Kaisin V. V., Khramtsov D. M., Kozlova H. G. Improving the Prevention of Shoulder Subluxation in Patients with Post-Stroke Hemiparesis. Journal of Education, Health and Sport. 2026;89:70883. eISSN 2391-8306.
https://dx.doi.org/10.12775/JEHS.2026.89.70883
https://apcz.umk.pl/JEHS/article/view/70883
https://zenodo.org/records/19579632

The journal has had 40 points in Minister of Science and Higher Education of Poland parametric evaluation. Annex to the announcement of the Minister of Education and Science of 05.01.2024 No. 32318. Has a Journal's Unique Identifier: 201159. Scientific disciplines assigned: Physical culture sciences (Field of medical and health sciences); Health Sciences (Field of medical and health sciences). Punkty Ministerialne 40 punktów. Załącznik do komunikatu Ministra Nauki i Szkolnictwa Wyższego z dnia 05.01.2024 Lp. 32318. Posiada Unikatowy Identyfikator Czasopisma: 201159. Przypisane dyscypliny naukowe: Nauki o kulturze fizycznej (Dziedzina nauk medycznych i nauk o zdrowiu); Nauki o zdrowiu (Dziedzina nauk medycznych i nauk o zdrowiu).
Received: 20.02.2026. Revised: 27.02.2026. Accepted: 11.03.2026. Published: 26.03.2026.

Improving the Prevention of Shoulder Subluxation in Patients with Post-Stroke Hemiparesis

V. V. Kaisin[1], D. M. Khramtsov[1,2], H. G. Kozlova[2]

[1]Petro Mohyla Black Sea National University, Mykolaiv, Ukraine
[2]MC "Expert Health", Odesa, Ukraine

Abstract

Background: Shoulder subluxation is a common and clinically significant complication of post-stroke hemiparesis, particularly in the early recovery period, when muscle hypotonia and impaired motor control predominate. It is associated with increased risk of hemiplegic shoulder pain and reduced functional recovery, highlighting the need for effective preventive strategies.

Objective: To improve prevention of shoulder subluxation in patients with post-stroke hemiparesis by evaluating the effectiveness of combining supportive interventions with Mulligan Mobilization with Movement (MWM) manual techniques.

Methods: A prospective randomized controlled trial included 43 patients (45–80 years) in the early recovery period (7–90 days post-stroke). Participants were randomly assigned to a control group (n=21), receiving standard rehabilitation, or a main group (n=22), receiving additional MWM techniques. Outcomes were assessed at baseline and after 4–6 weeks using Fugl–Meyer Assessment for Upper Extremity (FMA-UE), Action Research Arm Test (ARAT), Visual Analog Scale (VAS), Modified Barthel Index (MBI), and acromiohumeral distance (AHD). Statistical analysis included Mann–Whitney U test and Spearman correlation ($p<0.05$).

Results: Both groups improved; however, the main group demonstrated significantly greater gains in motor function (FMA-UE: 48 vs 41; $p=0.003$) and functional activity (ARAT: 38 vs 28; $p=0.002$), along with greater pain reduction (VAS: 1 vs 2; $p=0.01$) and improved joint stability (AHD: 9.8 mm vs 11.5 mm; $p=0.004$). Strong positive correlation was observed between FMA-UE and ARAT ($\rho=0.71$; $p<0.001$), while AHD and VAS negatively correlated with functional outcomes.

Conclusions: The addition of Mulligan MWM techniques to standard rehabilitation significantly enhances motor recovery, reduces pain, and improves shoulder stability in post-stroke patients, supporting their inclusion in early rehabilitation protocols.

Key words: stroke; post-stroke hemiparesis; shoulder subluxation; glenohumeral instability; Mulligan Mobilization with Movement/MWM; rehabilitation; upper limb function; acromiohumeral distance; hemiplegic shoulder pain.

