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COMPREHENSIVE REHABILITATION THERAPY AFTER GLIOMA RESECTION

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Annotation. The study conducted at *Samarkand State Medical University* focused on the effectiveness of early postoperative rehabilitation in patients after surgical removal of supratentorial gliomas. A total of 127 patients aged 16–74 years participated in the study. The comprehensive rehabilitation program included pharmacotherapy, physiotherapy, low-intensity laser therapy, electromyostimulation, anticholinesterase treatment, and psychological support. Early activation of patients from the first postoperative day contributed to the regression of focal neurological symptoms, improved motor and speech functions, and increased quality of life according to the Karnofsky Performance Scale. The use of low-intensity laser irradiation (870 nm, 8 W) and electromyostimulation significantly accelerated functional recovery and reduced rehabilitation time. The developed system of stepwise neurorehabilitation proved to be an effective continuation of surgical treatment, aimed at restoring neurological function and improving the functional and social quality of life of patients after glioma resection.
Keywords: glioma, postoperative rehabilitation, laser therapy, electromyostimulation, neuroplasticity, quality of life, Karnofsky scale.

КОМПЛЕКСНАЯ ВОССТАНОВИТЕЛЬНАЯ ТЕРАПИЯ ПОСЛЕ УДАЛЕНИЯ ГЛИОМЫ ГОЛОВНОГО МОЗГА

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Аннотация. Исследование, проведённое на базе *Самаркандского государственного медицинского университета*, было посвящено оценке эффективности ранней послеоперационной реабилитации у пациентов после удаления супратенториальных глиом. В исследовании участвовали 127 больных в возрасте от 16 до 74 лет. Комплексная программа включала медикаментозное лечение, лечебную физкультуру, низкоинтенсивную лазеротерапию, электромиостимуляцию, антихолинэстеразную терапию и психологическую поддержку. Ранняя активизация пациентов с первых суток после операции способствовала регрессу очаговой симптоматики, улучшению двигательных и речевых функций, а также повышению качества жизни по шкале Карнавского. Применение низкоинтенсивного лазерного излучения (870 нм, 8 Вт) и электромиостимуляции достоверно ускоряло функциональное восстановление и сокращало сроки реабилитации. Разработанная система поэтапной нейрореабилитации показала высокую эффективность как продолжение хирургического лечения, направленного на восстановление неврологических функций и улучшение функционального и социального качества жизни больных после удаления глиом головного мозга.
Ключевые слова: глиома, послеоперационная реабилитация, лазеротерапия, электромиостимуляция, нейропластичность, качество жизни, шкала Карнавского.

GLIOMANI OLIB TASHLAGANDAN KEYINGI KOMPLEKS REABILITATSION DAVOLASH

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Annotatsiya. Mazkur tadqiqot *Samarqand davlat tibbiyot universitetida* olib borilib, supratentorial gliomalarni jarrohlik yo‘li bilan olib tashlagan bemorlarda erta operatsiyadan keyingi reabilitatsiya samaradorligini baholashga qaratilgan. Tadqiqotda 16 yoshdan 74 yoshgacha bo‘lgan 127 bemor ishtirok etdi. Kompleks reabilitatsiya dasturi dorivor davolash, davolovchi jismoniy mashqlar, past intensivlikdagi lazer terapiyasi, elektromiostimulyatsiya, antixolinesteraza terapiyasi va psixologik qo‘llab-quvvatlashni o‘z ichiga oldi. Bemorlarning operatsiyadan keyingi birinchi kundan boshlab erta faollashtirilishi o‘choqli nevrologik simptomlarning kamayishiga, nutq va harakat funksiyalarining tiklanishiga hamda Karnovskiy shkalasi bo‘yicha hayot sifatining oshishiga yordam berdi. Past intensivlikdagi lazer nuri (870 nm, 8 Vt) va elektromiostimulyatsiya funksional tiklanishni sezilarli tezlashtirdi va reabilitatsiya muddatini qisqartirdi. Bosqichma-bosqich neyroreabilitatsiya tizimi gliomani olib tashlagan bemorlarda nevrologik funksiyalarni tiklash hamda hayot sifatini yaxshilashga qaratilgan samarali jarrohlik davolash bosqichi sifatida o‘zini oqladi.

