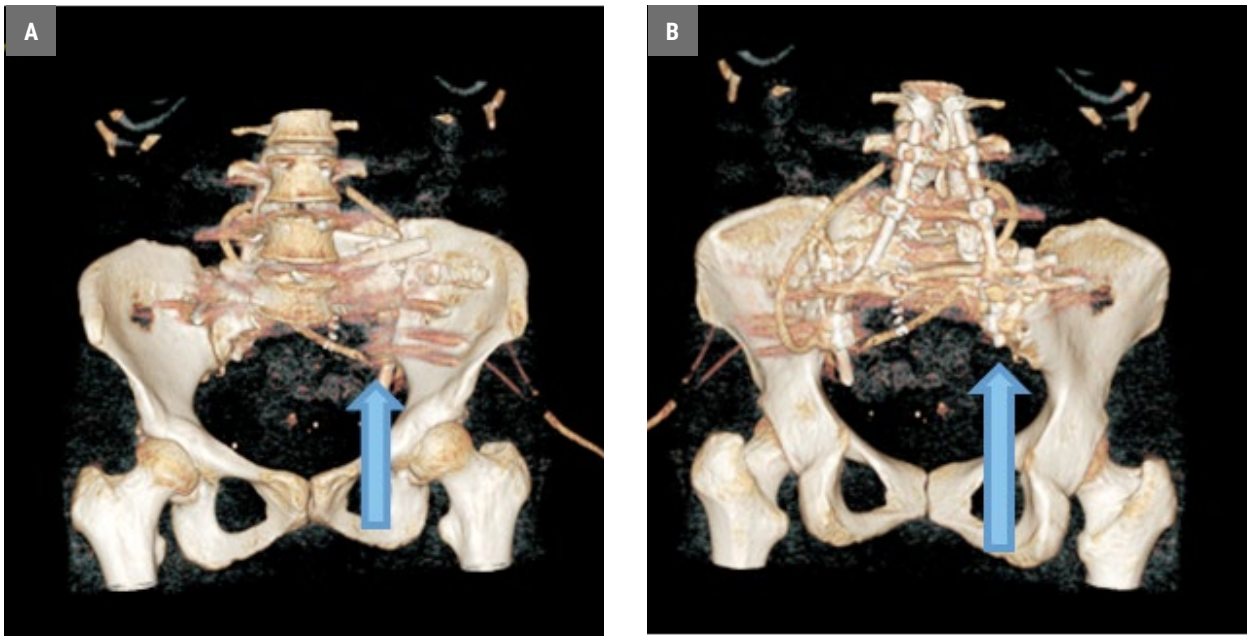

Fig. 3. 3D SCT reconstruction of the pelvis after stage 2 (arrows indicate the zone of additional stabilization of the pelvis).

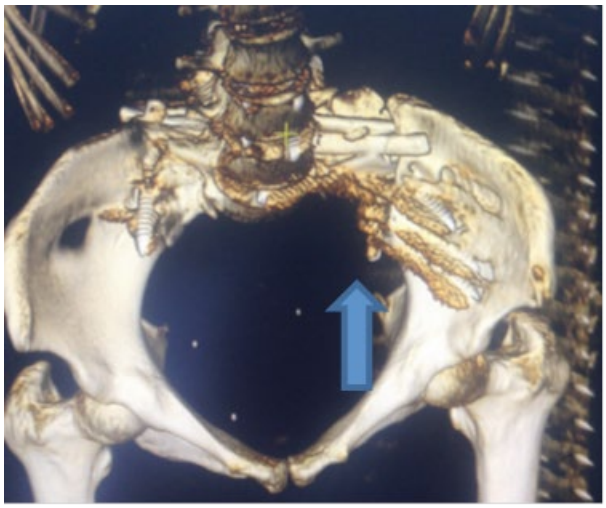

Fig. 4. 3D SCT pelvic reconstruction six months after stage 2 (arrows indicate the emerging spondyloidesis).

Fig. 5. SCT of the right hip joint (indicated tumor).

RESEARCH RESULTS AND DISCUSSION

The presented cases of two-stage surgical treatment with extensive postresection bone defects in pelvic and sacral tumors were evaluated according to the following criteria: surgical, orthopedic, oncological.

Surgical result. At stage 1, the average duration of the operation was 3.5 hours, intraoperative blood loss was 1–4.5 l. The average length of hospital stay was 18 days. All patients were prescribed adequate antibiotic therapy, anticoagulant therapy, and accompanying therapy.

