

**PREOPERATIVE 3D PLANNING OF ORGAN-PRESERVED FOR PELVIC BONE
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ABSTRACT

Preoperative planning with the use of modern methods of radiation imaging makes it possible to determine with high accuracy the surgical tactics for pelvic tumors, which is due to the possibility of identifying important anatomical structures adjacent to the tumor (neurovascular structures, hollow organs), planning the volume of resection, as well as studying the macro specimen. It also provides an opportunity to compare the pre- and postoperative state after the operation, as well as the volume of the resected bone fragment with the planned one.

KEYWORDS: neurovascular structures, hollow organs.**INTRODUCTION**

The treatment of malignant tumors of the pelvic bones is still a difficult problem in clinical oncology. Operations for tumors of the pelvic bones are less developed and insufficiently illuminated in the literature compared with diseases of other parts of the musculoskeletal system.^[1,2,3]

Several decades ago, the majority of patients with tumor lesions of the pelvic bones underwent mutilation (interilio-abdominal dissection), which were accompanied by massive blood loss, frequent postoperative complications, high postoperative mortality, unsatisfactory functional results and patient disability. Performing a radical resection of the pelvic bones during tumor removal is often accompanied by a violation of the integrity of the pelvic ring.^[4,5,6] When performing a surgical intervention on the anterior semicircle, which includes the upper and lower branches of the pubic and ischial bones, restoration of the continuity of the pelvic bones is not required, since after such operations the quality of life of patients does not significantly decrease. Violation of the integrity of the pelvic bones in the posterior semicircle leads to an uneven distribution of mechanical stress between the spine and lower extremities, as a result of which the axial function of the skeleton is impaired, the support ability of the lower extremities is significantly reduced, and the patient loses the ability to move without additional support.^[7]

Resection of the pelvic bones, especially in the area of the sciatic tuberosity and the ilio-sacral joint, are technically difficult surgical interventions, due to the complex geometric three-dimensional structure of the pelvic bones, as well as the proximity of important organs and neurovascular structures. The high percentage of local recurrences is due to the complexity of the anatomical and topographic structure of the pelvis and the limited operative working field, and according to various authors it is 28-35%. In addition, improper planning, without taking into account the soft tissues of the pelvic region, or its failure to perform, leads to incorrect performance of intraoperative osteotomy, which, in turn, can have far-reaching consequences, expressed in a decrease in local control.^[8,9]

MATERIAL AND METHODS

We applied the preoperative planning method using MSCT and 3D reconstruction. The main tasks of preoperative planning were to determine the extent of the tumor and the involvement of surrounding organs and tissues in the process, as well as to accurately determine the edges of the resection. A distinctive feature of the planning method we proposed was that, in order to recreate the intraoperative situation during MSCT, the position of the patient during the study fully corresponded to his position during the planned operation, which is really important due to the displacement of anatomical structures and a change in the topographic location of organs and bones. pelvis. Significant moments at this stage were the use of various types of rollers, pillows, head restraints and fixation

devices, which thereby create an intraoperative position of the patient. The advantage of using MSCT apparatus for planning radiation therapy is the flat surface of the table, which corresponds to the surface of the operating table, while standard MSCT machines have a concave surface.

In addition, the patient was marked with a permanent marker on the skin and metal wires and point metal marks, indicating important bone and anatomical landmarks, which in turn greatly facilitated orientation both during 3D planning and during surgery.

During the use of the Monaco planning system, the boundaries of the osteotomy of the pelvic bones were delineated, as well as the distances from the anatomically important points, at the angles and direction of the osteotomy path during the operation, were measured.

The criterion for the effectiveness of preoperative 3D planning was the status of the resection margins after surgery, as well as the percentage of intraoperative complications. In addition, we compared MSCT of the resection volume in the preoperative period, obtained with 3D reconstruction and MSCT after resection.

The first stage of preoperative planning was the construction of a three-dimensional model of the pelvis using MSCT.

For the further stages of preoperative planning, a planning system for radiotherapy was used.

During preoperative 3D planning, it is possible to outline the volume of resection, as well as organs, tissues and neurovascular structures on CT slices. The scanning step was 1 mm. After the completion of the MSCT, the obtained images are transmitted via the local network to the planning system.

