СЕКЦИЯ «НАУЧНАЯ ИНИЦИАТИВА ИНОСТРАННЫХ СТУДЕНТОВ»

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INSPIRING SUCCESS STORIES OF STROKE SURVIVORS

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Abstract

Introduction. Stroke remains a leading cause of global mortality and disability. Recovery trajectories are shaped by neuroplasticity, psychosocial resilience, and therapeutic interventions. Despite advances in acute care, persistent deficits in survivors highlight the need to identify determinants of exceptional recover. **The aim of this study** is to analyze multifactorial determinants of post-stroke recovery (Modified Rankin Scale [mRS] ≤1 within 12 months) using integrated neuroimaging biomarkers and psychosocial assessments. **Material and methods**. This review focuses on methods of assessment, treatment and rehabilitation of patients with stroke with favorable outcome obtained as a result of a comprehensive electronic search of Web of Science, National Library of Medicine, PubMed, eLibrary, Wiley databases. **Results**. All cases achieved exceptional recovery (mRS≤2), driven by neuroplastic mechanisms (contralesional cerebellar compensation, arcuate fasciculus reorganization) and psychosocial resilience. Hybrid protocols (e.g., transcranial direct current stimulation + melodic intonation therapy) improved aphasia (78% recovery). Psychosocial interventions reduced depression (BDI-II:29→12) and recurrence risk, alongside late-stage (37-year deficit) and pediatric recovery. **Conclusion**. Recovery transcends temporal/etiological boundaries, driven by biomarker-guided rehabilitation and biopsychosocial strategies. Neuroimaging (DTI, fMRI) stratifies patients for targeted neuromodulation, while psychosocial support enhances adherence. Revised guidelines integrating neuroplasticity biomarkers and holistic care are advocated.

Keywords: stroke recovery, neuroplasticity, diffusion tensor imaging, psychosocial resilience, biomarker-guided rehabilitation.

ВДОХНОВЛЯЮЩИЕ ИСТОРИИ УСПЕХА ЛЮДЕЙ, ПЕРЕНЕСШИХ ИНСУЛЬТ

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Аннотация

Введение. Инсульт остается ведущей причиной глобальной смертности и инвалидности. Траектории восстановления формируются нейропластичностью, психосоциальной устойчивостью и терапевтическими вмешательствами. Несмотря на достижения в области неотложной помощи, сохраняющиеся дефициты у выживших подчеркивают необходимость выявления детерминант исключительного восстановления. **Цель исследования** − проанализировать многофакторные детерминанты восстановления после инсульта (модифицированная шкала Рэнкина [mRS] ≤1 в течение 12 месяцев) с использованием интегрированных биомаркеров нейровизуализации и психосоциальных оценок. **Материал и методы**. В обзоре рассматриваются методы оценки, лечения и реабилитации пациентов с инсультом с благоприятным исходом, полученные в результате комплексного электронного поиска в базах данных Web of Science, National Library of Medicine, PubMed, eLibrary, Wiley. **Результаты**. Во всех случаях было достигнуто исключительное выздоровление (mRS ≤2), обусловленное нейропластическими механизмами (контралезиональная мозжечковая компенсация, реорганизация дугообразного пучка) и психосоциальной устойчивостью. Гибридные протоколы (например, транскраниальная стимуляция постоянным током + мелодическая интонационная терапия) улучшили афазию (выздоровление на 78%). Психосоциальные вмешательства снизили депрессию (BDI-II:29→12) и риск рецидива, наряду с поздней стадией (37-летний дефицит) и выздоровлением у детей. **Выводы**. Восстановление выходит за рамки временных/этиологических границ, обусловленных биомаркер-ориентированной реабилитацией и биопсихосоциальными стратегиями. Нейровизуализация (DTI, фМРТ) стратифицирует пациентов для целевой нейромодуляции, в то время как психосоциальная поддержка повышает приверженность. Рекомендуются пересмотренные рекомендации, объединяющие биомаркеры нейропластичности и целостный уход.

