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ORIGINAL ARTICLE

NOVALIS TX RADIOSURGICAL PLATFORM EXPERIENCE IN NATIONAL MEDICAL RESEARCH CENTRE FOR ONCOLOGY OF THE MINISTRY OF HEALTH OF RUSSIAN

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ABSTRACT

Purpose of the study. The primary study presents an analysis of the results of stereotactic radiosurgery (SRS) and hypofractionated stereotactic radiotherapy (SRBT) of extra — and intracranial tumors obtained during four years of observation at «National Medical Research Centre for Oncology».

Material and methods. The study enrolled 277 patients. 184 patients (66.4%) received SRS, 54 patients (19.5%) received intracranial SRT, 39 patients (14.1%) received extracranial SRBT. Radiation treatment plans were developed with iPlan and Elements planning software, BrainLab. Radiation therapy was performed with Novalis Tx, Varian linear accelerator. Outcome assessment was performed with iPlan and Elements software, BrainLab, by comparing tumor volumes based on brain MRI series for brain tumors (or CT imaging for extracranial pathology) before the treatment and during four-year follow-up. Stereotactic radiosurgical and hypofractive radiotherapy techniques were used. In radiosurgical surgery, radiation therapy was performed with a single high-precision approach of the therapeutic dose to the target for the purpose to reach biological effect in the irradiated volume with minimal impact on the surrounding tissues. Single focal doses (SFD) were selected due to histology, and the dose was prescribed according to the accepted criteria of The International Commission on Radiation Units and Measurements (ICRU) (2010) Report 83. Hypofractionated stereotactic radiotherapy was performed using 2–5 Fractions (FR) with an average range of 3–10 Gy.

Results. During the entire period of observation tumor volume and clinical symptoms in patients who received SRS were reported to reduce in 69.8%, to be stable in 19.6%, increased in 9.8%, respectively. For patients, who received intracranial SRT, tumor volume and clinical symptoms were reported to reduce in 59.3%, increased in 21.4%, to be stable in 9.3%. For patients with extracranial tumors, who went SRBT, tumor volume and clinical symptoms were reported to be stable in 58.9%, reduced in 38.5%, increased in 6.7%.

Conclusion. The analysis of the obtained data shows the high efficiency of SRS and SRBT methods, which allow to achieve local control over both malignant and benign tumours.

Keywords:
radiation therapy, radiosurgery, SRS, SBRT, SRT, tumor.

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ОРИГИНАЛЬНАЯ СТАТЬЯ

ОПЫТ ПРИМЕНЕНИЯ РАДИОХИРУРГИЧЕСКОГО КОМПЛЕКСА NOVALIS TX В ПРАКТИКЕ ФГБУ «НМИЦ ОНКОЛОГИИ» МИНЗДРАВА РОССИИ

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РЕЗЮМЕ

Цель исследования. Анализ полученных в течение четырех лет наблюдений результатов проведенной стереотаксической радиохирургии (SRS) и стереотаксической радиотерапии в режиме гипофракционирования (SRBT) экстра- и интракраниальных опухолей в ФГБУ «НМИЦ онкологии» МЗ РФ.

Пациенты и методы. В исследование включено 277 пациентов, разделенные на 3 группы. В первой группе 184 пациента (66,4%) с примененной SRS, во второй группе 54 пациента (19,5%) с примененной SRT, в третьей группе 39 больных (14,1%) с проведенной SRBT экстракраниальных опухолей. Разработка планов лучевой терапии проводилась на системах планирования iPlan и Elements, BrainLab. Лучевая терапия проводилась на линейном ускорителе Novalis Tx, Varian. Оценка проводилась с использованием программного обеспечения iPlan и Elements, BrainLab, путем сравнения объемов опухолей по данным МРТ исследования головного мозга и СРКТ для экстракраниальной патологии в момент лечения и в течение четырех лет наблюдения. Использовались стереотаксические радиохирургические и гипофракционные методики лучевой терапии. При радиохирургическом лечении лучевая терапия проводилась с однократным высокоточным подведением терапевтической дозы к мишени с целью биологического эффекта в облучаемом объеме при минимальном воздействии на окружающие ткани. Разовые очаговые дозы (РОД) подбирались в зависимости от гистологии, а предписание дозы проводилось согласно принятым критериям The International Commission on Radiation Units and Measurements (ICRU) (2010) Report 83. Гипофракционированная стереотаксическая лучевая терапия проводилась с использованием 2–5 Фракций (Фр) со средним диапазоном РОД 3–10 Гр.