Stroke remains one of the leading causes of disability worldwide, with an incidence of 150–300 cases per 100,000 population annually, while ischemic strokes account for up to 80–85% of all cases [1, 2]. In the structure of stroke consequences, hemiparesis develops in 70–80% of patients in the acute period, and persistent motor deficits remain in 40–50% of cases, resulting in a significant socioeconomic burden and the need for effective rehabilitation [3]. One of the most clinically significant complications of post-stroke hemiparesis is glenohumeral instability manifested by shoulder subluxation [4, 5]. According to the literature, its prevalence ranges from 17% to 81%, depending on the timing of assessment and severity of neurological deficit [4-7]. The highest risk of subluxation occurs in the early recovery period (first 2–4 weeks after stroke), when muscle hypotonia predominates. Hemiplegic shoulder pain develops in 30–70% of patients, and in 20–30% of cases it tends to become chronic. Importantly, the presence of shoulder subluxation increases the risk of pain by 2–3 times, further limiting upper limb function and reducing rehabilitation effectiveness [6, 7].

The pathogenesis of glenohumeral instability is multifactorial and includes decreased tone of stabilizing muscles of the shoulder joint, particularly the deltoid muscle and rotator cuff muscles, impaired scapulohumeral rhythm, sensorimotor disorders, and improper limb positioning. These factors lead to caudal displacement of the humeral head under gravity, stretching of the capsuloligamentous structures, and formation of subluxation, negatively affecting functional recovery and quality of life [6].

In modern clinical practice, various approaches are used to prevent shoulder subluxation, including supportive devices (slings, orthoses), kinesiotaping, and manual techniques aimed at correcting movement biomechanics and restoring muscle control [8-10]. However, the lack of a unified evidence-based approach for selecting the optimal strategy, especially in the early recovery period, determines the relevance of further research.

The aim of the study was to improve the prevention of shoulder subluxation in patients with post-stroke hemiparesis by evaluating the effectiveness of combining supportive means with Mulligan Mobilization with Movement (MWM) manual techniques in the early recovery period.

Materials and Methods. The study was designed as a prospective randomized controlled clinical trial with parallel groups. The total sample included 43 patients who were randomly assigned into two comparable groups: a control group (n=21), which received a standard rehabilitation program, and a main group (n=22), in which Mulligan MWM techniques [10] were additionally applied. The groups did not differ significantly in age, sex, or severity of neurological deficit: mean age was 64.2±2.1 years in the control group and 63.7±2.4 years in the main group (p>0,05), while stroke severity according to NIHSS corresponded to a moderate level (9.1±0.8 and 9.4±0.7 points, respectively; p>0,05). Baseline upper limb function assessed by the Fugl–Meyer Assessment (FMA-UE) [11] was 32.5±3.2 points in the control group and 31.8±3.5 points in the main group (p>0,05), indicating pronounced hemiparesis.

Inclusion criteria were age 45–80 years, presence of post-stroke hemiparesis, early recovery period (7–90 days), sufficient cognitive function (MMSE ≥24 or MoCA ≥22), and signs of hypotonia or initial glenohumeral instability. Exclusion criteria included severe stroke (NIHSS >20), severe pain syndrome (VAS >7), orthopedic shoulder pathology, and severe comorbid somatic conditions.

The effectiveness of rehabilitation interventions was assessed using validated clinical scales. Motor function was evaluated using FMA-UE [11], functional activity using the Action Research Arm Test (ARAT) [12], pain intensity using the Visual Analog Scale (VAS) [13], and independence in daily living using the Modified Barthel Index (MBI) [14]. The degree of glenohumeral instability was assessed clinically and instrumentally by measuring the acromiohumeral distance (AHD) [15], while muscle tone was evaluated using the Modified Ashworth Scale (MAS) and Modified Tardieu Scale (MTS) [16, 17].

The study was conducted in accordance with the principles of the Declaration of Helsinki, with informed consent obtained from all participants and approval granted by the local ethics committee [18].

