

Extracorporeal Shock Wave Therapy Versus Nirmal Table Functional Activity on Hand Functions in Chronic Stroke Patients; A Comparative Study

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INTRODUCTION

Extracorporeal Shock Wave Therapy in Physiotherapy

Extracorporeal Shock Wave Therapy (ESWT) is a non-invasive physiotherapy intervention increasingly used in the management of chronic musculoskeletal disorders. It delivers high-energy acoustic waves to a selected area of the body through a treatment applicator. Originally developed for lithotripsy, shock-wave technology has subsequently been adapted for orthopaedic and rehabilitation applications. Its therapeutic effects are associated with mechanical stimulation of tissues, modulation of pain, changes in local circulation, and biological responses that may support tissue repair. The physiological effects of ESWT are thought to involve mechano-transduction, in which mechanical energy produces cellular and tissue responses. These responses may influence local blood flow, cellular activity, protein synthesis and tissue remodelling. ^[1,2]

ESWT is broadly classified into focused shock wave therapy (F-ESWT) and radial shock wave therapy (R-ESWT). Focused waves can deliver energy at a specific depth, whereas radial waves disperse energy from the applicator into the surrounding tissues. ^[2,3]

From a physiotherapy perspective, ESWT is generally most useful when integrated with therapeutic exercise, progressive loading, stretching, manual therapy and patient education, rather than being considered a stand-alone replacement for rehabilitation. The therapist should conduct an appropriate clinical assessment before treatment and establish measurable outcomes such as pain intensity, range of motion, muscle performance and functional ability. ESWT is generally well tolerated. Temporary discomfort during treatment, redness, swelling or minor bruising can occur. Appropriate screening is necessary, particularly in individuals with significant coagulation disorders, active infection or situations in which shock-wave exposure is contraindicated. ^[2] Overall, ESWT represents a valuable adjunct within evidence-based physiotherapy, particularly for persistent musculoskeletal conditions where conventional conservative management has provided insufficient improvement. Continued research is required to establish optimal treatment parameters and identify which patient characteristics are associated with the greatest clinical benefit. ^[1,3]

Dosage:^[4]

- **Energy Flux Density:** 0.03–0.10 mJ/mm²; 1–2 bar
- **Impulses:** 1000–2000/muscle
- **Frequency:** 4–10 Hz
- **Sessions:** 1–5 treatments
- **Interval:** One session every 1–2 weeks

Role of Extracorporeal Shock Wave Therapy in Chronic Stroke:

This is also used in managing post-stroke spasticity. In chronic stroke patients, ESWT can be applied to spastic muscles to reduce abnormal muscle tone, improve joint range of motion, and facilitate functional movement. Evidence indicates beneficial effects on both upper & lower limb spasticity, with improvements reported in motor function and selected functional outcomes. ^[5,6]

Nirmal Table Functional Activity in Physiotherapy

It is a rehabilitation apparatus designed to facilitate active and resisted exercises for the fingers, hand, wrist and forearm. It is commonly used in physiotherapy and occupational therapy to improve joint mobility, muscle strength, coordination, grip function and dexterity. The equipment incorporates a table-mounted pulley system, cords with finger loops, adjustable weights, and attachments for wrist and forearm movements. A major advantage is its ability to provide graded resistance during functional upper-limb activity. Individual fingers can be connected to the pulley loops, allowing patients to practise flexion and extension movements against controlled resistance. The apparatus

can therefore be used for progressive strengthening while simultaneously encouraging selective finger movement. The available weights can be adjusted according to the patient's muscle capacity and rehabilitation stage.^[7,8,9] The table also supports wrist and forearm functional training through pronation–supination and wrist-circumduction exercises. These activities are particularly relevant when reduced wrist mobility, weakness or impaired coordination affects activities such as grasping, manipulating objects, writing, dressing and other activities of daily living. Functional upper-limb rehabilitation is generally enhanced when repetitive exercises are progressively related to meaningful tasks rather than focusing exclusively on isolated impairments. Clinically, the Nirmal Table may be incorporated into rehabilitation following hand injuries, neurological conditions, postoperative stiffness and other disorders associated with impaired upper-limb function. The therapist should select the resistance, repetitions and movement range according to the patient's diagnosis, pain, strength and functional goals. It should be viewed as an exercise and functional-training aid, rather than as a substitute for individualized task-specific rehabilitation.^[10,11] The Nirmal Table can be incorporated into chronic stroke rehabilitation to provide repetitive, graded training of the affected hand, wrist and forearm. Finger exercises, pulley-assisted movements, wrist activities and forearm pronation–supination can facilitate active movement, strengthening, coordination and motor control. These activities can be progressed from assisted to resisted exercises according to the patient's residual ability. Repetitive, task-oriented upper-limb practice is supported in stroke rehabilitation and may improve motor function, performance and activities of daily living. Thus, Nirmal Table exercises can serve as an adjunct to functional, goal-directed stroke rehabilitation.