Результаты. В течение всего периода наблюдений в группе пациентов после SRS в 69,8% случаев отмечена положительная динамика, в 19,6% отмечена стабилизация процесса, в 9,8% — отрицательная динамика. В группе SRT у 59,3% больных наблюдается положительная динамика, в 21,4% — отрицательная динамика и в 9,3% — стабилизация процесса. В группе SRBT экстракраниальных опухолей в 38,5% — положительная динамика, в 58,9% отмечена стабилизация процесса, в 6,7% — отрицательная динамика.

Заключение. Анализ полученных данных говорит о высокой эффективности методик SRS и SRBT, которые позволяют добиться локального контроля как над злокачественными, так и доброкачественными новообразованиями.

Ключевые слова:
лучевая терапия, радиохирургия, SRS, SBRT, SRT, новообразования.

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INTRODUCTION

Recently, stereotactic methods of radiation therapy for various pathological formations have come to the forefront of combined treatment of neoplasms [1]. In the classical version, radiation therapy was based on the quantitative doctrines of classical radiobiology and was performed with single focal doses up to 2 Gy. the goal of standard fractionation was to reduce the risk of damage to surrounding tissues. However, the appearance of stereotactic techniques that provide high accuracy and conformality of irradiation of the pathological focus, and the development of target visualization techniques, significantly increased the single dose of radiation and reduced the number of radiation fractions without increasing the risk of damage to normal tissues, increasing the effectiveness of radiation exposure [2]. For example, in the treatment of vestibular sutures, recent articles confirm that the control of tumor growth after radiosurgery is achieved in 93–100%. Lunsford L. D. with co-authors, he studied the results of treatment after 5 and 10 years in 829 patients with vestibular schwannomas who underwent radiosurgery at the University of Pittsburgh. This article reported 98% control of tumor growth during long-term follow-up. In 62% of cases had positive dynamics in the form of a reduction of lesions in 33% of the stabilization process, 6% negative trend in higher education [3]. Today, stereotactic radiosurgery has been considered as the first line of treatment for patients with metastatic brain damage [4]. The management of patients with brain metastases has become a serious problem due to the increasing frequency and complexity of diagnostic and therapeutic approaches [5, 6]. in 2014, the European Association of neuro-oncologists (EANO) created an interdisciplinary working group to develop evidence-based recommendations for patients with brain metastases from solid tumors [7]. Stereotactic radiation therapy and radiosurgery today play a crucial role in the treatment of not only cancer lesions, but also vascular and functional pathologies of the brain and spinal cord. For a number of diseases, this is an important part of combined treatment, and if it is impossible or there is an increased risk of surgical intervention, it is an alternative to direct surgery, often the only possible method of influencing the pathological process [8]. Available clinical data confirm the important role of stereotactic radiosurgery in achieving high local control of brain metastases.

The purpose of the study: analysis of four — year results of stereotactic radiosurgery (SRS) and stereotactic radiotherapy in hypofractionation mode (SRBT) of extra-and intracranial tumors in the Federal state budgetary institution NMRC of Oncology of the Russian Ministry of Health.

PATIENTS AND METHODS

The study included 277 patients divided into 3 groups. In the first group, there were 184 patients

Table 1. Dynamics in groups of stereotactic radiation therapy for 4 years

	Patients' number	Positive dynamics		Process stabilization		Negative dynamics	
		Benign formation	Malignant formation	Benign formation	Malignant formation	Benign formation	Malignant formation
Group I (SRS)	184	68	60	19	17	-	8
The percentage		69.8 %		19.6 %		9.8 %	
Group II (SBRT)	57	9	5	14	8	-	1
The percentage		38.5 %		58.9 %		6.7 %	
Group III (SRT)		23	8	9	-	-	11
The percentage		59.3 %		9.3 %		21.4 %	

(66.4%) with SRS: 77 (41.8%) with metastatic brain damage; 57 (31.0%) with meningiomas; 31 (16.8%) with cranial nerve neurinomas; 9 (4.9%) patients with recurrent glial tumors, 8 (4.3%) with vascular malformations, 2 (1.0%) with hemangiopericytoma and pineoblastoma.