The contouring of the resection volume was carried out together with a radiation therapist and a general

oncologist surgeon. When planning the volume of resection, both the macroscopic volume of the tumor, which is the instrumentally visualized volume of the tumor, and the boundaries of the possible microscopic spread of the tumor, which is 2 cm from the edges of the visible tumor, were taken into account.

The postoperative material was compared with the planned preoperative resection volume using software.

RESULTS

Clinical example

Patient B., born in 1976, was admitted to the hospital with complaints: pain in the sacrum region radiating to the right leg.

Anamnesis: Considers herself ill around January 2019, when she noted pain in the lumbar spine irradiating to the right leg. In September 2019, due to increased pain syndrome, she performed MRI of the lumbosacral spine, which revealed a volumetric formation of the S1 vertebra on the right. Biopsy performed. Histology is a highly differentiated chondrosarcoma. Revision of histological preparations No. 4906/19 - Highly differentiated chondrosarcoma.

Local status: Moves with crutches. Sparing lameness on the right. Visually in the right iliac region without signs of tumor growth. On palpation without clear signs of a tumor, local pain is noted. The skin is not changed. Movement in the hip joint in full. Peripheral l / nodes are not enlarged. ECOG - 1. Karnofski - 90, VAS - 4. Watkins -1.

Diagnosed with malignant neoplasm of the pelvic bones, sacrum and coccyx, diagnosis code according to ICD-10 C41.4. Chondrosarcoma of the sacral vertebrae SI G2T2bNOM0 (IIB)

The patient underwent preoperative planning according to our proposed technique.



Fig. 1: Preoperative laying and marking of the patient.

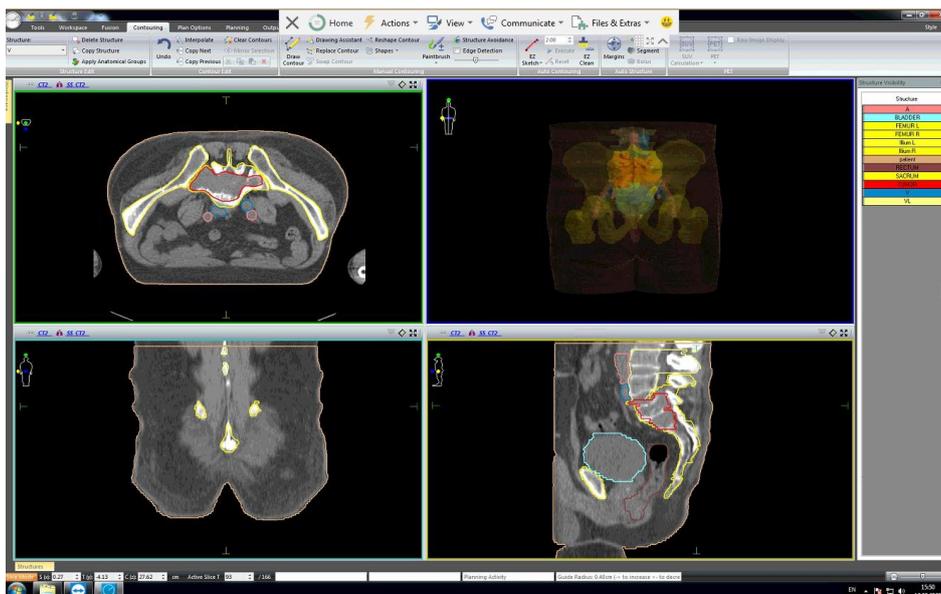


Fig. 2: The process of delineating anatomical structures and tumors in different projections.