Alternate Hypothesis (H_1): There will be a statistically significant difference in hand function among chronic stroke patients receiving Extracorporeal Shock Wave Therapy compared with those receiving Nirmal Table functional activity.

Null Hypothesis (H_0): There will be no statistically significant difference in hand function among chronic stroke patients receiving Extracorporeal Shock Wave Therapy compared with those receiving Nirmal Table functional activity.

METHODOLOGY

Type of Study: A comparative experimental study with a two-group pre-test–post-test design.

Study Setting: The study was conducted in the Department of Physiotherapy, Nims University Rajasthan. Participants will be recruited from the outpatient department and eligible chronic stroke patients referred for upper-limb rehabilitation.

Sample Size: Sample size estimation was done by using G*Power software (version 3.1.9.7). However, because the present study was planned with 20 participants, it will be considered a pilot comparative study, with 10 participants allocated to each group.

Inclusion Criteria

- Clinically diagnosed stroke patients between 40 and 65 years.
- Chronic stroke duration of more than 6 months.
- Presence of impaired hand function on the affected side.
- Ability to understand and follow simple verbal instructions.
- Modified Ashworth Scale score of 1 to 3 for the selected upper-limb muscles, where ESWT is clinically indicated.

Exclusion Criteria

- Severe cognitive or communication impairment preventing assessment or participation.
- Severe fixed contracture of the wrist or fingers.
- Severe pain or acute musculoskeletal injury of the affected upper limb.
- Recent upper-limb surgery or fracture.
- Pacemaker or other condition contraindicating the selected treatment protocol.

Sampling Method: Non-probability sampling method was used because eligible chronic stroke patients were selected from the available population.

Sampling Technique: Purposive sampling was used and participants were allocated into two groups using simple random allocation:

- **Group A (n=10):** ESWT group
- **Group B (n=10):** Nirmal Table functional activity group

Procedure

After obtaining approval from the Institutional Ethics Committee, eligible participants were screened according to the selection criteria. The investigator explained the objectives, procedures, possible benefits and potential risks to

each participant. Baseline demographic information, including age, sex, affected side, stroke duration and relevant clinical characteristics, will be documented. Pre-intervention assessment of hand function was taken and outcome measure such as the Fugl-Meyer Assessment–Upper Extremity (FMA-UE) and/or Action Research Arm Test (ARAT).

Group A – ESWT:

Participants received ESWT over clinically selected spastic or functionally relevant upper-limb muscles. A standardized physiotherapy protocol was used, with treatment parameters selected according to the target muscle, clinical presentation. Treatment was provided once weekly for 4 weeks, followed by conventional hand rehabilitation.

Group B – Nirmal Table Functional Activity:

Participants performed structured Nirmal Table exercises involving finger flexion-extension, resisted finger movements, wrist movements, forearm pronation-supination and graded pulley-based activities. Exercises were progressed according to individual motor capacity and functional tolerance.

Both groups received the same standardized conventional physiotherapy programme, excluding the experimental intervention, to reduce differences in co-intervention. Post-intervention assessment was performed using the same outcome measures immediately after completion of the intervention period. Changes in hand function from pre-test to post-test were compared within and between groups.

Outcome Measure

Action Research Arm Test (ARAT) – assessment of grasp, grip, pinch and gross upper-limb movement.

Fugl-Meyer Assessment–Upper Extremity (FMA-UE) – assessment of motor recovery of the affected upper limb.

