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ЕЖЕМЕСЯЧНЫЙ НАУЧНЫЙ ЖУРНАЛ

Медицинские новости Грузии

საქართველოს სამედიცინო სიახლენი

GEORGIAN MEDICAL NEWS

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GMN: Georgian Medical News is peer-reviewed, published monthly journal committed to promoting the science and art of medicine and the betterment of public health, published by the GMN Editorial Board since 1994. GMN carries original scientific articles on medicine, biology and pharmacy, which are of experimental, theoretical and practical character; publishes original research, reviews, commentaries, editorials, essays, medical news, and correspondence in English and Russian.

GMN is indexed in MEDLINE, SCOPUS, PubMed and VINITI Russian Academy of Sciences. The full text content is available through EBSCO databases.

GMN: Медицинские новости Грузии - ежемесячный рецензируемый научный журнал, издаётся Редакционной коллегией с 1994 года на русском и английском языках в целях поддержки медицинской науки и улучшения здравоохранения. В журнале публикуются оригинальные научные статьи в области медицины, биологии и фармации, статьи обзорного характера, научные сообщения, новости медицины и здравоохранения. Журнал индексируется в MEDLINE, отражён в базе данных SCOPUS, PubMed и ВИНИТИ РАН. Полнотекстовые статьи журнала доступны через БД EBSCO.

GMN: Georgian Medical News – საქართველოს სამედიცინო სიახლენი – არის ყოველთვიური სამეცნიერო სამედიცინო რეცენზირებადი ჟურნალი, გამოიცემა 1994 წლიდან, წარმოადგენს სარედაქციო კოლეგიისა და აშშ-ის მეცნიერების, განათლების, ინდუსტრიის, ხელოვნებისა და ბუნებისმეტყველების საერთაშორისო აკადემიის ერთობლივ გამოცემას. GMN-ში რუსულ და ინგლისურ ენებზე ქვეყნდება ექსპერიმენტული, თეორიული და პრაქტიკული ხასიათის ორიგინალური სამეცნიერო სტატიები მედიცინის, ბიოლოგიისა და ფარმაციის სფეროში, მიმოხილვითი ხასიათის სტატიები.

ჟურნალი ინდექსირებულია MEDLINE-ის საერთაშორისო სისტემაში, ასახულია SCOPUS-ის, PubMed-ის და ВИНИТИ РАН-ის მონაცემთა ბაზებში. სტატიების სრული ტექსტი ხელმისაწვდომია EBSCO-ს მონაცემთა ბაზებიდან.

WEBSITE

www.geomednews.com

К СВЕДЕНИЮ АВТОРОВ!

При направлении статьи в редакцию необходимо соблюдать следующие правила:

1. Статья должна быть представлена в двух экземплярах, на русском или английском языках, напечатанная через **полтора интервала на одной стороне стандартного листа с шириной левого поля в три сантиметра**. Используемый компьютерный шрифт для текста на русском и английском языках - **Times New Roman** (**Кириллица**), для текста на грузинском языке следует использовать **AcadNusx.** Размер шрифта - **12**. К рукописи, напечатанной на компьютере, должен быть приложен CD со статьей.

2. Размер статьи должен быть не менее десяти и не более двадцати страниц машинописи, включая указатель литературы и резюме на английском, русском и грузинском языках.

3. В статье должны быть освещены актуальность данного материала, методы и результаты исследования и их обсуждение.

При представлении в печать научных экспериментальных работ авторы должны указывать вид и количество экспериментальных животных, применявшиеся методы обезболивания и усыпления (в ходе острых опытов).

4. К статье должны быть приложены краткое (на полстраницы) резюме на английском, русском и грузинском языках (включающее следующие разделы: цель исследования, материал и методы, результаты и заключение) и список ключевых слов (key words).

5. Таблицы необходимо представлять в печатной форме. Фотокопии не принимаются. **Все цифровые, итоговые и процентные данные в таблицах должны соответствовать таковым в тексте статьи**. Таблицы и графики должны быть озаглавлены.