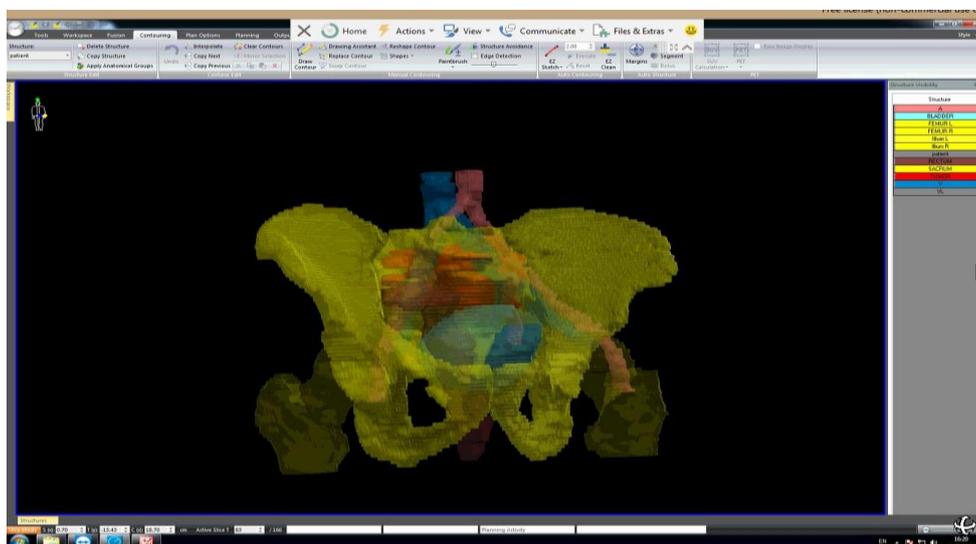


Fig. 3: 3D reconstruction of the pelvis with the isolation of the vessels, rectum, urinary bladder (front view).

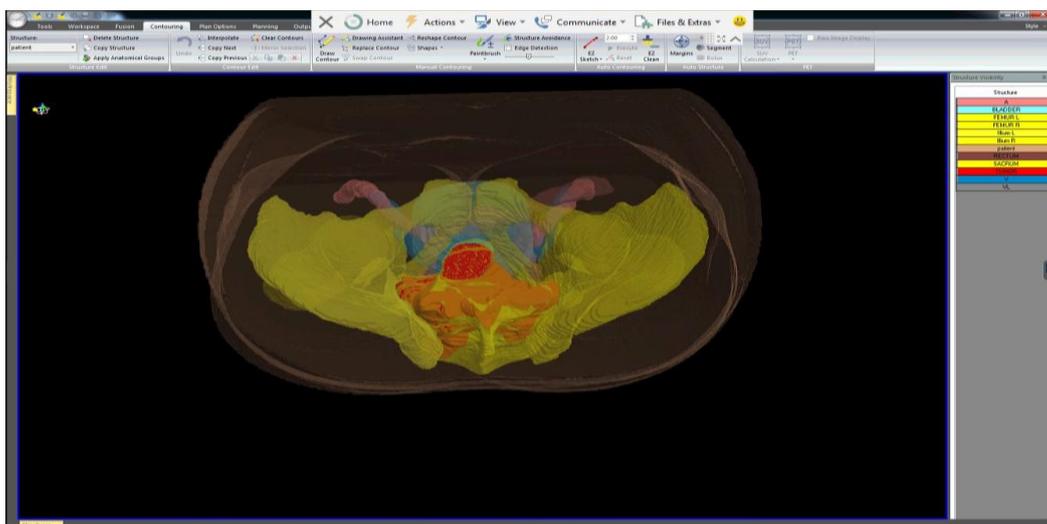


Fig. 4: 3D reconstruction with the isolation of the vessels, rectum, bladder (top view).