Assessments were conducted dynamically: at baseline and after a 4–6 week rehabilitation course. All patients received standard rehabilitation including physical therapy, occupational therapy, positioning, and education on proper limb care, while the main group additionally received Mulligan techniques [10] performed 5 times per week throughout the treatment course.

Statistical analysis was performed using non-parametric methods due to non-normal distribution; the Mann–Whitney U test was used for intergroup comparisons and Spearman's rank correlation coefficient for assessing relationships between variables, with statistical significance set at $p<0.05$. Data were presented as median and interquartile range Me (Q1; Q3) or mean ± standard error (M±m) [19].

Results and Discussion. At baseline, both groups showed no statistically significant differences in clinical-functional indicators ($p>0.05$), confirming proper randomization. FMA-UE scores were 32–33 points, ARAT scores 20–21 points, VAS pain levels 3 (2; 5), and AHD 13.2–13.5 mm, corresponding to moderate instability.

After rehabilitation, both groups improved, but the main group demonstrated significantly greater progress. FMA-UE increased to 41 (36; 45) in the control group and to 48 (42; 52) in the main group (U=129.0; p=0.003). ARAT increased to 28 (22; 34) and 38 (32; 45), respectively (U=118.5; p=0.002). Pain decreased to 2 (1; 3) in the control group and 1 (0; 2) in the main group (U=134.0; p=0.01).

AHD decreased to 11.5 (10.2; 13.8) mm in the control group and 9.8 (8.5; 11.2) mm in the main group (U=122.0; p=0.004), indicating better shoulder stabilization (Figure 1).

The observed between-group difference in acromiohumeral distance (AHD) has important clinical implications, as AHD is an objective surrogate marker of glenohumeral alignment and mechanical stability. A greater reduction in AHD in the main group indicates more effective approximation of the humeral head toward the glenoid, reflecting improved activation of stabilizing muscles and restoration of scapulohumeral rhythm. Clinically, this is associated with a lower risk of progressive subluxation, decreased mechanical strain on the capsuloligamentous structures, and reduced likelihood of chronic hemiplegic shoulder pain. Moreover, improved joint congruency facilitates more efficient force transmission during upper limb movements, thereby enhancing functional recovery. Thus, the greater decrease in

AHD observed in the main group not only confirms superior biomechanical stabilization but also supports its role as a meaningful predictor of better rehabilitation outcomes.