6. Фотографии должны быть контрастными, фотокопии с рентгенограмм - в позитивном изображении. Рисунки, чертежи и диаграммы следует озаглавить, пронумеровать и вставить в соответствующее место текста **в tiff формате**.

В подписях к микрофотографиям следует указывать степень увеличения через окуляр или объектив и метод окраски или импрегнации срезов.

7. Фамилии отечественных авторов приводятся в оригинальной транскрипции.

8. При оформлении и направлении статей в журнал МНГ просим авторов соблюдать правила, изложенные в «Единых требованиях к рукописям, представляемым в биомедицинские журналы», принятых Международным комитетом редакторов медицинских журналов - http://www.spinesurgery.ru/files/publish.pdf и http://www.nlm.nih.gov/bsd/uniform_requirements.html
В конце каждой оригинальной статьи приводится библиографический список. В список литературы включаются все материалы, на которые имеются ссылки в тексте. Список составляется в алфавитном порядке и нумеруется. Литературный источник приводится на языке оригинала. В списке литературы сначала приводятся работы, написанные знаками грузинского алфавита, затем кириллицей и латиницей. Ссылки на цитируемые работы в тексте статьи даются в квадратных скобках в виде номера, соответствующего номеру данной работы в списке литературы. Большинство цитированных источников должны быть за последние 5-7 лет.

9. Для получения права на публикацию статья должна иметь от руководителя работы или учреждения визу и сопроводительное отношение, написанные или напечатанные на бланке и заверенные подписью и печатью.

10. В конце статьи должны быть подписи всех авторов, полностью приведены их фамилии, имена и отчества, указаны служебный и домашний номера телефонов и адреса или иные координаты. Количество авторов (соавторов) не должно превышать пяти человек.

11. Редакция оставляет за собой право сокращать и исправлять статьи. Корректура авторам не высылается, вся работа и сверка проводится по авторскому оригиналу.

12. Недопустимо направление в редакцию работ, представленных к печати в иных издательствах или опубликованных в других изданиях.

При нарушении указанных правил статьи не рассматриваются.

REQUIREMENTS

Please note, materials submitted to the Editorial Office Staff are supposed to meet the following requirements:

1. Articles must be provided with a double copy, in English or Russian languages and typed or compu-ter-printed on a single side of standard typing paper, with the left margin of **3** centimeters width, and **1.5** spacing between the lines, typeface - **Times New Roman** (**Cyrillic**), print size - **12** (referring to Georgian and Russian materials). With computer-printed texts please enclose a CD carrying the same file titled with Latin symbols.

2. Size of the article, including index and resume in English, Russian and Georgian languages must be at least 10 pages and not exceed the limit of 20 pages of typed or computer-printed text.

3. Submitted material must include a coverage of a topical subject, research methods, results, and review.

Authors of the scientific-research works must indicate the number of experimental biological species drawn in, list the employed methods of anesthetization and soporific means used during acute tests.

4. Articles must have a short (half page) abstract in English, Russian and Georgian (including the following sections: aim of study, material and methods, results and conclusions) and a list of key words.

5. Tables must be presented in an original typed or computer-printed form, instead of a photocopied version. **Numbers, totals, percentile data on the tables must coincide with those in the texts of the articles.** Tables and graphs must be headed.

6. Photographs are required to be contrasted and must be submitted with doubles. Please number each photograph with a pencil on its back, indicate author's name, title of the article (short version), and mark out its top and bottom parts. Drawings must be accurate, drafts and diagrams drawn in Indian ink (or black ink). Photocopies of the X-ray photographs must be presented in a positive image in **tiff format**.

Accurately numbered subtitles for each illustration must be listed on a separate sheet of paper. In the subtitles for the microphotographs please indicate the ocular and objective lens magnification power, method of coloring or impregnation of the microscopic sections (preparations).

7. Please indicate last names, first and middle initials of the native authors, present names and initials of the foreign authors in the transcription of the original language, enclose in parenthesis corresponding number under which the author is listed in the reference materials.