Complications after stage 1: 1 patient had necrosis of the wound edges, infection of seroma, which required necrectomy and wound rehabilitation with preservation of implants.

In all patients, stage 2 (reconstructive stage) was not accompanied by great traumatism. The average blood loss is 800 ml. The average duration of the operation was 2 hours. There were no complications after the reconstructive stage of the operation.

Orthopedic result. Patients were activated with lifting on crutches for 2–4 days (at each of the 2 stages). Rehabilitation doctors and psychologists worked with patients every day.

The functional result was evaluated according to the Enneking scale [13]. In 1 patient after reconstruction of the acetabulum and hip joint with an endoprosthesis, the functional result was assessed as good. In patients after sarcectomy, the functional result was assessed as good and satisfactory.

Oncological result. All patients underwent radical surgical intervention – according to the morphological conclusion, the resection edges are negative (R0) in all patients. Patients (according to indications) received adjuvant chemo-radiation therapy according to clinical recommendations [14].

The follow–up period for patients is 6–36 months. Relapse in 1 patient (after 1 year), 1 patient died – generalization of the process (metastases to the lungs after 12 months), in 5 patients there are no signs of relapse and metastases.

Clinical case No. 1. Patient R., 39 L., in IX-2017, complained of pain in the sacrum, weakness in the n/ extremities, pelvic disorders and impaired walking function (previously, she had been treated for polyosteochondrosis for more than six months). She moved in a wheelchair and for short distances with a walker. During the examination, a tumor lesion of the sacrum was diagnosed with a soft-tissue intraphase component and compression of the roots of the sacral canal and extra-channel on the left (Fig. 1). According to the conclusion of trepan biopsy and IHC – a malignant tumor of sarcomatous nature, the morphological picture and immunophenotype most correspond to pleomorphic liposarcoma. She refused the proposed surgical treatment. The patient underwent 8 courses of polychemotherapy radiation therapy in II-2018 (50Gr) – there is a slight positive effect with partial regression of pain and radicular syndrome.

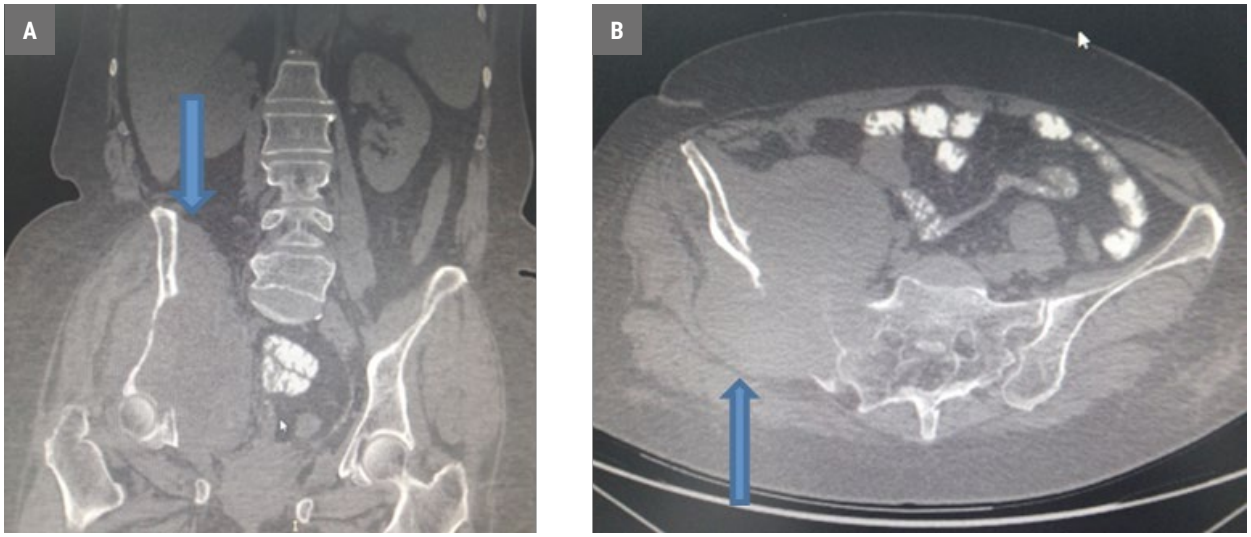

Fig. 6. Pelvic SCT, fibrosarcoma of the iliac bone after 4 weeks (the tumor is indicated).

