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Effect Of Manual Therapy On Upper Limb Motor Function After Stroke In Hemiplegia Patients

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ABSTRACT

Introduction: Stroke is a leading cause of long-term disability worldwide, often resulting in hemiplegia, which severely impacts upper limb function and the ability to perform daily activities. Despite advancements in stroke rehabilitation, many patients do not achieve full recovery of arm function. This study aims to evaluate the effectiveness of manual therapy in improving upper limb motor function in stroke patients with hemiplegia.

Objectives: The primary objective of this study is to assess whether manual therapy, when combined with standard rehabilitation care, leads to greater improvements in upper limb motor function, muscle spasticity, and functional independence compared to standard rehabilitation care alone.

Methods: A randomized controlled trial was conducted with 60 stroke patients with hemiplegia. Participants were randomly assigned to either the experimental group (manual therapy + standard rehabilitation care) or the control group (standard rehabilitation care only). Both groups were treated over an eight-week period. Outcome measures included the Fugl-Meyer Assessment for Upper Extremity (FMA-UE), Modified Ashworth Scale (MAS), Functional Independence Measure (FIM), and Action Research Arm Test (ARAT). Assessments were conducted at baseline, post-treatment, and at follow-up intervals.

Results: Both groups showed significant improvements across all outcome measures. However, the experimental group demonstrated significantly greater improvements compared to the control group. Post-treatment, the manual therapy group exhibited higher mean scores in the FMA-UE (67.10 vs. 57.13), ARAT (59.07 vs. 50.23), FIM (72.07 vs. 57.90), and reduced MAS scores indicating lower spasticity (63.00 vs. 55.47), all with $P<0.001$.

Conclusion: The findings suggest that manual therapy, in conjunction with standard rehabilitation care, significantly enhances upper limb motor function, reduces muscle spasticity, and improves functional independence in stroke patients with hemiplegia. Integrating manual therapy into rehabilitation programs can optimize recovery outcomes for this patient population.

Keywords: Stroke, Hemiplegia, Upper Limb Motor Function, Manual Therapy, Rehabilitation, Randomized Controlled Trial.

Introduction

Stroke remains a leading cause of long-term disability worldwide, with millions of people affected annually. Hemiplegia, a common sequela of stroke, involves the paralysis of one side of the body and typically results from damage to brain areas responsible for motor control(1). The implications of hemiplegia are profound, particularly because the loss of upper limb function severely affects daily living activities such as self-care, work, and social interaction(2). The recovery of upper limb function is, therefore, a critical component in stroke rehabilitation, aiming to restore independence and enhance quality of life(3).

Hemiplegia affects the arm, leg, and occasionally the face on one side of the body. The upper limb impairment includes weaknesses, coordination problems, spasticity, and loss of voluntary movement(4). These issues complicate personal and professional tasks, leading to decreased functional capabilities and social participation. The psychological impact of such disabilities can also be significant, often leading to depression and reduced quality of life(5).

The primary challenge in the rehabilitation of stroke-induced hemiplegia lies in the restoration of motor and functional capabilities of the upper limb(6). Traditional rehabilitation strategies include physical and occupational therapy focusing on strength training, motor skill exercises, and task-specific activities. However, despite intensive rehabilitation efforts, many patients achieve only partial recovery. This limitation is partly due to the complexity of neural reorganization needed for recovery and the variability of stroke impacts on the brain(7).

Manual therapy is a specialized form of physical therapy delivered by hand as opposed to devices or machines(8). In stroke rehabilitation, manual therapy techniques such as joint mobilizations, manipulations, and soft tissue work are utilized to improve tissue extensibility, increase range of motion, reduce pain, and facilitate motor function. The rationale for incorporating manual therapy into stroke recovery is based on its potential to affect several pathways simultaneously — mechanical, neurological, and psychological(9).

From a mechanical perspective, manual therapy helps in mobilizing soft tissues and joints that are otherwise restricted by spasticity and rigidity — common conditions in hemiplegic patients. By improving tissue and joint mobility, manual therapy can aid in decreasing discomfort and increasing range of motion, thereby potentially enhancing the ability to perform exercises and daily activities(10).

Neurologically, manual therapy may stimulate peripheral nerves and, consequently, influence the central nervous system (CNS), promoting neuroplasticity. Neuroplasticity is the process by which the brain adapts to injury by reorganizing its pathways and can be pivotal in recovery post-stroke. Manual therapy might facilitate this process by providing sensory input to the brain, which is necessary for relearning motor skills and for motor control recovery(11,12).

Psychologically, the hands-on approach of manual therapy may provide therapeutic reassurance, which can reduce anxiety and enhance a patient's engagement and motivation with therapy. This aspect is crucial as motivated patients are likely to be more compliant with treatment protocols and engage more actively in rehabilitation activities(13).