8. Please follow guidance offered to authors by The International Committee of Medical Journal Editors guidance in its Uniform Requirements for Manuscripts Submitted to Biomedical Journals publication available online at: http://www.nlm.nih.gov/bsd/uniform_requirements.html
http://www.icmje.org/urm_full.pdf
In GMN style for each work cited in the text, a bibliographic reference is given, and this is located at the end of the article under the title "References". All references cited in the text must be listed. The list of references should be arranged alphabetically and then numbered. References are numbered in the text [numbers in square brackets] and in the reference list and numbers are repeated throughout the text as needed. The bibliographic description is given in the language of publication (citations in Georgian script are followed by Cyrillic and Latin).

9. To obtain the rights of publication articles must be accompanied by a visa from the project instructor or the establishment, where the work has been performed, and a reference letter, both written or typed on a special signed form, certified by a stamp or a seal.

10. Articles must be signed by all of the authors at the end, and they must be provided with a list of full names, office and home phone numbers and addresses or other non-office locations where the authors could be reached. The number of the authors (co-authors) must not exceed the limit of 5 people.

11. Editorial Staff reserves the rights to cut down in size and correct the articles. Proof-sheets are not sent out to the authors. The entire editorial and collation work is performed according to the author's original text.

12. Sending in the works that have already been assigned to the press by other Editorial Staffs or have been printed by other publishers is not permissible.

Articles that Fail to Meet the Aforementioned Requirements are not Assigned to be Reviewed.

ავტორთა საყურადღებოდ!

რედაქციაში სტატიის წარმოდგენისას საჭიროა დავიცვათ შემდეგი წესები:

1. სტატია უნდა წარმოადგინოთ 2 ცალად, რუსულ ან ინგლისურ ენებზე,დაბეჭდილი სტანდარტული ფურცლის 1 გვერდზე, 3 სმ სიგანის მარცხენა ველისა და სტრიქონებს შორის 1,5 ინტერვალის დაცვით. გამოყენებული კომპიუტერული შრიფტი რუსულ და ინგლისურენოვან ტექსტებში - **Times New Roman (Кириллица)**, ხოლო ქართულენოვან ტექსტში საჭიროა გამოვიყენოთ **AcadNusx.** შრიფტის ზომა – 12. სტატიას თან უნდა ახლდეს CD სტატიით.

2. სტატიის მოცულობა არ უნდა შეადგენდეს 10 გვერდზე ნაკლებს და 20 გვერდზე მეტს ლიტერატურის სიის და რეზიუმეების (ინგლისურ, რუსულ და ქართულ ენებზე) ჩათვლით.

3. სტატიაში საჭიროა გაშუქდეს: საკითხის აქტუალობა; კვლევის მიზანი; საკვლევი მასალა და გამოყენებული მეთოდები; მიღებული შედეგები და მათი განსჯა. ექსპერიმენტული ხასიათის სტატიების წარმოდგენისას ავტორებმა უნდა მიუთითონ საექსპერიმენტო ცხოველების სახეობა და რაოდენობა; გაუტკივარებისა და დაძინების მეთოდები (მწვავე ცდების პირობებში).

4. სტატიას თან უნდა ახლდეს რეზიუმე ინგლისურ, რუსულ და ქართულ ენებზე არანაკლებ ნახევარი გვერდის მოცულობისა (სათაურის, ავტორების, დაწესებულების მითითებით და უნდა შეიცავდეს შემდეგ განყოფილებებს: მიზანი, მასალა და მეთოდები, შედეგები და დასკვნები; ტექსტუალური ნაწილი არ უნდა იყოს 15 სტრიქონზე ნაკლები) და საკვანძო სიტყვების ჩამონათვალი (key words).

5. ცხრილები საჭიროა წარმოადგინოთ ნაბეჭდი სახით. ყველა ციფრული, შემაჯამებელი და პროცენტული მონაცემები უნდა შეესაბამებოდეს ტექსტში მოყვანილს.