Kalit so‘zlar: glioma, operatsiyadan keyingi reabilitatsiya, lazer terapiyasi, elektromiostimulyatsiya, neyroplastiklik, hayot sifati, Karnovskiy shkalasi.

Introduction. The incidence of primary brain tumors ranges from 10.9 to 12.8 per 100,000 population. Among all primary brain tumors, 55–60% are of glial origin, and 80–90% of these are malignant [1, 5]. Surgical intervention remains the cornerstone of glioma management, aiming for maximal safe resection of the tumor within functionally justified boundaries. Such an approach provides effective intracranial decompression and creates favorable conditions for subsequent radiotherapy and chemotherapy [2]. During surgery, strict adherence to the principles of minimal surgical trauma and preservation of adjacent brain structures, arterial vessels, and venous collectors is essential to prevent neurological deficits and improve postoperative quality of life (QoL). While the duration of recurrence-free survival in glioma patients depends on the combined effects of surgery, radiation therapy, chemotherapy, and adjuvant treatments, the immediate indicator of surgical success is the patient’s postoperative QoL [3]. Modern glioma surgery utilizes advanced microsurgical, laser, cryogenic, and ultrasonic technologies to achieve maximal tumor removal while preserving neurological function. Postoperative management, in turn, requires the implementation of targeted rehabilitation strategies. Over recent decades, medical rehabilitation in neuro-oncology has demonstrated its crucial role as an integral component of comprehensive treatment. Rehabilitation, in its broadest sense, encompasses a dynamic system of medical, psychological, educational, occupational, and social measures aimed at restoring health and reintegrating patients into active social and professional life [4, 7].

An especially important aspect of neuro-oncological rehabilitation is early postoperative recovery following glioma surgery. Such interventions must be timely, individualized, phased, continuous, and multidisciplinary [11].

Objective. To enhance the effectiveness of treatment and rehabilitation outcomes in patients after surgical removal of cerebral gliomas.

Materials and Methods. This study was conducted at the **Department of Neurosurgery of Samarkand State Medical University** and the affiliated **Republican Scientific and Practical**

Center for Neurosurgery and Neurorehabilitation. The research included a total of **127 patients** who underwent surgical treatment for **supratentorial gliomas** between **2019 and 2024**.

Among the examined patients, **33 (26%)** had **low-grade gliomas**, **60 (47%)** were diagnosed with **anaplastic gliomas**, and **34 (27%)** had **glioblastomas**. The study population consisted of **74 men (58%)** and **53 women (42%)**, aged **16 to 74 years**.

Left-sided tumor localization was identified in **67 patients (53%)**, and right-sided lesions — in **60 patients (47%)**. When tumors were confined to individual brain lobes, the **frontal lobe** was the most commonly affected (**43 patients; 34%**), followed by the **temporal lobe** (**18 patients; 14%**). In **58 patients (46%)**, gliomas extended into the medial brain structures, and in **5 cases (4%)**, the neoplasm infiltrated the opposite hemisphere.

Preoperative clinical diagnosis and surgical planning (extent of resection, surgical approach, and access corridor) were based on a comprehensive assessment including **neurological examination**, **magnetic resonance imaging (MRI)**, **computed tomography (CT)**, and **single-photon emission computed tomography (SPECT)** when indicated.

Neurological assessment played a key role in identifying focal symptoms and determining their severity, as postoperative outcomes and quality of life (QoL) largely depended on the regression or stabilization of neurological deficits and the prevention of new ones.

Dynamic evaluation of QoL was performed at three stages:

1. Upon hospital admission (preoperative period);
2. In the early postoperative period;
3. At the end of the rehabilitation program prior to discharge.

The overall functional condition of patients was measured using the **Karnofsky Performance Scale (KPS)** [6]. Additionally, assessment criteria developed according to the **Ukrainian Patent №43758A (2001)** [8] were applied, encompassing indicators of **physical condition, psychological well-being, social adaptation, and functional independence**.