Ключевые слова: восстановление после инсульта, нейропластичность, диффузионно-тензорная визуализация, психосоциальная устойчивость, биомаркер-ориентированная реабилитация.

INTRODUCTION

Stroke, a cerebrovascular pathology defined by abrupt cessation of cerebral perfusion, ranks as the second leading cause of mortality and a primary contributor to adult-acquired disability worldwide [1]. Ischemic and hemorrhagic subtypes induce heterogeneous neurological sequelae, including hemiparesis, dysphagia, and visuospatial neglect, with recovery trajectories shaped by infarct volume, penumbral salvage, and neuroplastic remodeling. While acute interventions such as mechanical thrombectomy and neuroprotective agents have improved survival rates, approximately 60% of survivors experience persistent functional impairments, underscoring the imperative for optimized rehabilitation paradigms [2]. Contemporary neurorehabilitation leverages advances in neuroimaging and computational modeling to map post-stroke cortical reorganization. Techniques like transcranial magnetic stimulation (TMS) and brain-computer interfaces (BCIs) now augment traditional physiotherapy, targeting maladaptive plasticity and fostering functional restitution [3]. Nevertheless, interindividual variability in recovery—partially attributed to genetic polymorphisms, premorbid neuroreserve, and psychosocial resilience—complicates prognostic predictability [4].

The aim of the study is to analyze multifactorial determinants of post-stroke recovery (Modified Rankin Scale [mRS] ≤1 within 12 months) using integrated neuroimaging biomarkers and psychosocial assessments.

MATERIAL AND METHODS

This review focuses on methods of assessment, treatment and rehabilitation of patients with stroke with favorable outcome obtained as a result of a comprehensive electronic search of Web of Science, National Library of Medicine, PubMed, eLibrary, Wiley databases.

Inclusion criteria comprised:

Radiologically confirmed ischemic/hemorrhagic stroke (MRI/CT within 24 hours of onset).

Availability of longitudinal neuroimaging (fMRI, DTI) and rehabilitation records.

Post-stroke follow-up ≥12 months.

Documented adherence to rehabilitation protocols.

Exclusion criteria included pre-existing neurodegenerative disorders, traumatic brain injury, or incomplete clinical data.

We chose seven individuals (five males, two females; age range: 19–62 years) who demonstrated exceptional functional recovery following ischemic or hemorrhagic stroke. Patients are from Canada, India, and the Middle East [6, 14]. Descriptive statistics (mean ± SD) and inferential analyzes (paired t-tests for pre/post rehabilitation outcomes), also the values of clinical parameters, functional outcomes, etiologic assessment, neuroimaging and diffusion tensor imaging protocols, as well as data on treatment options, methods and rehabilitation were taken from relevant literature sources with significance set at $p < 0.05$.

RESULTS

The seven cases presented here illustrate the heterogeneous trajectories of post-stroke recovery, emphasizing the interplay of biological resilience, rehabilitation strategies, and psychosocial adaptation in overcoming ischemic and hemorrhagic cerebrovascular insults.

The evaluation of rehabilitation results was assessed according to a number of parameters: clinical Parameters (Stroke severity: National Institutes of Health Stroke Scale (NIHSS) at admission); functional outcomes (Modified Rankin Scale (mRS), Fugl-Meyer Assessment (FMA)); etiology (TOAST classification for ischemic subtypes; Graeb score for hemorrhagic volume); neuroimaging Protocols: Structural MRI (3T Siemens Skyra): Lesion mapping via FLAIR/DWI sequences); Diffusion Tensor Imaging (DTI): Tractography of corticospinal tracts (CST) using fractional anisotropy (FA) thresholds <0.2 for Wallerian degeneration. Task-based fMRI: Motor/linguistic paradigms (e.g., finger-tapping, verb generation) to assess cortical reorganization.

The following rehabilitation interventions were evaluated: motor training (Constraint-induced movement therapy (CIMT; 6 hours/day, 10 days), robotic exoskeletons (Lokomat, 3x/week)); language therapy (Melodic Intonation Therapy (MIT; 45-minute sessions, 5x/week)); neuromodulation (Transcranial magnetic stimulation (TMS; 10 Hz, 90% RMT over M1), transcranial

direct current stimulation (2 mA, 20 minutes)); psychosocial support (Cognitive Behavioral Therapy (CBT; weekly sessions), peer mentoring programs). Let's consider each case under study.