6. ფოტოსურათები უნდა იყოს კონტრასტული; სურათები, ნახაზები, დიაგრამები - დასათაურებული, დანომრილი და სათანადო ადგილას ჩასმული. რენტგენოგრამების ფოტოასლები წარმოადგინეთ პოზიტიური გამოსახულებით **tiff** ფორმატში. მიკროფოტოსურათების წარწერებში საჭიროა მიუთითოთ ოკულარის ან ობიექტივის საშუალებით გადიდების ხარისხი, ანათალების შეღებვის ან იმპრეგნაციის მეთოდი და აღნიშნოთ სურათის ზედა და ქვედა ნაწილები.

7. სამამულო ავტორების გვარები სტატიაში აღინიშნება ინიციალების თანდართვით, უცხოურისა – უცხოური ტრანსკრიპციით.

8. სტატიას თან უნდა ახლდეს ავტორის მიერ გამოყენებული სამამულო და უცხოური შრომების ბიბლიოგრაფიული სია (ბოლო 5-8 წლის სიღრმით). ანბანური წყობით წარმოდგენილ ბიბლიოგრაფიულ სიაში მიუთითეთ ჯერ სამამულო, შემდეგ უცხოელი ავტორები (გვარი, ინიციალები, სტატიის სათაური, ჟურნალის დასახელება, გამოცემის ადგილი, წელი, ჟურნალის №, პირველი და ბოლო გვერდები). მონოგრაფიის შემთხვევაში მიუთითეთ გამოცემის წელი, ადგილი და გვერდების საერთო რაოდენობა. ტექსტში კვადრატულ ფჩხილებში უნდა მიუთითოთ ავტორის შესაბამისი N ლიტერატურის სიის მიხედვით. მიზანშეწონილია, რომ ციტირებული წყაროების უმეტესი ნაწილი იყოს 5-6 წლის სიღრმის.

9. სტატიას თან უნდა ახლდეს: ა) დაწესებულების ან სამეცნიერო ხელმძღვანელის წარდგინება, დამოწმებული ხელმოწერითა და ბეჭდით; ბ) დარგის სპეციალისტის დამოწმებული რეცენზია, რომელშიც მითითებული იქნება საკითხის აქტუალობა, მასალის საკმაობა, მეთოდის სანდოობა, შედეგების სამეცნიერო-პრაქტიკული მნიშვნელობა.

10. სტატიის ბოლოს საჭიროა ყველა ავტორის ხელმოწერა, რომელთა რაოდენობა არ უნდა აღემატებოდეს 5-ს.

11. რედაქცია იტოვებს უფლებას შეასწოროს სტატია. ტექსტზე მუშაობა და შეჯერება ხდება საავტორო ორიგინალის მიხედვით.

12. დაუშვებელია რედაქციაში ისეთი სტატიის წარდგენა, რომელიც დასაბეჭდად წარდგენილი იყო სხვა რედაქციაში ან გამოქვეყნებული იყო სხვა გამოცემებში.

აღნიშნული წესების დარღვევის შემთხვევაში სტატიები არ განიხილება.

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THE EFFECT OF SOFT ROBOTIC GLOVE ON THE FLEXION AND EXTENSION OF HAND FOR STROKE PATIENTS: A CLINICAL TRIAL

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Abstract.

Background: Stroke defined by diminished cerebral blood flow, results in brain damage and neurological impairments. It often leads to considerable difficulties, such as limited mobility and compromised hand function, usually manifesting as a weakening in the ability to open and shut the hand. **Objective:** The study evaluates the differences between opening and closing hands when utilizing a soft robot. **Methods:** The study was conducted in the Mosul Specialist Rehabilitation Center which involved 68 participants, all over 20 years old, with visual impairments. The Iranian Clinical Trials Registry and Ministry of Planning approved the study, The Fugl-Meyer Assessment for Upper Extremity Action Research Arm Test, and Arm Motor Ability Test were used to assess finger extension and flexion. **Results:** A study revealed that stroke patients who utilized a soft robotic glove experienced notable improvements in hand functionality. Average hand closure scores increased significantly, from 8.14 to 20.36 out of 21 points. Women demonstrated greater progress in hand opening rates compared to men, with an average improvement of 1.91 times between pre- and post-assessments. In contrast, the control group exhibited similar hand-opening advancements across genders. Patients with both ischemic and hemorrhagic strokes showed enhanced abilities in opening and closing their hands. Additionally, the study identified a statistically significant improvement in hand function improvements based on stroke type. **Conclusion:** The study found that stroke patients using a soft robotic glove showed significant improvements in hand-closing abilities, while exercise had minimal impact. Women showed an average increase in hand opening rate. Both male and female patients showed improvement, with hemorrhagic strokes showing remarkable advancements.