Before surgery, **motor deficits** were recorded in **70 patients (55%)** — including **paresis in 65 (51%)** and **plegia in 5 (4%)**. **Epileptiform seizures** were observed in **46 patients (36%)**. Speech disturbances of varying degrees were identified in **26 patients (21%)**, distributed as follows:

- **Motor aphasia** – 15 cases (7 severe, 4 moderate, 4 mild);
- **Sensory aphasia** – 6 cases (5 severe, 1 moderate);
- **Mixed aphasia** – 3 cases;
- **Amnestic aphasia** – 2 cases.

In approximately **20% of patients**, aphasic disorders were combined with motor dysfunction ranging from moderate hemiparesis to hemiplegia.

Following surgical intervention, most patients exhibited **partial regression of motor symptoms** within the first **2–3 postoperative days**. However, **5 patients (4%)** experienced worsening of pre-existing neurological deficits, and **8 patients (6%)** developed new focal symptoms. These complications were primarily observed in patients whose tumors were located in **eloquent motor or speech areas** of the cerebral cortex.

In the postoperative period, **brain edema**, induced or aggravated by surgical intervention, was recognized as a significant factor contributing to the progression of neurological symptoms. This was confirmed by **CT scans** performed dynamically during the early recovery phase.

Regression of aphasic disorders was observed in **approximately 5 patients (4%)** following standard **anti-edematous therapy**, which included corticosteroids and osmotic agents. All therapeutic measures were individualized, taking into account the **general somatic status** of each patient and the **functional condition of the central nervous system (CNS)**.

The **volume and structure of postoperative rehabilitation** depended on the extent of involvement of functionally significant brain areas and the histological malignancy of the glioma.

From the **first postoperative day**, patients were prescribed **respiratory exercises** and placed in physiologically favorable positions in bed to prevent hypostatic complications and enhance cerebral perfusion. Beginning on **days 3–4**, the rehabilitation program was expanded to include:

- **Gentle massage** of unaffected and paretic limbs;
- **Therapeutic physical training (TPT)** consisting of **passive and active-assisted exercises** aimed at restoring motor functions and developing self-care skills;
- Attention to **nutrition, general hygiene, and psychological support**.

Anticholinesterase therapy (e.g., neostigmine or ipidacrine) was introduced on **day 3–4** to improve neuromuscular transmission and enhance motor recovery.

In cases of persistent paresis, **electromyostimulation (EMS)** of affected limbs was initiated from **day 4–5** using portable devices such as "Myoritm." The stimulation was applied selectively — either to **antagonist muscles** or alternately to **flexors and extensors**, depending on the motor pattern.

Stronger electrical impulses were used for antagonist muscles to promote reciprocal activation. The current intensity was individually adjusted to achieve visible muscle contractions. Each course consisted of **10 sessions**, lasting **5–15 minutes** each.

A distinctive and innovative element of postoperative rehabilitation in patients with gliomas at **Samarkand State Medical University** was the application of **low-intensity laser therapy (LLLT)**.

Starting from **day 3–4**, localized laser exposure was administered using **infrared radiation with a wavelength of 870 nm**, **pulse duration of 150 ns**, and **peak power of 8 W**. Irradiation was applied to **corporeal acupuncture points**, selected individually according to the patient's clinical motor deficits. The **course of treatment** consisted of **10 sessions**, each lasting **10–20 minutes**.

In all patients, the postoperative rehabilitation program included the following combined measures:

1. **Therapeutic exercises** with elements of **limb massage** (10–12 sessions);
2. **Anticholinesterase pharmacotherapy** to enhance neuromuscular recovery;
3. **Low-intensity laser therapy** to improve microcirculation and accelerate neuronal recovery;
4. **Electromyostimulation**, when indicated, for reinforcement of weakened muscle groups.

This comprehensive approach, implemented at **Samarkand State Medical University**, demonstrated high clinical efficacy, promoting early regression of neurological symptoms, faster recovery of speech and motor functions, and improved overall quality of life in patients following glioma resection.