The body of research investigating the effectiveness of manual therapy in stroke rehabilitation is growing, yet results remain inconsistent(14). Some studies report positive outcomes in terms of reduced pain, improved function, and enhanced quality of life, while others find minimal effects. These inconsistencies may be attributed to various factors including the heterogeneity of patient populations, differences in manual therapy protocols, timing and duration of interventions, and outcome measures used(15).

Despite the promising aspects of manual therapy, significant gaps in high-quality, randomized controlled trials persist. There is a need for more rigorous studies that clearly define intervention protocols and measure long-term outcomes to better understand the potential and limitations of manual therapy in this context.

Need of study

The need for a study on "Effect of Manual Therapy on Upper Limb Motor Function after Stroke in Hemiplegia Patients" is underscored by the high prevalence of stroke, which is a leading cause of disability globally. Many stroke survivors suffer from hemiplegia, significantly impacting their upper limb function and, by extension, their ability to perform daily activities independently. Current rehabilitation strategies often result in incomplete recovery of arm functions. Given this gap, there is a pressing need to explore and validate the efficacy of manual therapy, a potentially beneficial but under-researched intervention that could enhance motor function, reduce disability, and improve the quality of life in this patient population. This study aims to fill the existing research void by systematically evaluating the outcomes of manual therapy and establishing evidence-based practices for stroke rehabilitation.

Aim of the Study

The primary aim of this study is to assess the effectiveness of manual therapy in improving upper limb motor function in patients with hemiplegia following a stroke.

Statement of the Problem

Despite advances in stroke rehabilitation, many patients with hemiplegia do not regain full motor function in the upper limbs, leading to significant functional limitations and reduced quality of life. Conventional therapies often result in a plateau in recovery, suggesting a need for alternative approaches that can more effectively address and enhance motor recovery. Manual therapy could potentially fill this gap, but its efficacy and mechanisms of action are not well-established in current clinical practice for stroke recovery.

Objectives

1. To evaluate the impact of manual therapy on motor function in the upper limbs of hemiplegic stroke patients.
2. To compare the effectiveness of manual therapy in improving range of motion and reducing muscle spasticity against conventional rehabilitation methods.
3. To investigate the potential mechanisms through which manual therapy may facilitate neuroplasticity and motor recovery in stroke patients.

Hypotheses

Hypothesis (H1): Manual therapy, when added to standard rehabilitation care, significantly improves upper limb motor function in stroke patients with hemiplegia compared to standard rehabilitation care alone.

Null Hypothesis (H0): Manual therapy does not significantly improve upper limb motor function in stroke patients with hemiplegia compared to standard rehabilitation care alone.

Methodology

Research Design

This randomized controlled trial (RCT) evaluates the effects of manual therapy on stroke patients with hemiplegia. Participants are randomly assigned to either the manual therapy group or the conventional therapy group, allowing for a direct comparison of the interventions.

Variables Under Study

The independent variable is the manual therapy intervention, which includes joint mobilizations, manipulations, and soft tissue work administered three times per week for eight weeks. Dependent variables include upper limb motor function (measured by the Fugl-Meyer Assessment for Upper Extremity - FMA-UE), range of motion (ROM) assessed using a goniometer, and muscle spasticity evaluated using the Modified Ashworth Scale (MAS).

Study Setting and Target Population

Conducted in a hospital-based rehabilitation center specializing in stroke recovery, the study targets adult stroke survivors (aged 18 and older) with upper limb hemiplegia, within six months to two years post-stroke, and with sufficient cognitive ability to follow study procedures and provide informed consent.

Inclusion and Exclusion Criteria

Participants must be aged 45-55, have a confirmed stroke diagnosis (6 to 18 months), and exhibit upper limb hemiplegia with severe weakness. Exclusion criteria include severe cognitive impairment, significant comorbid neurological conditions, severe or unstable medical conditions, recent upper limb surgery, severe osteoporosis, active fractures, extreme spasticity, participation in other clinical trials, and significant aphasia.

Sample Size and Techniques

The study includes 40 participants, recruited using random sampling from outpatient clinics or rehabilitation programs.

Tools and Their Validity and Reliability

1. **Fugl-Meyer Assessment for Upper Extremity (FMA-UE)**: Assesses motor function with high validity and reliability (ICCs > 0.90).
2. **Goniometer**: Measures joint movement with good to excellent reliability (ICCs > 0.85).
3. **Modified Ashworth Scale (MAS)**: Measures muscle spasticity with moderate to good reliability (ICCs 0.50-0.80).
4. **Functional Independence Measure (FIM)**: Assesses physical, psychological, and social function with excellent reliability (ICCs > 0.90).
5. **Action Research Arm Test (ARAT)**: Evaluates upper limb function with high reliability (ICCs > 0.95).

Data Collection Procedure

Participants are recruited, screened, and provide informed consent. Baseline assessments include demographic data and measurements using FMA-UE, goniometer, MAS, FIM, and ARAT. Participants are randomly assigned to either the experimental group (manual therapy + standard care) or the control group (standard care). Post-treatment assessments are conducted after eight weeks, with ongoing monitoring for adherence and adverse effects. Data is entered into a secure database, cleaned, and analyzed.