Key words. Flexion, extension, robotic, glove, stroke, clinical trial.

Introduction.

Reduced or blocked cerebral blood flow, which results in brain tissue damage and impaired neurological function, characterizes a stroke [1-4]. It predominantly occurs in older individuals [5-7], leading to severe disabilities by weakening their muscles and limiting their movement [8].

Most individuals who have experienced a stroke will encounter difficulties with their hands [1,8], rendering them less functional for daily activities [9-11]. The extent of their impairment is contingent upon the severity of the stroke [12]. This impairment modifies hand function and affects the performance of everyday activities [11-15]. The body's coordination, strength, and dexterity are needed to do daily tasks with the hands.

People who have experienced stroke affecting the motor system often exhibit more varied movements [12-18]. Regardless of coordination patterns, discrepancies in force management were observed during bilateral movements [19]. Following a stroke, the balance between the two hemispheres of the brain changes, as does the direction of the ascending pathways [20]. The findings indicated that neurons undergo alterations during activity in both hemispheres [20-22]. Stroke patients, like healthy individuals, face increased challenges in performing anti-phase motions compared to in-phase movements [23,24]. In healthy individuals, these movements are managed by different areas of the brain [20,21,25]. Individuals who have had strokes in either the left or right hemisphere are likely to face distinct challenges with coordinating their left and right sides [19,25,26]. However, it remains unclear what effects strokes in the left and right hemispheres have on limb performance during bilateral movements [17,27]. The study aimed to examine the performance variations between hand-opening and hand-closing motions using a soft robotic system.

Materials and Methods.

From July 21, 2024, to November 20, 2024, randomized control trails were conducted in the Mosul Specialist Rehabilitation Center on how to use a soft robotic glove with a randomized control design to evaluate patients' hand opening and closing abilities. Figure 1 guided the selection of participants. They had to be at least two weeks post-stroke, older than twenty years old, and able to understand or follow simple instructions without visual impairment. Cognitive abnormalities, vision impairment, tremors, diabetes, and upper limb spasms that hindered device placement were the exclusion criteria. The study looked at 68 people who had thrombotic or hemorrhagic strokes. They were split into two groups: a robotic glove group (n = 35) and a control group (n=33). The cross-sectional sample size calculation was used to figure out the sample size. Researchers offered daily help, including appointment reminders, progress tracking, and transportation support. The study was approved by the Iranian Clinical Trials Registry on July 15, 2024 (IRCT registration number: IRCT20240623062222N1). The Ministry of Planning, the Faculty of Nursing at Baghdad University, and the Nineveh Health Directorate all gave their ethical approval as well. Patients who have agreed to participate in the study were asked to sign the consent form after verbal explanation of the study and the aims of the study.

In addition to being utilized during the training phase, the soft robotic glove was also utilized during the first and second post-assessment phases. During these phases, the glove was utilized for each patient for a minimum of eight weeks, with three to four sessions per week.

Outcome measurements: The research team utilized widely recognized hand function tests for stroke patients to design the hand functional tasks used in this study. These included