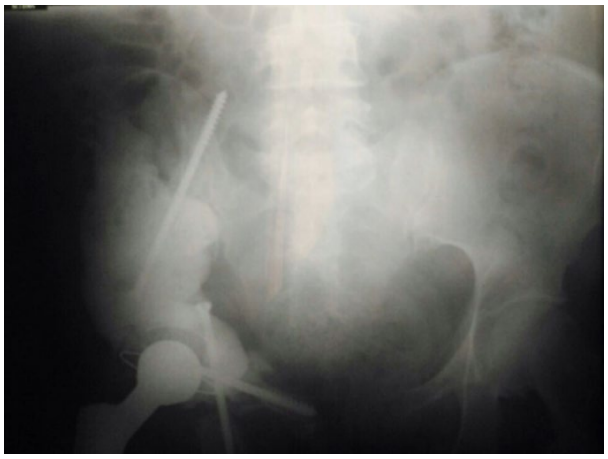

Fig. 7. Pelvic X-ray in direct projection after stage 1.

Taking into account the volume and duration of the intervention, radiation changes in the access area, and the high risk of infectious complications, it was decided to divide surgical treatment into two stages. In IX-2018, the first stage was sacrectomy with resection of the left sacroiliac joint, lumbo-pelvic stabilization (Fig. 2). The duration of the operation was 4 hours 50 minutes, blood loss was 3.0 liters; the Cell-Saver Sorin system was used.

In III–IV-2018, the 2nd reconstructive stage of intervention was planned, but the patient applied only in V-2019. She complained of pain in the area of surgery. There is no data for a relapse on SCT. Fatigue fracture of the locking rod, instability of the structure on the side of the greatest defect was revealed. 05/20/2019 – stage 2 reconstructive surgery: fusion with auto-allografts, supplemented with lumbar-pelvic stabilization (Fig. 3).

XI-2019, control examination of the patient. The data for tumor recurrence is not determined, it is already possible to see the reconstruction of transplants and the emerging spondyloidesis (Fig. 4).

Clinical case No. 2. Patient K., 49 years old. Diagnosis: (C41.4) Fibrosarcoma of the right iliac bone, G3T-2N0M0, Stil, cl. gr. 2. Applied in March 2017 (Fig. 5).

After trepanobiopsy (HA – fibrosarcoma), chirurgical treatment was offered, which the patient refused. She reapplied after 4 weeks due to increased pelvic pain. According to the CT data, rapid progression of the disease was revealed (Fig. 6). Surgical treatment (two-stage) was re-proposed.

05/17/2017 resection of the right half-ring of the pelvis with the right hip joint was performed, the defect was replaced with a cement articulating spacer and a femoral component of the endoprosthesis (Fig. 7).

The tumor was removed in one block. The edges of the resection R0. Then 3 courses of adjuvant polychemotherapy were conducted.

Histological conclusion: Low–grade fibrosarcoma with extensive foci of necrosis, hemorrhages, with destruction of bone beams (G3), in some areas – undifferentiated fibrosarcoma with the presence of