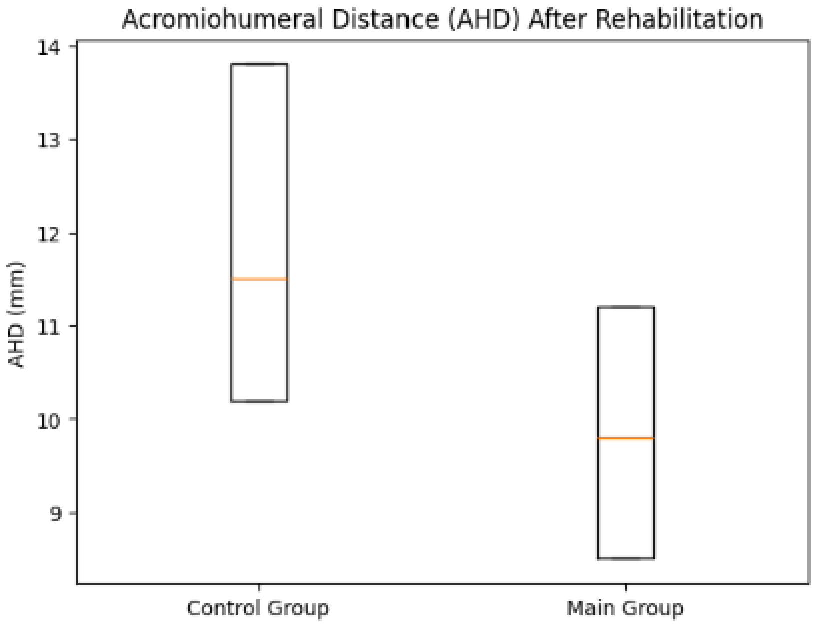

Figure 1. Clinical changes of acromiohumeral distance (AHD) after rehabilitation

Correlation analysis revealed a strong positive relationship between FMA-UE and ARAT ($\rho=0.71$; $p<0.001$), a moderate negative correlation between FMA-UE and AHD ($\rho=-0.48$; $p=0.003$), and a negative correlation between VAS and ARAT ($\rho=-0.46$; $p=0.004$).

The results confirm that manual techniques improve biomechanics, proprioception, and muscle activation. Compared to other interventions, kinesiotaping provides moderate effects, while slings may limit activity.

Conclusions:

1. Patients with post-stroke hemiparesis in the early recovery period demonstrate significant impairments in motor function, functional activity, and moderate glenohumeral instability.
2. The use of Mulligan MWM techniques combined with standard rehabilitation significantly improves motor function ($p=0.003$), functional activity ($p=0.002$), reduces pain ($p=0.01$), and decreases shoulder subluxation ($p=0.004$).
3. Strong correlations exist between motor recovery and functional activity, with negative effects of instability and pain.
4. MWM techniques are most effective in patients with mild to moderate instability and hypotonia.

5. Incorporating manual techniques enhances rehabilitation outcomes, reduces chronic pain risk, and improves patient independence.

No conflict of interest is declared

References:

1. Muratova T, Khramtsov D, Stoyanov A, Vorokhta Y. Clinical epidemiology of ischemic stroke: global trends and regional differences. Georgian Med News. 2020 Feb;(299):83-86. PMID: 32242851.

2. Feigin VL, Brainin M, Norrving B, Martins SO, Pandian J, Lindsay P, F Grupper M, Rautalin I. World Stroke Organization: Global Stroke Fact Sheet 2025. Int J Stroke. 2025 Feb;20(2):132-144. doi: 10.1177/17474930241308142. Epub 2025 Jan 3. PMID: 39635884; PMCID: PMC11786524.

3. Lee JP, Chen S, Tsai CT, Chung HC, Chang WD. Characteristics Associated with the Differential Activity of Nondominant and Dominant Affected Hands in Patients with Poststroke Right Hemiparesis. Occup Ther Int. 2020 May 24;2020:2387378. doi: 10.1155/2020/2387378. PMID: 32565757; PMCID: PMC7285389.

4. Qu Y, Shi X, Wang Y, Ji T, Chen L, Yu S, Huo M. Observation of risk factors for shoulder subluxation after stroke using ultrasonography to measure thickness of the supraspinatus muscle: a cross-sectional study. Front Neurol. 2025 Mar 19;16:1532004. doi: 10.3389/fneur.2025.1532004. PMID: 40177404; PMCID: PMC11961407.

5. Park JM, Park HJ, Yoon SY, Kim YW, Shin JI, Lee SC. Comparative Effectiveness of Treatments for Shoulder Subluxation After Stroke: A Systematic Review and Network Meta-Analysis. J Clin Med. 2025 Sep 29;14(19):6913. doi: 10.3390/jcm14196913. PMID: 41095992; PMCID: PMC12525310.

6. Housset V, Ho SWL, Lädermann A, Phua SKA, Hui SJ, Nourissat G. Multidirectional instability of the shoulder: a systematic review with a novel classification. *EFORT Open Rev*. 2024;9(4):285–296. doi:10.1530/EOR-23-0029.

7. Razmjou H, Rahnama L. Measurement properties of commonly used outcome measures in patients with glenohumeral instability. *Physiother Can*. 2025;77:e20240062. doi:10.3138/ptc-2024-0062

8. Jones R, White P, Greenwood R, Kumar P. The Lycra arm sleeve for treatment of glenohumeral subluxation in people with sub-acute stroke: a randomized controlled (RC)

feasibility study. Top Stroke Rehabil. 2025 May;32(4):419-427. doi: 10.1080/10749357.2024.2403808. Epub 2024 Sep 21. PMID: 39305078.