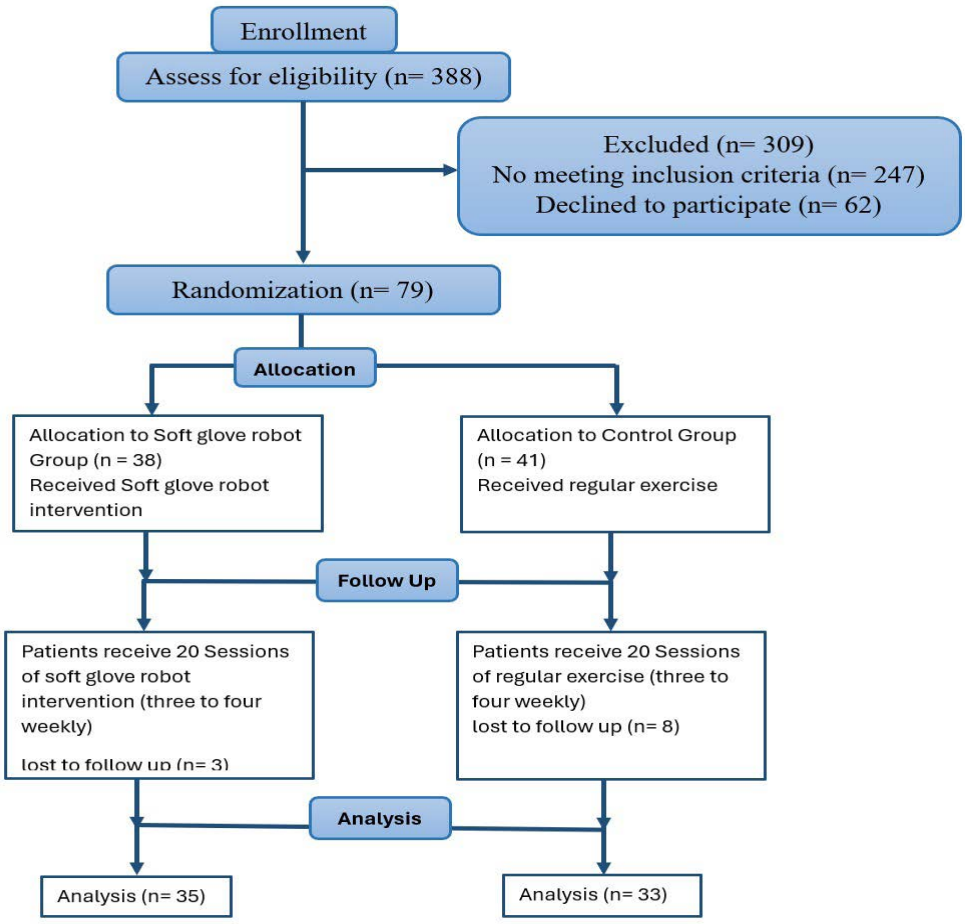

Figure 1. *Flowchart for choosing samples in a randomized controlled experiment (RCT).*

the Fugl-Meyer Assessment-Upper Extremity (FMA-UE), the Action Research Arm Test (ARAT), and the Arm Motor Ability Test (AMAT). By assigning tasks that emphasized finger extension and flexion, the researchers assessed and rated participants' ability to perform activities of daily living (ADLs) both with and without the SR Glove. All evaluations were conducted on the affected hand, with higher scores reflecting improved performance or greater functional ability.

Scoring system:

The ARAT is scored on a four-level ordinal scale (0-3)

0 = cannot perform any part of the test,

1 = performs the test partially,

2 = completes the test, but takes abnormally long, time

3 = performs the test normally

Note. ARAT=Action Research Arm Test; ARAT score range, 0-57.

Low ability=scores 0-19.

†Moderate ability=scores 20-38.

‡High ability=scores 39-57.

ARAT scores range from 0 to 57, with 57 indicating optimal performance. As an observational assessment of mobility, the ARAT has no cutoff scores. It predicts upper extremity functional recovery after stroke, with scores of <10, 10-56, and 57 corresponding to poor, moderate, and satisfactory recovery, respectively

Statistical analysis: Eleven patients were excluded from the statistical analysis due to noncompliance with the rehabilitation protocol. Statistical analyses were performed utilizing SPSS for Windows, version 27. The mean, standard deviation, and paired t-test were utilized to compare outcomes between open and closed-hand conditions across the two groups. The data were tested for normal distribution. A p-value below 0.05 was deemed statistically significant.

Results.