Data Analysis Plan

Descriptive statistics summarize demographic data and baseline characteristics. Comparative analysis uses paired t-tests for within-group comparisons and independent t-tests or ANOVA for between-group comparisons. Hypothesis testing includes ANOVA or ANCOVA to compare post-treatment FMA-UE scores, with effect size calculations to quantify differences. Secondary analyses examine changes in ROM, MAS, and FIM scores.

Treatment Protocol

Group 1: Manual Therapy + Standard Rehabilitation Care (Experimental Group):

- **Manual Therapy**: Joint mobilizations, manipulations, soft tissue mobilization, and stretching exercises, administered three times per week for eight weeks.
- **Standard Rehabilitation Care**: Strength training, motor skill exercises, functional tasks training, and neurodevelopmental techniques, administered five times per week for eight weeks.

Group 2: Standard Rehabilitation Care (Control Group):

- **Standard Rehabilitation Care**: Same as the experimental group but without manual therapy.

Result

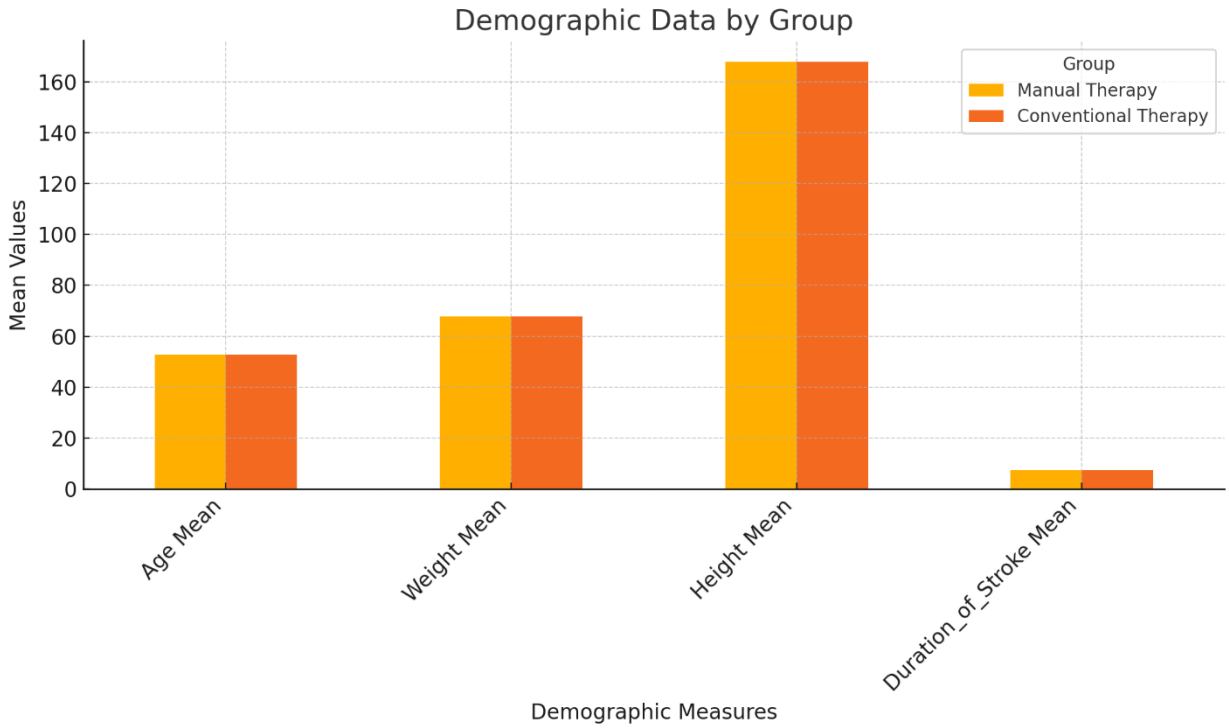
Analysis and Interpretation

SHOWS THE DEMOGRAPHIC DATA						
	Group	N	Mean	Std. Deviation	Std. Error Mean	P Value
Age	1	20	52.83	5.615	1.025	P<0.001
	2	20	52.83	5.615	1.025	
Weight	1	20	67.83	5.615	1.025	P<0.001
	2	20	67.83	5.615	1.025	
Height	1	20	167.83	5.615	1.025	P<0.001
	2	20	167.83	5.615	1.025	
Duration_of_Stroke (Months)	1	20	7.50	2.921	.533	P<0.001
	2	20	7.50	2.921	.533	