9. Kim YJ, An J, Lee BH. Effects of Sling-Suspension-Based Active Shoulder Joint Exercise on Shoulder Joint Subluxation, Pain, Muscle Strength, and Upper Limb Function in Patients with Subacute Stroke. Medicina (Kaunas). 2024 Aug 20;60(8):1350. doi: 10.3390/medicina60081350. PMID: 39202631; PMCID: PMC11356110.

10. Satpute K, Reid S, Mitchell T, Mackay G, Hall T. Efficacy of mobilization with movement (MWM) for shoulder conditions: a systematic review and meta-analysis. J Man Manip Ther. 2022 Feb;30(1):13-32. doi: 10.1080/10669817.2021.1955181. Epub 2021 Aug 1. PMID: 34334099; PMCID: PMC8865120.

11. Hsieh HC, Liao RD, Yang TH, Leong CP, Tso HH, Wu JY, Huang YC. The clinical effect of Kinesio taping and modified constraint-induced movement therapy on upper extremity function and spasticity in patients with stroke: a randomized controlled pilot study. Eur J Phys Rehabil Med. 2021 Aug;57(4):511-519. doi: 10.23736/S1973-9087.21.06542-4. Epub 2021 Jan 15. PMID: 33448755.

12. Daghsen L, Fleury L, Bouvier J, Zavanone C, Dupont S, Hummel FC, Rosso C. Evaluation of a shortened version of the Action Research Arm Test (ARAT) for upper extremity function after stroke: The Mini-ARAT. Clin Rehabil. 2022 Sep;36(9):1257-1266. doi: 10.1177/02692155221097322. Epub 2022 May 6. PMID: 35522473.

13. Yim J, Kim B. Effectiveness of Shoulder Taping in Treating Hemiplegic Shoulder Subluxation: A Randomized Controlled Study of 35 Patients. Med Sci Monit. 2024 May 31;30:e944222. doi: 10.12659/MSM.944222. PMID: 38820090; PMCID: PMC11149471.

14. Kamdi MKA, Shafei MN, Musa KI, Hanafi MH, Suliman MA. Comparison of the Modified Barthel Index (MBI) Score Trends Among Workers With Stroke Receiving Robotic and Conventional Rehabilitation Therapy. Cureus. 2023 Jan 25;15(1):e34207. doi: 10.7759/cureus.34207. PMID: 36843743; PMCID: PMC9957641.

15. Mackenzie TA, Bdaiwi AH, Herrington L, Cools A. Inter-rater Reliability of Real-Time Ultrasound to Measure Acromiohumeral Distance. PM R. 2016 Jul;8(7):629-34. doi: 10.1016/j.pmrj.2015.11.004. Epub 2015 Nov 19. PMID: 26603199.

16. Vidmar T, Goljar Kregar N, Puh U. Reliability of the Modified Ashworth Scale After Stroke for 13 Muscle Groups. Arch Phys Med Rehabil. 2023 Oct;104(10):1606-1611. doi: 10.1016/j.apmr.2023.04.008. Epub 2023 Apr 29. PMID: 37121531.

17. Glinsky J. Tardieu Scale. J Physiother. 2016 Oct;62(4):229. doi: 10.1016/j.jphys.2016.07.007. Epub 2016 Aug 4. PMID: 27634157.

18. Pavić I, Alfirević N, Vuletić S, editors. Bioethics and social ethics in the modern world: the environmental and social sustainability context(s). Cham: Palgrave Macmillan; 2025. 223 p. doi:10.1007/978-3-031-86418-6

19. Twisk JWR. *Basic principles of applied medical statistics: a practical guide*. 1st ed. Cham: Springer; 2025. 268 p. doi:10.1007/978-3-031-86278-6.