RESULTS

Data Analysis

Data was analysed by using software SPSS 25.0

Table 1: Mean and Standard deviation of Age Group A & B

Group A			Group B	
N	Mean	Std. Deviation	Mean	Std. Deviation
10	54.5000	5.79751	54.3000	5.57873

Table 2: Mean and Standard deviation of ARTA Pre- Post & FMA-UE Pre–Post Group A)

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	ARTA Pre A	27.5000	10	6.81909	2.15639
	ARTA Post A	32.0000	10	7.13364	2.25586
Pair 2	FMA-UE Pre A	48.7000	10	4.66786	1.47611
	FMA-UE Post A	51.0000	10	4.39697	1.39044

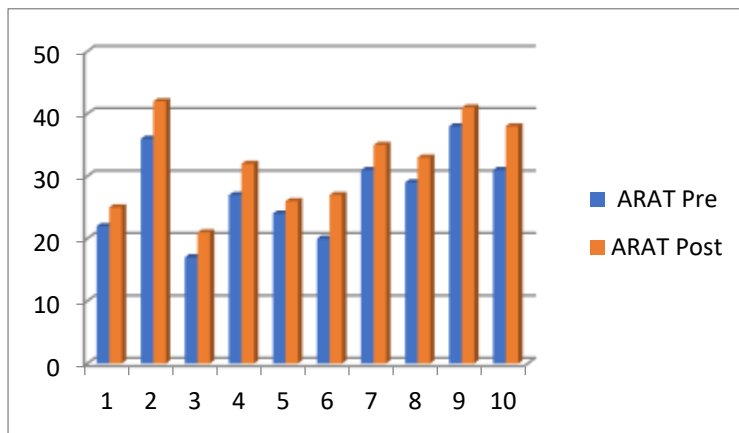
Paired t test:

A paired t–test was conducted to compare the pre and post value of ARAT and FMA-UE. There was a significant difference in the ARAT pre (M=27.50, SD= 6.81), ARAT post (M=32.00, SD=2.25) and FMA-UE Pre (M=48.70, SD=1.470), FMA-UE Post (M=51.00, SD=1.47). The paired-samples t-test revealed a statistically significant improvement from pre-test to post-test in ARTA scores, $t = -8.293$, $p < 0.001$, with a mean difference of -4.50 (95% CI: -5.73 to -3.27). Similarly, FMA-UE scores demonstrated a statistically significant improvement from pre-test to post-test, $t = -7.667$, $p < 0.001$, with a mean difference of -2.30 (95% CI: -2.98 to -1.62)."

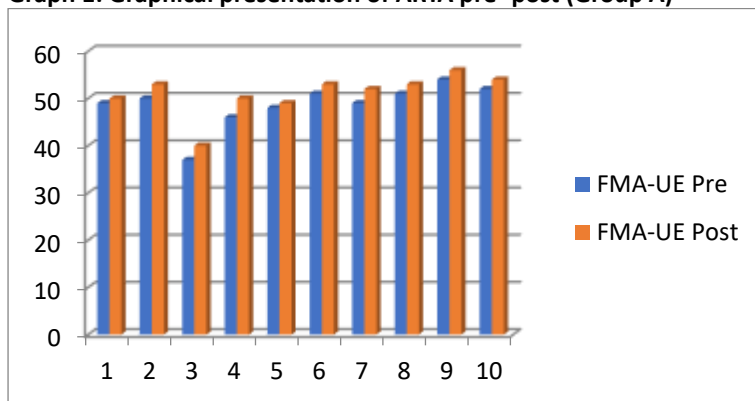
Table 3: Paired t test for ARTA Pre- Post and FMA-UE Pre – Post (Group A)

Paired Samples Test							
Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference			
				Lower			
				Upper			

Pair 1	ARTA Pre – Post	-4.500	1.715	.542	-5.727	-3.272	-8.293	9	.000
Pair 2	FMA-UE Pre – Post	-2.300	.948	.300	-2.978	-1.621	-7.667	9	.000



Graph 1: Graphical presentation of ARTA pre- post (Group A)



Graph 2 Graphical presentation of FMA-UE pre- post (Group A)

Table 4: Mean & Standard deviation of ARTA Pre- Post and FMA-UE Pre-Post (Group B)