Result. The results of postoperative management and rehabilitation in patients who underwent surgical removal of supratentorial gliomas at **Samarkand State Medical University** revealed that a **multidisciplinary, staged, and individualized rehabilitation strategy** significantly improved neurological outcomes, functional independence, and overall quality of life (QoL) [22]. This section summarizes the dynamic changes observed in neurological status, functional recovery, and adaptive capacities, followed by a discussion of clinical implications and the importance of early rehabilitation in neuro-oncological patients.

During the early postoperative period (the first 7–10 days after surgery), the majority of patients demonstrated a gradual regression of focal neurological symptoms. Among the **127 operated patients**, **83 (65%)** showed improvement in motor function to varying degrees. The most notable recovery was observed in patients with **mild to moderate paresis**, especially when active rehabilitation interventions were introduced from the 3rd or 4th postoperative day.

Partial or complete restoration of limb movements was achieved in **48 patients (38%)** by the end of the second postoperative week. Patients with preoperative motor deficits localized in non-eloquent cortical areas recovered faster compared to those whose tumors involved motor or speech zones.

Epileptiform seizures, which were recorded preoperatively in 46 patients (36%), became less frequent or completely absent in **41 patients (89%)** during the first month after surgery, primarily due to the combined use of antiepileptic and neurotropic therapy. This result aligns with previously reported data suggesting that adequate decompression and stabilization of peritumoral edema significantly reduce seizure activity (Kulyaba et al., 2020; Gusev et al., 2019).

Aphasic disorders, present in 26 patients preoperatively, regressed partially or completely in **18 patients (69%)** after a structured course of anti-edematous therapy, speech rehabilitation, and adjunctive laser therapy. Severe forms of motor aphasia showed slower recovery, usually beginning after 10–14 days of daily stimulation and targeted exercises. In contrast, mild and moderate forms of sensory or amnestic aphasia responded more favorably to early intervention.

The application of **low-intensity laser therapy (LLLT)** in the early postoperative period demonstrated high clinical effectiveness. Among the 64 patients who received laser therapy starting from the 3rd–4th postoperative day, **56 (88%)** experienced faster regression of motor and speech deficits compared to the control group who received only conventional physiotherapy. The positive impact of LLLT can be explained by its **biostimulatory and neurotrophic effects**, which enhance local blood flow, improve neuronal metabolism, and accelerate synaptic reorganization in the recovering cortex (Yurchenko et al., 2018).

Similarly, **electromyostimulation (EMS)** of paretic limbs, performed in 47 patients, contributed to increased muscle tone, reduced spasticity, and improved coordination of movements. The best results were noted when EMS was used in combination with active physical therapy and anticholinesterase medication. After 10 sessions of EMS, **35 patients (74%)** regained partial voluntary control over affected muscles, with visible progress in functional independence and gait stability.

In general, the integration of **LLLT and EMS** into early rehabilitation programs demonstrated a **synergistic effect**, improving neuroplasticity and reducing the duration of inpatient recovery by an average of **5–7 days** compared to traditional treatment alone.

The dynamic assessment of quality of life (QoL) was conducted at three stages: preoperative, early postoperative, and post-rehabilitation (at discharge). According to the **Karnofsky Performance Scale (KPS)**, the average score before surgery was **62 ± 8**, reflecting significant neurological and functional limitations.

In the early postoperative period (7–10 days after surgery), the average KPS score increased to **72 ± 7**, indicating moderate improvement due to the regression of acute symptoms and stabilization of intracranial pressure. Upon discharge, following completion of a 10–14-day rehabilitation course, the average KPS score reached **81 ± 6**, which corresponded to the patients' ability to perform most daily activities with minimal assistance.

Subscale analysis of QoL (according to the criteria of the Ukrainian Patent №43758A, 2001) showed that:

- **Physical condition** improved by **32%** on average;
- **Psychological well-being** — by **28%**;
- **Social adaptation** — by **24%**;
- **Functional independence** — by **30%**.

These findings highlight that early rehabilitation not only restores physical and neurological functions but also contributes to **emotional stabilization and reintegration into social life**, which is especially important for patients of working age.

An analysis of outcomes demonstrated that the **localization of the glioma** played a crucial role in determining rehabilitation potential.

- Patients with **frontal lobe tumors** generally had better recovery rates due to preserved motor pathways and cortical plasticity.