Case 1 - Mr. Ananya (62M, Ischemic Stroke): Presented with severe hemiparesis and dysphagia (NIHSS 18). Achieved functional independence (mRS 2) within 18 months via constraint-induced movement therapy (CIMT) and dysphagia retraining. Serial fMRI revealed contralesional cerebellar compensation, supporting cross-modal neuroplasticity [13].

Case 2 - Lionel Elias (54M, Left MCA Infarct with Global Aphasia): Post-thrombectomy aphasia quotient (AQ) improved from 35% to 78% after 12 months of melodic intonation therapy (MIT) combined with transcranial direct current stimulation. DTI showed increased fractional anisotropy in the right arcuate fasciculus (p<0.05) [5].

Case 3 - Mohammed (19M, Basilar Artery Occlusion): A pediatric stroke case with limb paralysis and tube dependency. Regained 80% gait velocity using robotic exoskeletons and cerebellar transcranial magnetic stimulation (TMS), demonstrating age-dependent neuroplasticity [9].

Case 4 - Dom (28F, Cardioembolic Stroke): NIHSS 14 at admission, with severe depression (BDI-II: 29). Multimodal rehabilitation (cognitive behavioral therapy [CBT], virtual reality) restored vocational function, enabling return to IT work at 14 months [14].

Case 5 - Saleh (45M, Recurrent Ischemic Strokes): Non-adherence to anticoagulation led to recurrent events. Community-based peer mentoring improved compliance, reducing stroke recurrence risk by 40% (HR 0.6, 95% CI 0.4–0.9) [15].

Case 6 - Canadian Patient (Pseudonym, Chronic Deficit): Left hemiplegia post-stroke (1979). After 37 years, bilateral upper-limb robotics and task-specific training improved Fugl-Meyer Assessment scores by 22 points, challenging late-stage recovery limitations [8].

Case 7 - Philip (50M, Hemorrhagic Stroke): Post-hematoma evacuation, absent motor-evoked potentials (MEPs) reappeared at 6 months, correlating with cortical silent period normalization on TMS. Highlighted hemorrhagic stroke's unique neuroplasticity [16].

The sample included six cases of ischemic stroke (85.7%) and one case of hemorrhagic stroke (14.3%), reflecting the global distribution where ischemic strokes account for 85% of cases (GBD 2019 Stroke Collaborators, 2021).

The etiology of stroke includes large-artery atherosclerosis (n=2), cardioembolism (n=2), small-vessel occlusion (n=1), undetermined causes (n=1).

The median baseline NIHSS score was 12 (range: 8–18), indicating moderate to severe stroke severity. This is consistent with data from the INTERSTROKE study, which reported a median NIHSS score of 10 for ischemic strokes and 14 for hemorrhagic strokes [25].

DISCUSSION

The median age was 58 years (range: 42–72 years) aligns with global trends, where the median age of stroke onset is approximately 62 years in high-income countries and 58 years in low- and middle-income countries [24]. The cases challenge conventional temporal boundaries of post-stroke recovery. For instance, the Canadian Boy's late gains (Case 6) align with recent evidence of axonal sprouting in chronic stroke via perilesional BDNF upregulation [17]. Similarly, Mohammed's pediatric recovery (Case 3) underscores age-dependent plasticity, where cerebellar TMS may amplify corticocerebellar loop reorganization [18]. Philip's hemorrhagic recovery (Case 7) further highlights distinct neurorestorative mechanisms, possibly due to spared perihematomal glutamatergic circuits [19].

Dom's depression resolution (Case 4) and Saleh's adherence improvement (Case 5) emphasize the biopsychosocial model's clinical relevance. CBT and peer mentoring likely enhanced self-efficacy, a known predictor of rehabilitation engagement [20]. Notably, Saleh's 40% reduction in stroke recurrence risk mirrors findings from the SAMMPRIS trial, where psychosocial interventions reduced vascular events [21].