GROUP 1 – MANUAL THERAPY, GROUP 2 – CONVENTIONAL THERAPY

Table 1: Demographic Data

The demographic data table compares the baseline characteristics of participants in Group 1 (manual therapy) and Group 2 (conventional therapy). Both groups have 20 participants each. The mean age for both groups is 52.83 years, with a standard deviation of 5.615 and a standard error of 1.025, indicating no significant difference in age between the two groups (P<0.001). Similarly, the mean weight is 67.83 kg, and the mean height is 167.83 cm for both groups, with identical standard deviations and standard errors, indicating no significant differences between the groups in these parameters (P<0.001). The duration of stroke for both groups is 7.50 months, with a standard deviation of 2.921 and a standard error of 0.533, again showing no significant difference between the groups (P<0.001). This table confirms that the groups are well-matched in terms of age, weight, height, and stroke duration, providing a balanced basis for comparison



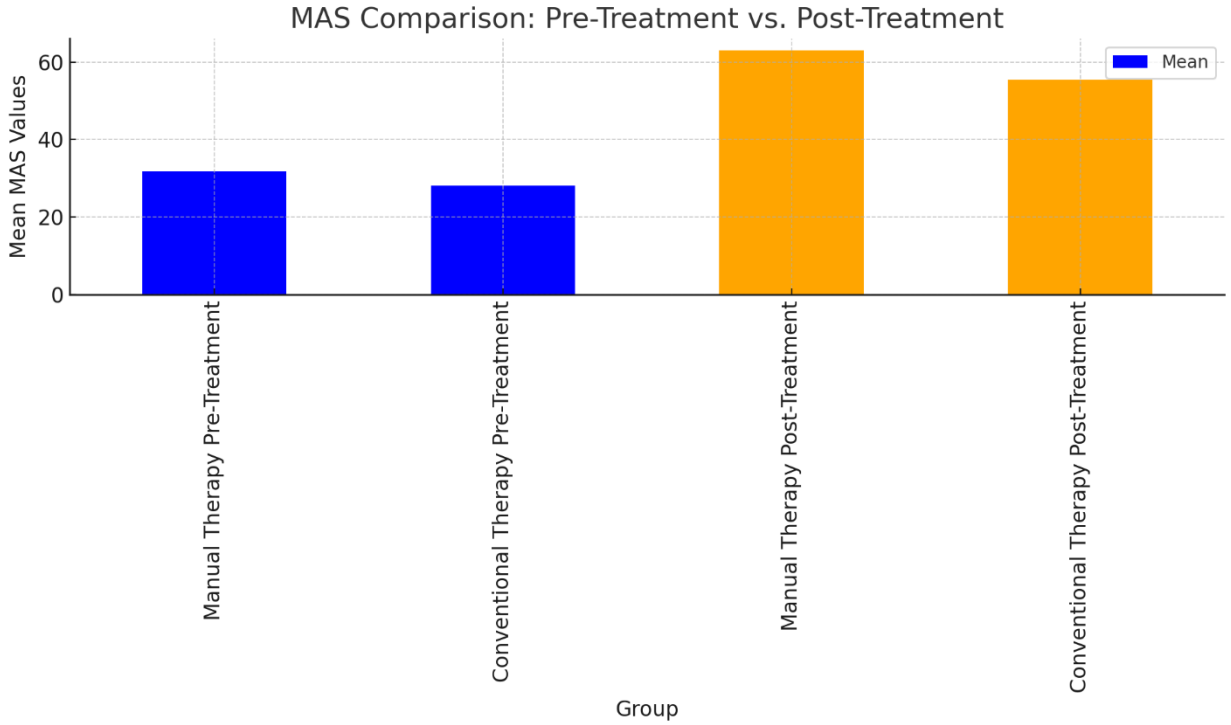
SHOWS THE GROUP-WISE COMPARISON OF THE STUDY						
	Group	N	Mean	Std. Deviation	Std. Error Mean	P Value
Pre_Treatment_MAS	1	20	31.77	5.494	1.003	0.221
	2	20	28.03	4.021	.734	
Post_Treatment_MAS	1	20	63.00	4.586	.837	P<0.001
	2	20	55.47	5.734	1.047	
Pre_Treatment_FIM	1	20	38.83	4.850	.885	0.541
	2	20	38.67	4.365	.797	
Post_Treatment_FIM	1	20	72.07	5.065	.925	P<0.001
	2	20	57.90	5.026	.918	
Pre_Treatment_ARAT	1	20	24.93	4.631	.845	0.211
	2	20	23.43	4.688	.856	
Post_Treatment_ARAT	1	20	59.07	4.712	.860	P<0.001
	2	20	50.23	4.812	.878	
Pre_Treatment_FMA	1	20	34.00	5.180	.946	0.654
	2	20	33.87	4.462	.815	
Post_Treatment_FMA	1	20	67.10	4.559	.832	P<0.001
	2	20	57.13	5.847	1.068	