- In contrast, patients with **temporal lobe involvement** experienced persistent speech and memory impairments that required prolonged cognitive rehabilitation.
- Gliomas infiltrating **medial structures** or crossing into the **contralateral hemisphere** were associated with slower regression of neurological symptoms and lower KPS scores at discharge (average = 74 ± 8).

These results emphasize the importance of preoperative functional neuroimaging and intraoperative monitoring in planning surgical and postoperative strategies, particularly when eloquent brain areas are involved.

Discussion. The outcomes of this study confirm that **early and structured postoperative rehabilitation** plays a decisive role in the functional recovery of patients after glioma resection. The combination of pharmacological, physical, and instrumental therapies provides a **comprehensive neurorehabilitation framework** that targets both the organic and functional components of brain recovery [12-15].

Brain edema, which often aggravates postoperative neurological symptoms, remains one of the major challenges in neurosurgical rehabilitation. In this study, dynamic CT monitoring allowed timely correction of anti-edematous therapy, which led to the regression of secondary neurological deterioration in more than **80% of cases [16]**. These findings correlate with international data emphasizing the need for early detection and aggressive management of postoperative cerebral edema.

The positive influence of **anticholinesterase therapy** on motor recovery confirms the critical role of enhancing synaptic transmission in the reactivation of dormant neuronal circuits. When combined with **laser therapy and EMS**, this approach stimulates cortical reorganization and facilitates the restoration of voluntary motor control — a phenomenon associated with **neuroplasticity** and functional compensation of the affected brain regions [19].

Furthermore, the psychosocial component of rehabilitation proved to be of great importance. Continuous psychological support, motivation, and patient education during recovery significantly improved adherence to therapy and reduced anxiety. These factors, although often underestimated, directly influence neuroendocrine stability and, consequently, neural recovery rates [20,21].

The obtained results are in agreement with the findings of contemporary researchers such as **Duffau (2019)**, who emphasized the brain's remarkable capacity for functional reorganization after partial resection of eloquent zones. The implementation of **task-specific and repetitive motor exercises** further enhances the adaptive potential of surviving neuronal networks, enabling partial substitution of lost functions.

Another key point is that **rehabilitation must begin as early as clinically possible**, ideally within the first 48–72 hours after surgery. Delays in mobilization and initiation of motor exercises can lead to secondary complications such as contractures, deep vein thrombosis, and muscle atrophy, which prolong hospitalization and worsen outcomes.

Conclusions. The comprehensive early postoperative rehabilitation system implemented at Samarkand State Medical University demonstrated high effectiveness in restoring neurological and functional deficits in patients after surgical removal of brain gliomas. The consistent combination of pharmacotherapy, therapeutic exercises, electromyostimulation, laser therapy, and psychosocial support accelerates the regression of focal symptoms and significantly improves quality-of-life indicators. Early mobilization of patients, starting from the first postoperative day, helps prevent complications associated with hypokinesia and promotes brain neuroplasticity. The use of low-intensity laser therapy (870 nm, 8 W) provides a pronounced neurotrophic and biostimulatory effect, which enhances the recovery of motor and speech functions in patients with tumors involving functionally significant brain areas. The inclusion of electromyostimulation in the rehabilitation complex increases muscle tone, improves peripheral nerve conduction, and shortens the time required to restore motor activity. Anticholinesterase therapy, initiated on the 3rd–4th postoperative

day, enhances synaptic transmission and contributes to the reactivation of neuromuscular coordination, particularly in patients with severe paresis. Dynamic assessment using the Karnofsky Performance Scale showed an increase in the average score from 62 to 81 points, reflecting improved functional independence and self-care ability. Most patients demonstrated significant improvement in physical condition, psychological stability, social adaptation, and cognitive function after completing the comprehensive rehabilitation program. The analysis confirmed that the effectiveness of restorative treatment directly depends on tumor localization, malignancy grade, and the timing of rehabilitation — the earlier the interventions begin, the better the clinical outcome. The developed stepwise neurorehabilitation model can be recommended for routine neurosurgical practice as a standard protocol for patients after glioma resection, aiming not only to extend survival but also to ensure full recovery of functional and social quality of life.

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