The patients who used the soft robotic glove got better at opening their hands, going from 7.26 out of 21 to 19.86 out of 21. The control group, on the other hand, didn't change much, with an average increase of only 3.15 between pre-and post-tests.

The study revealed that stroke patients who used robotic gloves experienced a significant improvement in hand closure, with a range of 8.14 to 20.36 out of 21 points. The control group's hand closure variance, on the other hand, was 8.05 to 13.15, which is a good difference.

Hand closing was significantly different between the pre- and post-tests for both groups ($p<0.05$). Opening the hand was significantly different after using a soft glove robot with a p-value below 0.05, but exercise had no effect on opening the hand in the control group.

Table 1. *Means of hand opening and closing by study groups.*

		Group		
	Testing	**Glove group**	**Control group**	**P-value**
Hand opening	Pre	7.26±3.58	6.12±2.74	0.067
	Post	19.86±11.96	9.27±6.51	**0.0001**
	P-value	**0.0001**	0.062	
Hand closing	Pre	8.14±4.92	8.05±4.72	0.09
	Post	20.36±14.49	13.15±9.51	**0.0001**
	P-value	**0.0001**	**0.048**	

Table 2. *Means of hand opening and closing by study groups according to sex differences.*

Testing		**Glove Group**		**P-value**	**Control Group**		**P-value**
		Male	**Female**		**Male**	**Female**	
Hand opening	Pre	9.17±6.46	5.35±2.08	**0.01**	6.40±2.99	5.30±2.19	0.08
	Post	11.08±8.12	8.78±5.07	**0.01**	10.11±7.98	8.43±5.43	**0.01**
	P-value	**0.0001**	**0.0001**		0.069	0.064	
Hand closing	Pre	4.63±1.87	3.51±1.66	0.062	3.66±1.86	4.39±1.73	0.09
	Post	12.64±8.91	7.90±4.87	**0.001**	6.06±2.70	7.09±4.33	0.06
	P-value	**0.0001**	**0.048**		**0.041**	0.062	

Table 3. *Means of hand opening and closing by study groups according to types of strokes.*

Testing		**Glove Group**		**Control Group**	
		Hemorrhagic	**Ischemic**	**Hemorrhagic**	**Ischemic**
Hand opening	Pre	7.73±4.84	5.04±3.52	5.15±3.63	4.10±2.86
	Post	15.56±10.09	12.63±8.90	10.88±8.01	9.65±6.64
	P-value	**0.0001**	**0.0001**	**0.0001**	**0.047**
Hand closing	Pre	8.36±5.44	7.08±3.03	7.11±3.05	6.94±4.01
	Post	18.52±12.54	13.85±9.87	12.53±8.71	10.22±7.82
	P-value	**0.0001**	**0.0001**	**0.043**	0.068

In correlation with sex differences, women who used the soft robotic glove improved their hand opening rate by 3.43 times more than men in the same group, who saw an average improvement of 1.91 times between the pre- and post-tests.

The improvement in hand opening was similar for both genders in patients who did not use a soft robotic glove (control group), with a maximum score of 3.71.

Hand opening was significantly different between the pre- and post-tests for both males and females among the soft robot group, while there were no significant differences between males and females in the control group ($p<0.05$).

Closing the hand was significantly different after using a soft glove robot among males and females, in addition to that there were significant differences among males between pre and post-test, while there were no significant differences among females in the control group ($p<0.05$).

It was found that patients who had both ischemic and hemorrhagic strokes got much better at opening their hands between the pre-and post-tests, with the highest convergent score being 7.83. Similarly, the hand-closing process demonstrated a significant maximum improvement rate of 10.24. There was a statistically significant difference between the two types of strokes in how well they opened and closed their hands in all tests ($p<0.05$).

The control group showed improvement in the ability to open and close their hands for both stroke types, achieving an average score of 5.42. The study discovered that there were statistically significant differences in how patients who had hemorrhagic strokes moved their hands before and after the test. These differences were not present in patients who had ischemic strokes.

Discussion.