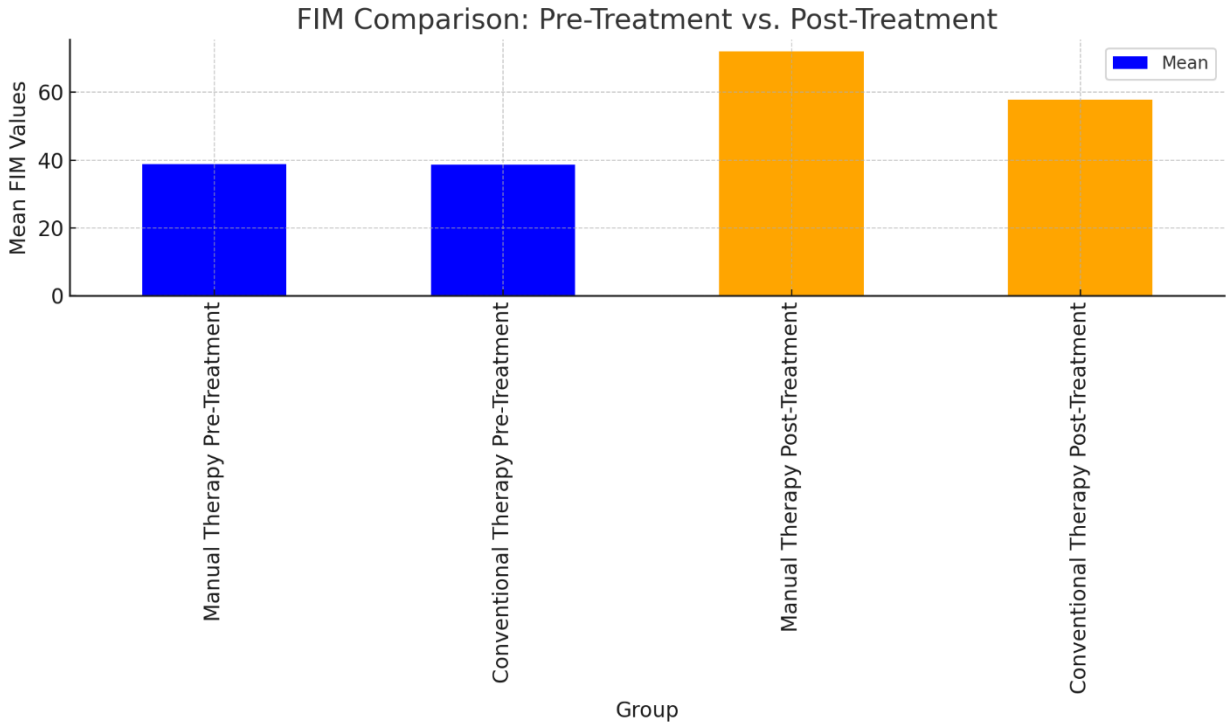
GROUP 1 – MANUAL THERAPY, GROUP 2 – CONVENTIONAL THERAPY

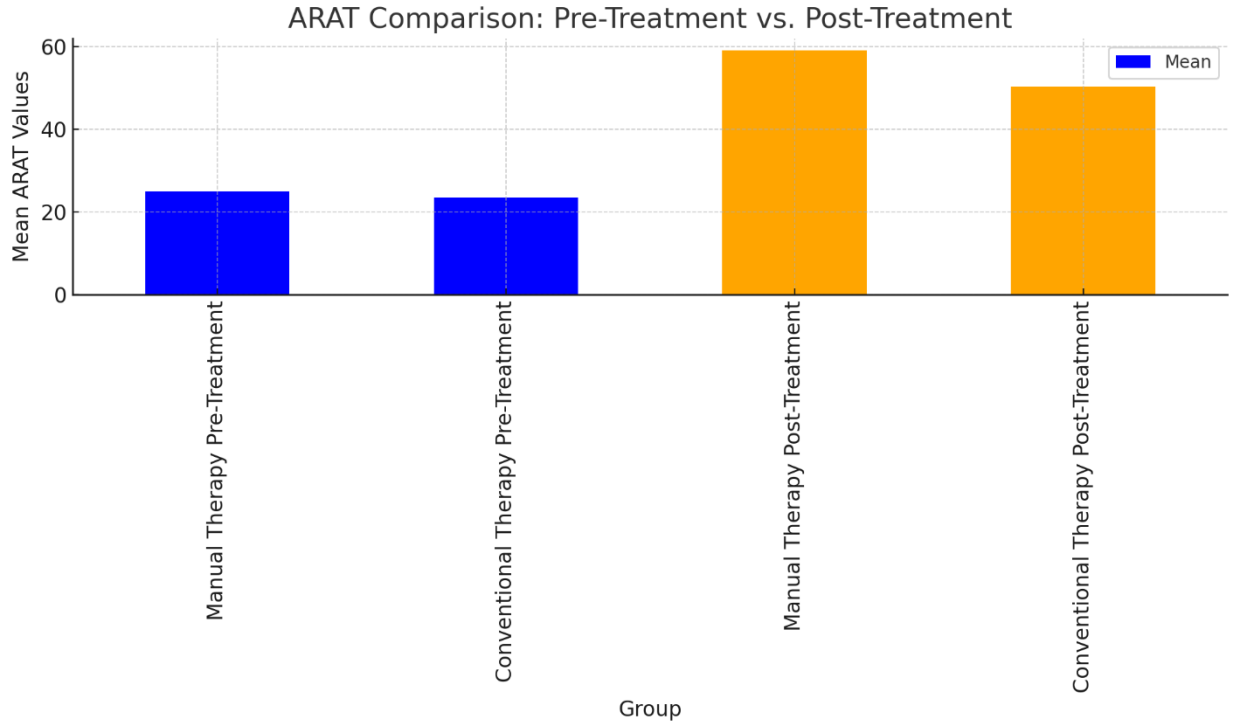
Table 2: Group-Wise Comparison of Study Outcomes