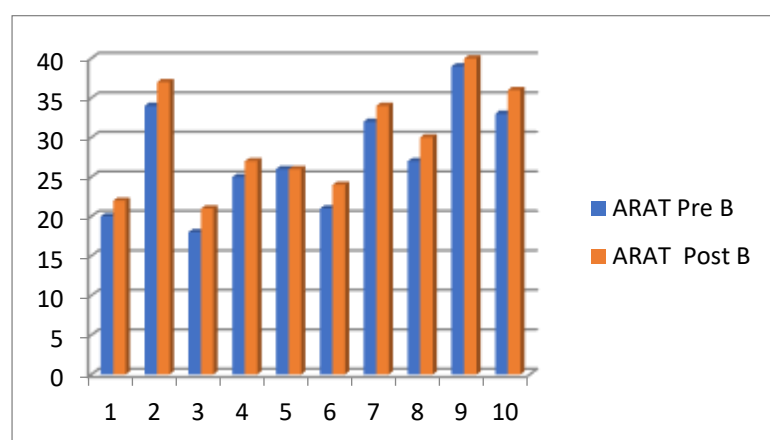
Paired Samples Statistics					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	ARTA Pre B	27.5000	10	6.85160	2.16667
	ARTA Post B	29.7000	10	6.71731	2.12420
Pair 2	FMAUE Pre B	47.3000	10	5.57873	1.76415
	FMAUE Post B	50.1000	10	4.90918	1.55242

Table 5: Paired t test for ARAT Pre-Post and FMA-UE Pre-Post (Group B)

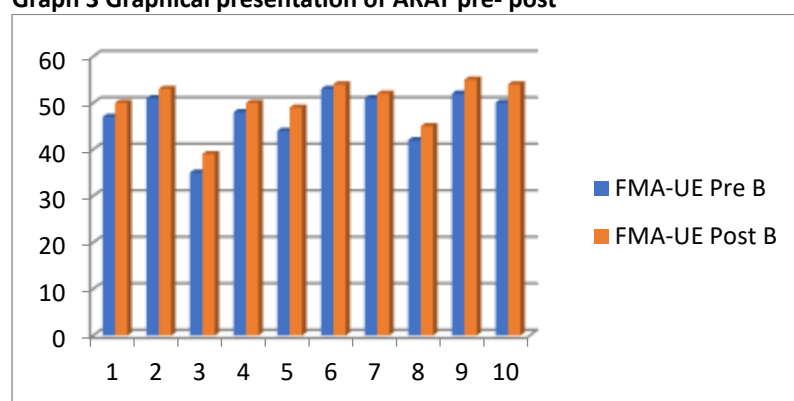
Paired Samples Test									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	ARTA Pre–Post B	-2.200	1.032	.326	-2.938	-1.461	-6.736	9	.000
Pair 2	FMA-UE Pre–Post B	-2.800	1.316	.416	-3.741	-1.858	-6.725	9	.000

A paired t–test was conducted to compare the pre and post value of ARAT and FMA-UE. There was a significant difference in the ARAT pre (M=27.50, SD= 6.81), ARAT post (M=29.70, SD=6.71) and FMA-UE Pre (M=47.30 SD=5.57) FMA-UE Post (M=50.10 SD=4.90).

The paired-samples t-test revealed a statistically significant improvement from pre-test to post-test in ARTA scores, $t = -6.736$ $p < 0.001$, with a mean difference of -2.20 (95% CI: -2.93 to -1.46). Similarly, FMA-UE scores demonstrated a statistically significant improvement from pre-test to post-test, $t = -6.72$, $p < 0.001$, with a mean difference of -2.80 (95% CI: -3.74 to -1.85).



Graph 3 Graphical presentation of ARAT pre- post



Graph 4: Graphical presentation of FMA-UE pre- post

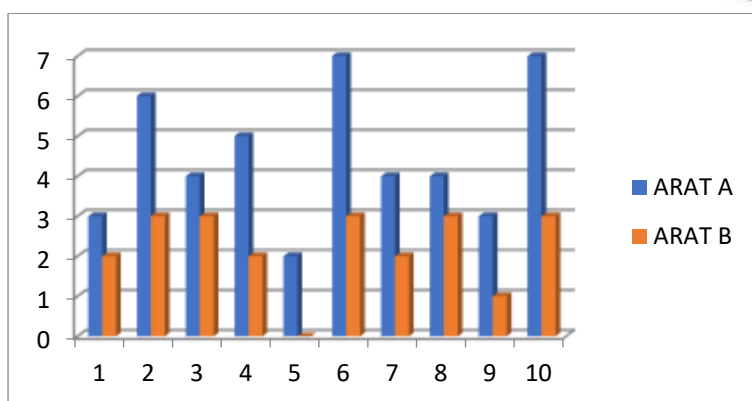
Table 6 Mean & Standard Deviation of both groups