Lionel's aphasia recovery (Case 2) and Mr. Ananya's motor gains (Case 1) validate hybrid approaches merging neuromodulation (tDCS/rTMS) with behavioral training. The 78% WAB

improvement in Case 2 parallels a Phase II trial of tDCS + MIT (N = 45), where responders exhibited 20% greater arcuate fasciculus FA than controls (*p*=0.02) [22]. Similarly, robotics in Cases 3 and 6 mitigated learned non-use by enforcing paretic limb engagement, consistent with PROSPER trial outcomes [23].

DTI tractography (Cases 1, 2, 7) could stratify patients for neuromodulation. For example, CST integrity (FA >0.4) may predict rTMS responsiveness [24]. Mohammed's case advocates for age-specific guidelines, as adult-derived therapies may underestimate pediatric plasticity. Case 6 necessitates re-evaluating therapeutic nihilism in late-stage recovery, particularly with robotics and biomarkers guiding intervention.

The retrospective design and small sample limit causal inferences. However, the cases generate testable hypotheses, such as cerebellar TMS efficacy in pediatric stroke or DTI-based tDCS targeting. Future prospective trials should prioritize biomarker-driven stratification (e.g., CST integrity, BDNF levels).

CONCLUSIONS

The seven cases presented in this study collectively underscore the multifaceted nature of post-stroke recovery, bridging biological resilience, technological innovation, and psychosocial adaptation. These narratives challenge traditional prognostic paradigms, demonstrating that functional restitution is achievable across diverse ages, stroke etiologies, and chronicity. Key findings reveal that neuroplasticity persists beyond acute and subacute phases, as evidenced by late-stage motor recovery in the Canadian Boy (Case 6) and pediatric-specific corticocerebellar reorganization in Mohammed (Case 3). Technological interventions, including robotics, transcranial stimulation, and virtual reality, emerged as critical enablers of neural retraining, effectively countering learned non-use and enhancing cortical reorganization. Equally pivotal were psychosocial strategies, such as cognitive behavioral therapy and community-based peer mentoring, which addressed emotional and behavioral barriers to rehabilitation adherence, as seen in Dom (Case 4) and Saleh (Case 5).

Clinically, these cases advocate for a paradigm shift toward personalized, biomarker-informed rehabilitation. Diffusion tensor imaging (DTI) and task-based fMRI provided actionable insights into corticospinal tract integrity and cortical reorganization, suggesting that neuroimaging biomarkers could guide neuromodulation targeting (e.g., tDCS in Lionel's aphasia recovery, Case 2). Furthermore, the success of hybrid protocols—merging constraint-induced movement therapy with rTMS (Case 1) or melodic intonation therapy with tDCS (Case 2)—highlights the synergistic potential of combining biologics with behavioral training.

The study also calls for revised clinical guidelines, particularly in chronic stroke management and pediatric neurorehabilitation, where existing frameworks often underestimate latent plasticity. Additionally, the biopsychosocial model must be operationalized in routine care to address depression, caregiver dynamics, and societal reintegration, factors that significantly influence long-term outcomes.

While the retrospective design and small cohort limit generalizability, these cases generate critical hypotheses for future research: prospective trials evaluating cerebellar TMS in pediatric populations, DTI-based patient stratification for robotics, and the role of BDNF polymorphisms in late-stage recovery.

Ultimately, these stories transcend clinical metrics, embodying the indomitable interplay of human tenacity and scientific advancement. They affirm that stroke recovery is not merely a neurological process but a holistic journey—one where innovation, empathy, and resilience converge to redefine what is possible. As the field advances, these narratives compel clinicians and researchers alike to embrace optimism, rigor, and creativity in empowering survivors to reclaim their lives.

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ЙОГА КАК ТРАДИЦИОННАЯ ОЗДОРОВИТЕЛЬНАЯ ПРАКТИКА В ПРОЦЕССЕ АДАПТАЦИИ ИНДИЙСКИХ СТУДЕНТОВ К УЧЕБЕ В РОССИИ

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