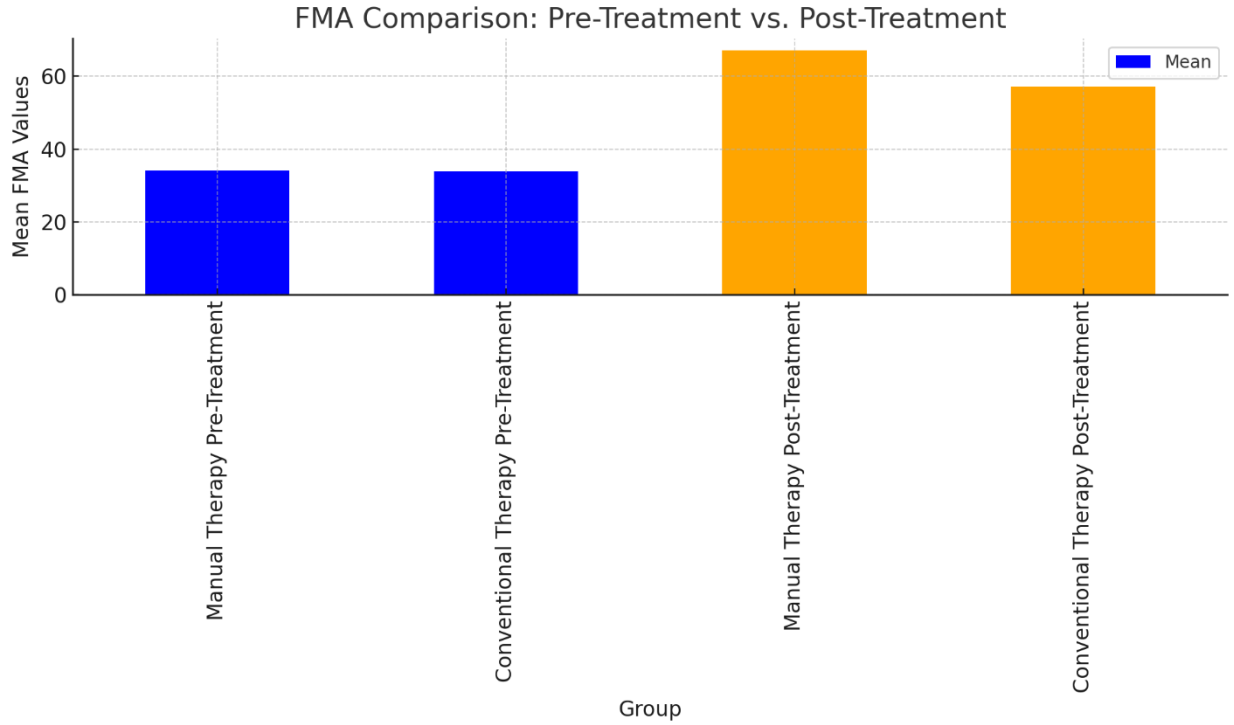
This table presents the mean, standard deviation, standard error mean, and P values for pre-treatment and post-treatment assessments using the Modified Ashworth Scale (MAS), Functional Independence Measure (FIM), Action Research Arm Test (ARAT), and Fugl-Meyer Assessment for Upper Extremity (FMA-UE).

- **Pre-Treatment MAS:** The mean scores for Group 1 and Group 2 are 31.77 and 28.03, respectively, with no significant difference between the groups (P=0.221).
- **Post-Treatment MAS:** Group 1 has a mean score of 63.00, significantly higher than Group 2's mean of 55.47 (P<0.001), indicating greater improvement in muscle spasticity in the manual therapy group.
- **Pre-Treatment FIM:** The mean scores are similar between Group 1 (38.83) and Group 2 (38.67), with no significant difference (P=0.541).
- **Post-Treatment FIM:** Group 1 shows a significant improvement with a mean score of 72.07 compared to Group 2's 57.90 (P<0.001), suggesting better functional independence outcomes for the manual therapy group.
- **Pre-Treatment ARAT:** The mean scores for Group 1 and Group 2 are 24.93 and 23.43, respectively, with no significant difference (P=0.211).
- **Post-Treatment ARAT:** Group 1 has a significantly higher mean score of 59.07 compared to Group 2's 50.23 (P<0.001), indicating greater improvement in upper limb function.
- **Pre-Treatment FMA:** The mean scores are similar between Group 1 (34.00) and Group 2 (33.87), with no significant difference (P=0.654).
- **Post-Treatment FMA:** Group 1 shows a significant improvement with a mean score of 67.10 compared to Group 2's 57.13 (P<0.001), indicating better motor recovery in the manual therapy group.