	ARAT-A	ARAT-B	FMA UE-A	FMA UE-B
Mean	4.5000	2.2000	2.3000	2.8000
N	10	10	10	10
Std. Deviation	1.71594	1.03280	.94868	1.31656

Independent t- test between both groups (ARAT)

PARAMETER	VALUE
Pooled Variance	2.01
Standard Error	0.63
t-value	3.631
df	18
Mean Difference (Treatment1- Treatment2)	2.300
95% Confidence Interval	0.969-3.630
p-value (Treatment 1>Treatment2)	0.001

The student's t-test assuming equal variances showed a mean difference of 2.01 between Group A and Group B. The calculated t-value was 3.631 with 18 degrees of freedom. The p-value was 0.001, which is less than 0.05, indicating a statistically significant difference between the two treatments. The 95% confidence interval for the mean difference was 0.9694 to 3.630, which does not include zero. Hence, it proves that treatment given in Group A is more effective than Group B.

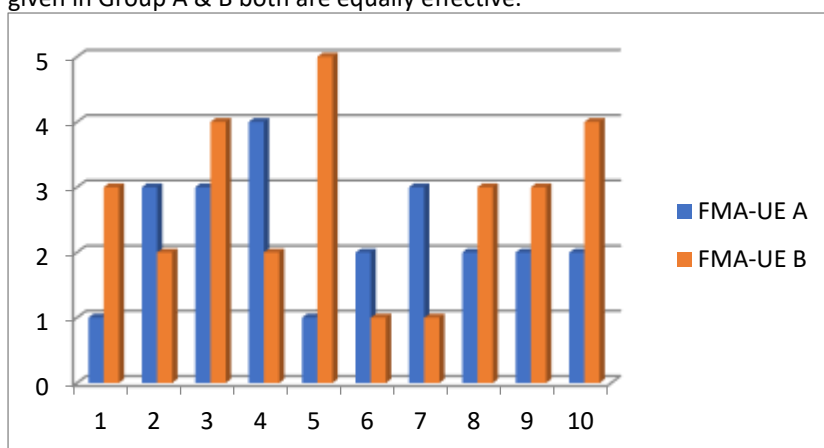


Graph5: Graphical representation between groups A & B (ARAT)

Independent t- test between both groups (FMA-UE)

PARAMETER	VALUE
Pooled Variance	1.32
Standard Error	0.51
t-value	-0.974
df	18
Mean Difference (Treatment1- Treatment2)	-0.500
95% Confidence Interval	-1.578-0.578
p-value (Treatment 1>Treatment2)	0.82

The student's t-test assuming equal variances showed a mean difference of 2.01 between Treatment 1 and Treatment 2. The calculated t-value was 3.631 with 18 degrees of freedom. The p-value was 0.001, which is less than 0.05, indicating a statistically non-significant difference between the two treatments. The 95% confidence interval for the mean difference was 0.9694 to 3.630, which does not include zero. Hence, this shows that treatment given in Group A & B both are equally effective.



Graph 6: Graphical representation between groups A & B (FMA-UE)

DISCUSSION

The result of this study shown that, Extracorporeal Shock Wave Therapy has its significant effect in improving hand function in chronic stroke patients. Similarly study done by Samar Abd Alhamed Tabra 2021^[13-16] explained that there was a significant decrease in wrist and hand spasticity after treatment and at follow-up in group I compared to group II (Modified Ashworth Scale after rESWT 1.45 ± 0.16 , 2.90 ± 0.18 and follow-up 1.55 ± 0.13 , 3.00 ± 0.15 in groups I and II, respectively). Also, there was a significant improvement of wrist control and hand function after treatment and at follow-up in group I compared to group II ($p < 0.001$). So, this study supports our study, hence, alternate hypothesis is accepted.

CONCLUSION

Treatment given in both the groups are effective but the patients treated with Extracorporeal Shock Wave Therapy in Group A has shown more improvement in hand function in stroke patients rather than Group B.

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Conflict of Interest - 'There is no conflict of interest'.

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Ethical statement – 'Ethical was obtained from departmental ethical committee.

Informed Consent - A prior written consent was taken from all the participants.

Data availability statement – 'The datasets generated during and/or analyzed during the current study are available from the corresponding author'.

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