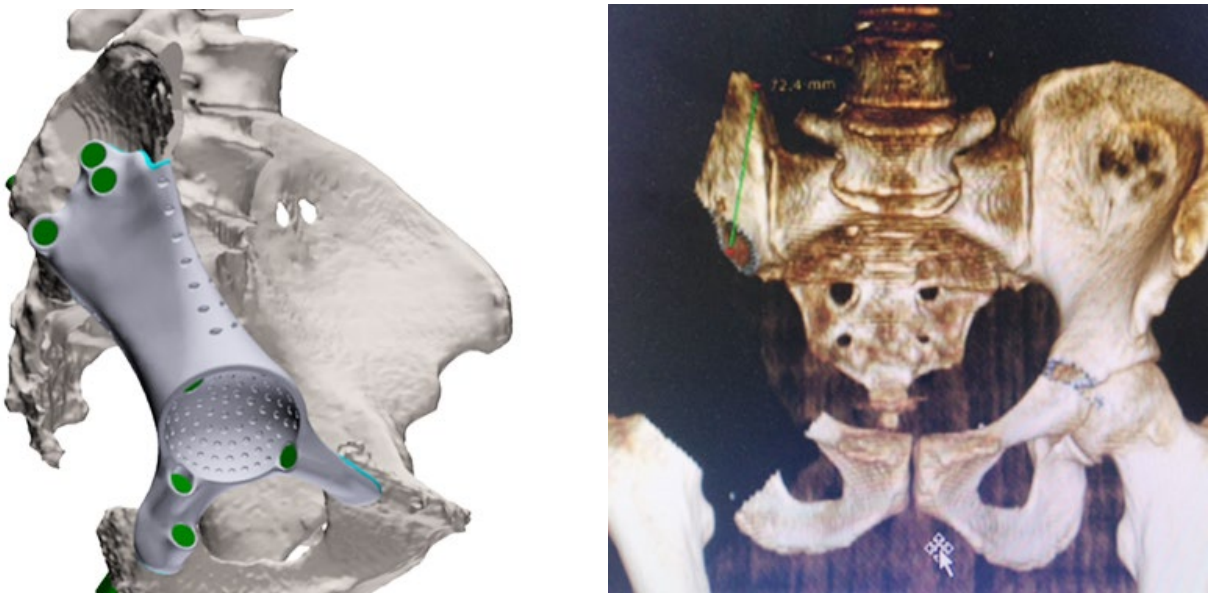

Fig. 8. 3D SCT-pelvic reconstruction, preoperative planning of an individual endoprosthesis.

multinucleated cells; resection lines without signs of tumor growth; in the lymph node – hyperplasia of lymphoid tissue, focal fibrosis.

4 courses of adjuvant polychemotherapy were performed (doxorubicin 75 mg/m^2 in the form of a 72-hour infusion, ifosfomide 2.5 g/m^2 in the form of a 3-hour infusion in 1–4 days).

During this time, an individual pelvic endoprosthesis was made (Fig. 8).

09/05/2017 by stage 2 was performed pelvic reconstruction with an individual titanium implant with hip replacement (Fig. 9).

CONCLUSION

1. The use of the described 2-stage technique allowed avoiding severe infectious complications requiring removal of implants and grafts in all patients.

2. Adequate vertebral-pelvic stabilization and (or) spacing of the defect contributes to the early functional rehabilitation of patients and the continuation of adequate adjuvant therapy in the inter-stage period, and also gives the surgeon time to prepare implants for the reconstructive stage of treatment.

3. The delayed reconstruction makes it possible to reduce the duration and traumatism of the main intervention without affecting the final result of treatment.

Fig. 9. A direct radiograph of the pelvis after stage 2 II-2019. According to the CT data, there is no data on local relapse.

Reference

1. Zatsepin ST. Bone pathology of adults. Moscow: Medicine, 2001, 640 p. (In Russ.).
2. Piven IM, Shlykov IL, Kuznetsova NL. Features of treatment of patients with pelvic bone tumors. Bulletin of Traumatology and Orthopedics named after V. D. Chaklin. 2010;3(3):63–65. (In Russ.).
3. Aliyev MD, Sokolovsky VA, Dmitrieva NV, Sinyukova GT, Sycheva LYu, Amiraslanov AA, et al. Complications of endoprosthetics in patients with bone tumors. Bulletin of the N. N. Blokhin Russian Research Center of the Russian Academy of Sciences, 2003;14(2-1):35–39. (In Russ.).
4. Karpenko VU, Derzhavin VA, Shchupak MU, Zheravin AA, Buharov AV, Bondarev AV, et al. Reconstruction with modular endoprosthesis after periacetabular resections in patiens with pelvic tumors. Early results. Multicenter research. Siberian Journal of Oncology. 2016;15(1):11–18. (In Russ.). https://doi.org/10.21294/1814-4861-2016-15-1-11-18
5. Zubritsky VF, Kozlov YuA. Infectious complications during large joint replacement. Bulletin of the National Medical and Surgical Center N. I. Pirogov. 2012;7(1):98–103.
6. Feldenzer JA, McGauley JL, McGillicuddy JE. Sacral and presacral tumors: problems in diagnosis and management. Neurosurgery. 1989 Dec;25(6):884–891.
7. Stener B, Gunterberg B. High amputation of the sacrum for extirpation of tumors. Principles and technique. Spine (Phila Pa 1976). 1978 Dec;3(4):351–366. https://doi.org/10.1097/00007632-197812000-00009
8. Konovalov NA, Korolishin VA, Asyutin DS, Timonin SYu, Martynova MA, Zakirov BA, et al. Complications of surgical treatment of sacral tumors. Questions of neurosurgery named after N. N. Burdenko. 2019;83(1):67–74. (In Russ.). https://doi.org/10.17116/neiro20198301167