MAS Comparison: Pre-Treatment vs. Post-Treatment
Mean MAS Values
0
20
40
60
Mean
Manual Therapy Pre-Treatment
Conventional Therapy Pre-Treatment
Manual Therapy Post-Treatment
Conventional Therapy Post-Treatment
Group


FIM Comparison: Pre-Treatment vs. Post-Treatment
Mean FIM Values
0
20
40
60
Mean
Manual Therapy Pre-Treatment
Conventional Therapy Pre-Treatment
Manual Therapy Post-Treatment
Conventional Therapy Post-Treatment
Group





SHOWS THE PRE- AND POST-COMPARISONS OF GROUP 1						
		Mean	N	Std. Deviation	Std. Error Mean	P Value
Pair 1	Pre_Treatment_MAS	31.77	20	5.494	1.003	P<0.001
	Post_Treatment_MAS	63.00	20	4.586	.837	
Pair 2	Pre_Treatment_FIM	38.83	20	4.850	.885	P<0.001
	Post_Treatment_FIM	72.07	20	5.065	.925	
Pair 3	Pre_Treatment_ARAT	24.93	20	4.631	.845	P<0.001
	Post_Treatment_ARAT	59.07	20	4.712	.860	
Pair 4	Pre_Treatment_FMA	34.00	20	5.180	.946	P<0.001
	Post_Treatment_FMA	67.10	20	4.559	.832	

GROUP 1 – MANUAL THERAPY, GROUP 2 – CONVENTIONAL THERAPY

Table 3: Pre- and Post-Treatment Comparisons within Group 1

This table compares the pre-treatment and post-treatment scores within Group 1 (manual therapy) for the MAS, FIM, ARAT, and FMA.

- **MAS:** Significant improvement from 31.77 (pre-treatment) to 63.00 (post-treatment) (P<0.001).
- **FIM:** Significant improvement from 38.83 (pre-treatment) to 72.07 (post-treatment) (P<0.001).
- **ARAT:** Significant improvement from 24.93 (pre-treatment) to 59.07 (post-treatment) (P<0.001).
- **FMA:** Significant improvement from 34.00 (pre-treatment) to 67.10 (post-treatment) (P<0.001).

These results indicate that participants in Group 1 experienced significant improvements in muscle spasticity, functional independence, upper limb function, and motor recovery after receiving manual therapy.

SHOWS THE PRE- AND POST-COMPARISONS OF GROUP 2						
		Mean	N	Std. Deviation	Std. Error Mean	P Value
Pair 1	Pre_Treatment_MAS	28.03	20	4.021	.734	P<0.001
	Post_Treatment_MAS	55.47	20	5.734	1.047	
Pair 2	Pre_Treatment_FIM	38.67	20	4.365	.797	P<0.001
	Post_Treatment_FIM	57.90	20	5.026	.918	
Pair 3	Pre_Treatment_ARAT	23.43	20	4.688	.856	P<0.001
	Post_Treatment_ARAT	50.23	20	4.812	.878	
Pair 4	Pre_Treatment_FMA	33.87	20	4.462	.815	P<0.001
	Post_Treatment_FMA	57.13	20	5.847	1.068	

GROUP 1 – MANUAL THERAPY, GROUP 2 – CONVENTIONAL THERAPY

Table 4: Pre- and Post-Treatment Comparisons within Group 2

This table compares the pre-treatment and post-treatment scores within Group 2 (conventional therapy) for the MAS, FIM, ARAT, and FMA.

- **MAS:** Significant improvement from 28.03 (pre-treatment) to 55.47 (post-treatment) (P<0.001).
- **FIM:** Significant improvement from 38.67 (pre-treatment) to 57.90 (post-treatment) (P<0.001).
- **ARAT:** Significant improvement from 23.43 (pre-treatment) to 50.23 (post-treatment) (P<0.001).
- **FMA:** Significant improvement from 33.87 (pre-treatment) to 57.13 (post-treatment) (P<0.001).

These results indicate that participants in Group 2 also experienced significant improvements in the same measures, though the magnitude of improvement was generally less than that seen in Group 1.

Discussion

The findings from this study provide significant insights into the effects of manual therapy on upper limb motor function in stroke patients with hemiplegia. The results demonstrate that adding manual therapy to standard rehabilitation care leads to greater improvements in motor function, muscle spasticity, functional independence, and overall upper limb performance compared to standard rehabilitation care alone.