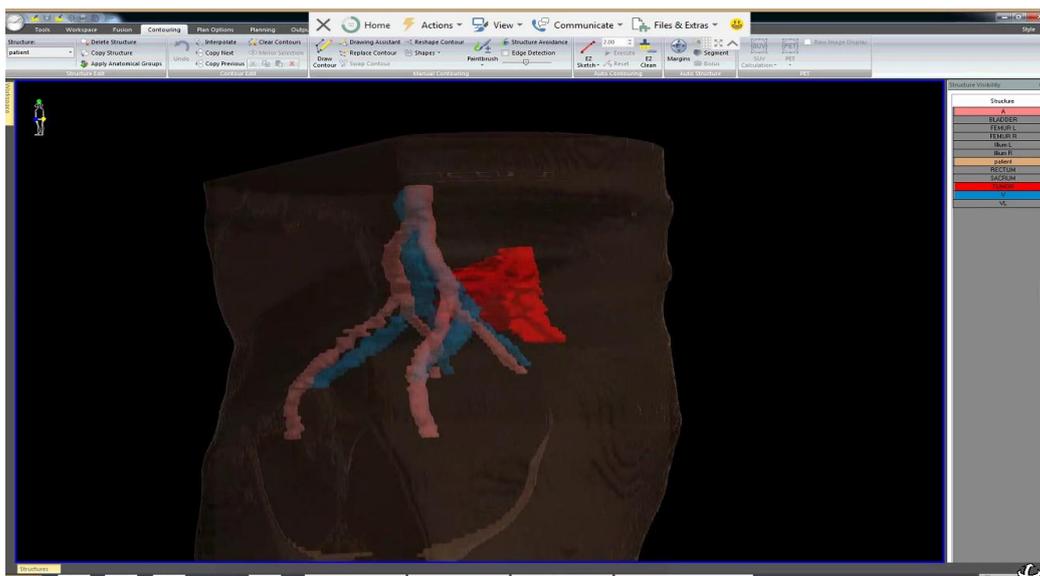


Fig. 3: The stage of determining the relationship of the tumor with the large main vessels (side view).

Surgical treatment was performed in the amount of sacrumectomy with restoration of the integrity of the pelvic ring.

The postoperative material, as well as the MSCT after the operation, were compared with the MSCT picture of the macropreparation obtained during 3D planning.

The histological conclusion: the morphological picture corresponds to the chondrosarcoma G2 of the sacrum.

Complications of surgical treatment: none.

For the current period, relapse and metastases are not observed.

In order to study the effectiveness of preoperative planning, we studied the time of surgical interventions, the number of repeated intraoperative resections, as well as the status of the resection margins.

Table 1: Comparative analysis of the duration of surgery for pelvic bone tumors with/without the use of preoperative 3D planning.

Duration of pelvic bone resection	Average duration (min)
using the 3D planning technique	60,95±7,3
without using the 3D planning technique	81,9±10,54

T=3,705, p<0,05, freedom level=9

Table 2: Resection margin status and percentage of intraoperative repeat resections depending on the use of preoperative 3D planning.

Parametr	With 3 D planning	Without 3 D planning	χ^2	p	
Resection margin status					
Positive	0	8	30,8	7,134*	0,008
Negative	21	14	53,8	7,134*	0,008
Intraoperative re-resection					
Yes	0	6	23,1	4,578*	0,033
No	21	16	61,5	4,578*	0,033
Intraoperative blood loss					
Yes	0	3	13,6	1,336*	0,248
No	21	19	86,4	1,336*	0,248

* value of the χ^2 test with Yates correction (number of observations in one group > 5)

When analyzing the results of using our proposed preoperative planning, it was revealed that a statistically significant decrease in the duration of the operation, due to a decrease in decision-making time, as well as a more accurate understanding of the topographic location of the

tumor, as well as its relationship with the surrounding anatomical structures. In addition, it should be noted that in the group of patients who underwent preoperative 3D planning, there was no resection, as well as a negative status of the resection margins during the pathological

examination. Also in this group, there was no intraoperative complication in the form of bleeding.

SUMMARY

Resection of the pelvic bones, especially in the area of the sciatic tuberosity and the ilio-sacral joint, are technically difficult surgical interventions, due to the complex geometric three-dimensional structure of the pelvic bones, as well as the proximity of important organs and neurovascular structures. The high percentage of local recurrences is due to the complexity of the anatomical and topographic structure of the pelvis and the limited operative working field, and according to various authors it is 28-35%. In addition, improper planning, without taking into account the soft tissues of the pelvic region, or its failure to perform, leads to incorrect performance of intraoperative osteotomy, which, in turn, can have far-reaching consequences, expressed in a decrease in local control.

Preoperative planning with the use of modern methods of radiation imaging makes it possible to determine with high accuracy the surgical tactics for pelvic tumors, which is due to the possibility of identifying important anatomical structures adjacent to the tumor (neurovascular structures, hollow organs), planning the volume of resection, as well as studying the macro specimen. It also provides an opportunity to compare the pre- and postoperative state after the operation, as well as the volume of the resected bone fragment with the planned one. All these data play an important role in determining further treatment tactics, as well as an individual approach to chemotherapy and radiation therapy in an adjuvant mode.

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