9. Chernogorov PV, Vashchenko LN, Rastorguev EE, Atmachidi DP, Luganskaya RG, Ausheva TV, et al. Surgical treatment of malignant tumors of the sacrum. St. Petersburg: Collection of Scientific Articles. Modern Achievements of Traumatology and Orthopedics, 2018, 271–274 p. (In Russ.).
10. Teplyakov VV, Karpenko VYu, Derzhavin VA, Frank GA, Bulanov AA, Bukharov AV, et al. Reconstructive surgery in treatment of patients with malignant tumors of the pelvic ring. Sarcomas of the Bones, Soft Tissues and Skin Tumors. 2012;(3):16–29. (In Russ.).
11. Aliev MD, Musaev ER. Epidemiology of sacral tumors. Review. Sarcomas of the Bones, Soft Tissues and Skin Tumors. 2014;(1):7–15. (In Russ.).
12. Derzhavin VA, Karpenko VYu, Bukharov AV. Reconstruction of the pelvic ring in patients with tumors of the sacroiliac joint. Siberian journal of oncology. 2015;1(3):38–44. (In Russ.).
13. Enneking WF, Dunham WK. Resection and reconstruction for primary neoplasms involving the innominate bone. J Bone Joint Surg Am. 1978 Sep;60(6):731–746.
14. Ministry of Health of the Russian Federation. Clinical recommendations. Malignant bone tumors. 2018. Available at: http://oncology.ru/association/clinical-guidelines/2018/zlokachestvennye_opukholi_kostey_pr2018.pdf, Accessed: 22.02.2022.

Information about authors:

Larisa N. Vashchenko – Dr. Sci. (Med.), professor, head of the department tumors of bones, skin, soft tissues and breast, National Medical Research Centre for Oncology, Rostov-on-Don, Russian Federation. ORCID: https://orcid.org/0000-0002-7302-7031, SPIN: 5573-4396, AuthorID: 286598

Pavel V. Chernogorov – MD, trauma and orthopedics doctor at the department of tumors of bones, skin, soft tissues and breast, National Medical Research Centre for Oncology, Rostov-on-Don, Russian Federation. ORCID: https://orcid.org/0000-0002-1202-497X, SPIN: 4643-4485, AuthorID: 922419

Roza G. Luganskaya – Cand. Sci. (Med.), MD, surgeon at the department of tumors of bones, skin, soft tissues and breast, National Medical Research Centre for Oncology, Rostov-on-Don, Russian Federation. ORCID: https://orcid.org/0000-0002-5608-3816, SPIN: 7257-9950, AuthorID: 734149

Artem A. Barashev – Cand. Sci. (Med.), MD, oncologist at the department of tumors of bones, skin, soft tissues and breast, National Medical Research Centre for Oncology, Rostov-on-Don, Russian Federation. SPIN: 4590-5745, AuthorID: 697517

Ekaterina S. Bosenko – Cand. Sci. (Med.), MD, surgeon at the department of tumors of bones, skin, soft tissues and breast, National Medical Research Centre for Oncology, Rostov-on-Don, Russian Federation. ORCID: https://orcid.org/0000-0002-9465-9935, SPIN: 5440-0334, AuthorID: 799243

Tatiana V. Ausheva – Cand. Sci. (Med.), MD, oncologist at the department of tumors of bones, skin, soft tissues and breast, National Medical Research Centre for Oncology, Rostov-on-Don, Russian Federation. ORCID: https://orcid.org/0000-0002-7073-9463, SPIN: 5069-4010, AuthorID: 264138, ResearcherID: AAQ-9943-2020

Natalia S. Saforyan✉ – Cand. Sci. (Med.), MD, surgeon at the department of tumors of bones, skin, soft tissues and breast, National Medical Research Centre for Oncology, Rostov-on-Don, Russian Federation. ORCID: https://orcid.org/0000-0002-7511-2715, SPIN: 1444-9003, AuthorID: 430648

Contribution of the authors:

Vashchenko L. N. – scientific editing and consulting;
Chernogorov P. V. – surgeries, research concept and design, manuscript writing, material processing;
Luganskaya R. G. – collection, analysis and interpretation of data, surgical assistance, article preparation;
Barashev A. A. – surgeries, collection, analysis and interpretation of data;
Bosenko E. S. – technical editing, bibliography design, illustration preparation, article preparation;
Ausheva T. V. – surgical assistance, collection, analysis and interpretation of data;
Saforyan N. S. – surgical assistance, material processing.