In the second group, 54 patients (19.5%) with SRT: 23 (42.6%) with meningiomas; 14 (25.9%) with cranial nerve neurinomas; 11 (20.4%) with metastatic brain damage; 3 (5.6%) with recurrent glial tumors; 1 (1.9%) with vascular malformations; 1 (1.9%) patient with hemangiopericytoma, 1 (1.9%) patient with craniopharyngioma.

In the third group, 39 patients were (14.1%) with SRBT extracranial tumors: 21 (53.8%) with vertebral body hemangiomas; 12 (30.8%) with primary and metastatic lung lesions, 3 (7.7%) with vertebral neurinomas, 3 (7.7%) with metastatic vertebral lesions.

All patients with intracranial pathology were immobilized using a three-layer thermoplastic mask. In patients with extracranial pathology, immobilization was performed using a thermoplastic head-neck-shoulders mask and a vacuum mattress for lesions of the cervical and upper thoracic spine, and using the Stradivarius™ SBRT system using an abdominal press to exclude mobility of the area of interest during breathing of the patient with lesions of the lower thoracic, lumbar and sacral spine. Topometric computed tomography was performed on a Siemens SOMATOM tomograph. Contouring and planning was carried out using iPlan/ELEMENTS software, BrainLab. The prescription dose coverage, D95%=100%. Verification of the radiation therapy plan was performed by independent recalculation of the dose by another algorithm, verification of the treatment plan on the matrix of the ArcCheck detector, Sun Nuclear. The assessment was performed using the iPlan RT Image, Elements (BrainLab) software and by comparing tumor volumes based on MRI data of the brain and IPT for extracranial pathology from the beginning of treatment and after four years of follow-up. Stereotactic radiosurgical and hypofractive radiotherapy techniques were used. In radiosurgical radiation, radiation therapy was performed with a single high-precision approach of the therapeutic dose to the target for the purpose of biological effect in the irradiated volume with minimal impact on the surrounding tissues. Single focal doses were selected depending on histology, and dose prescribing was performed according to the accepted criteria of The International Commission on Radiation Units and Measurements (ICRU) (2010) Report 83. Hypofractionated stereotactic radiotherapy was performed using 2–5 fractions (FR) with an average range of 3–10 Gy.

STUDY RESULTS AND THEIR DISCUSSION

After four years of observation in the first group of SRS (184 patients), 69.8% of cases showed positive dynamics (68 patients with benign tumors, 60 with malignant brain tumors), 19.6% showed stabilization of the process (19 patients with benign tumors, 17 with malignant brain tumors), 9.8% showed negative dynamics (8 patients with malignant brain tumors).

In the SRBT group of extracranial tumors, 58.9% showed stabilization of the process (14 patients with benign lesions of the spine and 8 patients with malignant lesions of the lungs and spine), 38.5% showed positive dynamics (9 patients with vertebral body hemangiomas, 5 patients with malignant lesions of the lungs and spine), and 6.7% showed negative dynamics only for malignant formations (1 patient with metastatic lung damage).

In the SRT group, 59.3% of patients showed positive dynamics (23 patients with benign tumors and 8 patients with malignant brain lesions, respectively); 9,3% — stabilization of the process in 5 people with benign formations and 21.4% negative dynamics (11 patients with malignant brain lesions).

CONCLUSION

During the past few decades, clinical studies have provided insight into the effectiveness of stereotactic radiotherapy techniques. Initially, stereotactic methods of treatment were used as an adjunct to surgical and systemic methods of treatment. Over the past 20 years, data from clinical and scientific

studies of foreign and domestic sources have begun to use radiosurgical effects on pathological formations in the first line of treatment, pushing aside such methods of radiation exposure as total irradiation of the entire brain. Increased indications for SRS, SBRT, and SRT methods for benign intra-and extracranial formations. The analysis of our own data shows the high efficiency of SRS and SRBT methods, which allow us to achieve local control over both malignant and benign neoplasms.

Authors contribution:
Kit O.I. – research concept and design, scientific editing.
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