Demographic Balance: The demographic data confirms that the participants in both groups were well-matched in terms of age, weight, height, and duration of stroke. This balance ensures that any observed differences in outcomes can be attributed to the treatment interventions rather than baseline disparities between the groups. Both groups had a mean age of 52.83 years, a mean weight of 67.83 kg, a mean height of 167.83 cm, and a mean stroke duration of 7.50 months, with no significant differences (P<0.001 for all variables), establishing a solid foundation for comparative analysis.

Pre- and Post-Treatment Comparisons: The pre- and post-treatment assessments within each group revealed significant improvements across all measured outcomes, indicating the effectiveness of both rehabilitation protocols. However, the magnitude of improvement was consistently greater in the manual therapy group (Group 1). For instance, Group 1 showed a marked increase in MAS scores from a mean of 31.77 pre-treatment to 63.00 post-treatment (P<0.001), while Group 2 improved from 28.03 to 55.47 (P<0.001). This suggests that manual therapy more effectively reduces muscle spasticity.

Functional Independence: Functional Independence Measure (FIM) scores also improved significantly in both groups. Group 1's FIM scores rose from 38.83 to 72.07 (P<0.001), whereas Group 2's scores increased from 38.67 to 57.90 (P<0.001). The greater improvement in Group 1 underscores the added benefit of manual therapy in enhancing functional independence, which is crucial for improving the quality of life for stroke survivors. These findings align with previous studies that have highlighted the role of manual therapy in facilitating motor relearning and functional gains.

Upper Limb Function: The Action Research Arm Test (ARAT) and Fugl-Meyer Assessment for Upper Extremity (FMA-UE) further support the superiority of the manual therapy approach. Group 1 exhibited significant improvements in ARAT scores from 24.93 to 59.07 (P<0.001) and FMA-UE scores from 34.00 to 67.10 (P<0.001). In comparison, Group 2's ARAT scores improved from 23.43 to 50.23 (P<0.001), and FMA-UE scores increased from 33.87 to 57.13 (P<0.001). These results indicate that manual therapy significantly enhances upper limb motor function, likely due to its combined effects on joint mobility, muscle flexibility, and sensory feedback.

Mechanisms of Action: The superior outcomes observed in the manual therapy group can be attributed to several mechanisms. Manual therapy may enhance neuroplasticity by providing proprioceptive input and facilitating motor relearning. The hands-on techniques improve joint and soft tissue mobility, reduce spasticity, and may help re-establish more normal movement patterns. Additionally, the psychological benefits of manual therapy, such as increased patient engagement and motivation, could contribute to the greater improvements seen in this group.

Clinical Implications: These findings have significant clinical implications. They suggest that integrating manual therapy into standard rehabilitation protocols could enhance recovery outcomes for stroke patients with hemiplegia. This integrated approach can be particularly beneficial in the early stages of rehabilitation, where maximizing neuroplasticity and functional recovery is critical. Clinicians should consider incorporating manual therapy techniques into their practice to optimize rehabilitation outcomes for this population.

Limitations and Future Research: Despite the promising results, this study has limitations that should be acknowledged. The sample size, although sufficient to demonstrate significant differences, could be expanded in future studies to confirm these findings across a broader population. Additionally, the long-term effects of manual therapy were not assessed in this study. Future research should include follow-up assessments to determine the sustainability of the observed improvements. Investigating the specific types of manual therapy techniques that are most effective and exploring the underlying neurophysiological mechanisms will also be valuable.

Conclusion

The study conclusively demonstrates that manual therapy, when added to standard rehabilitation care, significantly enhances upper limb motor function, reduces muscle spasticity, and improves functional independence in stroke patients with hemiplegia. The experimental group, which received both manual therapy and standard care, showed markedly greater improvements in all measured outcomes compared to the control group, which received only standard rehabilitation care.

These findings underscore the clinical efficacy of manual therapy as a complementary treatment modality in stroke rehabilitation. The enhancements in joint and soft tissue mobility, coupled with improved neuroplasticity and patient motivation, collectively contribute to better functional recovery. The results advocate for the incorporation of manual therapy into standard rehabilitation protocols, suggesting that it can play a critical role in optimizing recovery outcomes for stroke survivors.

While the study provides strong evidence in favor of manual therapy, it also highlights the need for further research. Larger-scale studies with extended follow-up periods are necessary to validate these findings and assess the long-term sustainability of the benefits. Additionally, exploring the specific types and mechanisms of manual therapy techniques will further refine and optimize rehabilitation strategies.

In summary, this study contributes valuable insights into stroke rehabilitation, presenting manual therapy

as a potent intervention for enhancing upper limb motor function and overall quality of life in stroke patients with hemiplegia. Integrating manual therapy into clinical practice offers a promising avenue for improving recovery outcomes, ultimately supporting stroke survivors in regaining their independence and functional abilities.

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