The study discovered that after the intervention, patients' ability to open and close their hands improved more than twice as much as those in the control group. This result may have the same effect as Lim's study which found Opening and closing the fingers are fundamental functions of hand movement. Similar results were found that the glove actuator may reduce flexion torque and facilitate finger extension, depending on the degree of spasticity, this has been summarized in the study of Lim [28]. Other studies divide participant scores in hand function tasks into categories such as hand-opening and hand-closing, highlighting the variations in scores between unassisted and assisted conditions for each individual. All participants achieved the same mean scores in both tasks, regardless of assistance [28,29]. The similarity in the results stems from conducting studies on a similar number of patients, adhering to the same selection criteria, selecting samples of similar ages, and utilizing 30 minutes for each session.

These results differed from a study involving 10 stroke patients who used a robotic glove for 4 weeks, participating in 25 rehabilitation sessions of up to 20 minutes each. At the end of therapy, the average improvement in extension was 88% in grip force assessment [30]. The discrepancy in results stems from researchers using 25 sessions and a limited number of

patients with the robotic glove, potentially leading to inflated improvement rates compared to this study's findings.

The study revealed that men showed greater progress than women in hand movements, particularly in closing hands, with significant differences observed, this finding contradicts multiple research studies indicating that gender does not influence the ability to open and close the hands, while simultaneously revealing statistically significant differences in hand function based on gender [28,31,32].

The study found no difference in hand closing and opening improvements based on stroke type, but significant differences in hand movements between hemorrhagic and ischemic strokes. This aligns with previous research suggesting stroke types don't affect a patient's ability to close and open the hand [28,31,33]. Owing to different risk factors, including hyperlipidemia, malhemodynamics, and ischemia [34-36], hand-focused rehabilitation methods can be used for both strokes, as the ability to close and open the hand is independent, the study emphasizes the importance of tailored therapy based on individual patient needs, rather than stroke classification. Future research could explore other functional aspects of motor recovery [32,33]. Non-significant improvement in finger opening and closing after using the robotic glove on 11 patients, averaging 20 years old, who completed only 12 rehabilitation sessions [28].

The limited number of sessions with young patients, particularly those under 20 experiencing right-hand weakness, has contributed to minimal improvement in overall hand function, especially in finger movement and hand opening. To address this issue, a more robust rehabilitation plan should be adopted, incorporating consistent therapy sessions and targeted exercises. Advanced techniques, such as neuromuscular stimulation or the use of assistive devices, could further accelerate recovery and improve hand mobility.

This study excluded 11 out of 68 participants due to protocol deviations, resulting in a final sample of 57 patients analyzed under a per-protocol (PP) approach rather than an intention-to-treat (ITT) analysis. Since ITT is the gold standard for randomized controlled trials (RCTs), the exclusion of these participants may introduce selection bias, as the analyzed group may not fully represent the original randomized population. This could overestimate treatment efficacy if dropouts had poorer outcomes.

One key limitation of this study is the potential for measurement bias due to the lack of comprehensive metrics assessing the impact of improved hand function on ADLs, independence, and quality of life. Additionally, performance bias may arise if participants receive varying levels of conventional therapy alongside the robotic intervention, potentially confounding the results. The lack of a blinded assessor could also introduce observer bias, as evaluators may be influenced by their expectations of the robotic glove's effectiveness. Future studies should incorporate functional and patient-reported outcome measures to better evaluate the clinical relevance of the soft robotic glove in enhancing stroke rehabilitation.

Conclusion.

The research demonstrated that stroke patients using a soft robotic glove experienced significant improvements in hand-closing abilities. Whereas exercise alone had a minimal impact on hand opening within the control group. Women using a soft robotic glove exhibited an increase in hand opening rate relative to males, with an average enhancement of two times between pre- and post-assessments. The study also found that hand-opening and hand-closing functions improved in both male and female patients who did not use the soft robotic glove. Patients with both ischemic and hemorrhagic strokes showed significant progress in hand-opening and hand-closing functions. While the control group exhibited minimal improvement, patients with hemorrhagic strokes displayed remarkable advancements in hand mobility compared to those with ischemic strokes.

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