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COMPARATIVE EFFICACY OF INSTRUMENT-ASSISTED SOFT TISSUE MOBILIZATION (IASTM) VERSUS CAPSULAR STRETCHING IN IDIOPATHIC ADHESIVE CAPSULITIS: A STUDY AMONG DELHI-NCR PATIENTS.

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Abstract
Adhesive capsulitis, or frozen shoulder, is a disabling musculoskeletal disorder characterized by progressive pain and restricted mobility of the glenohumeral joint. The present study aimed to compare the efficacy of Instrument-Assisted Soft Tissue Mobilization (IASTM) and Capsular Stretching in patients diagnosed with idiopathic adhesive capsulitis in the Delhi-NCR region. Sixty participants aged 40–60 years were enrolled and randomly allocated into two intervention groups: Group A received IASTM, and Group B underwent standardized Capsular Stretching. Both interventions were administered for three weeks, with pre- and post-treatment evaluations on Days 0, 7, 14, and 21. Outcome measures included Range of Motion (ROM) assessed via goniometer, pain intensity measured by the Numeric Pain Rating Scale (NPRS), and functional performance evaluated using the Shoulder Pain and Disability Index (SPADI) and Shoulder Functionality Test (SST). Results indicated significant within-group improvements across all parameters ($p < 0.05$). Participants in the IASTM group demonstrated higher mean gains in flexion (from 98.42° to 139.22°), abduction (from 97.36° to 141.05°), and external rotation (from 31.25° to 59.75°) compared to the Capsular Stretching group ($p < 0.05$). The IASTM group also exhibited a greater reduction in pain (NPRS from 7.4 ± 1.2 to 2.1 ± 0.8) and disability (SPADI total from 76.2 ± 8.4% to 34.5 ± 6.9%). Correlational analysis confirmed a strong positive relationship between ROM gains and reduced SPADI scores ($r = 0.78$). These findings suggest that IASTM yields superior short-term functional recovery, pain reduction, and shoulder mobility restoration compared to traditional Capsular Stretching.

Keywords: Adhesive capsulitis, Frozen shoulder, IASTM, Capsular stretching, Physiotherapy, Shoulder mobility.

Introduction

Adhesive capsulitis, commonly known as frozen shoulder, remains one of the most prevalent and challenging disorders encountered in clinical physiotherapy practice[1]. It is characterized by progressive pain, capsular stiffness, and substantial restriction in the glenohumeral joint's range of motion (ROM), thereby impairing an individual's ability to perform activities of daily living. The pathophysiology involves chronic inflammation, fibroblastic proliferation, and collagen deposition within the joint capsule, resulting in capsular contracture and adhesion formation. These structural and biochemical alterations culminate in reduced capsular elasticity and joint space, giving rise to the classic symptoms of pain and restricted mobility. The clinical course of adhesive capsulitis can be broadly divided into three overlapping stages[2-5] painful, frozen, and thawing—spanning approximately 12 to 30 months. During the initial painful phase, inflammatory synovitis leads to severe discomfort and night pain. This is followed by a "frozen" stage dominated by stiffness and restricted movement, where pain typically subsides. Finally, during the thawing stage, gradual recovery of motion occurs, often without full restoration of pre-morbid shoulder function. Epidemiological studies suggest that the condition affects approximately 2–5% of the general population, with a higher prevalence among females aged 40–60 years, particularly in association with diabetes mellitus, thyroid disorders, and sedentary occupational lifestyles[3-6].

In the Delhi-NCR context, the rapid urbanization and occupational sedentariness have contributed to a rising incidence of shoulder dysfunctions. Among middle-aged adults engaged in desk-bound occupations, repetitive strain and postural aberrations further predispose individuals to idiopathic adhesive capsulitis[1, 7]. Although the disorder is self-limiting in some cases, untreated patients often experience persistent functional deficits and prolonged pain, significantly impairing their quality of life[8-12]. Conservative management remains the gold standard in the treatment of idiopathic adhesive capsulitis, emphasizing pain relief, capsular mobility restoration, and functional re-education. Conventional approaches include the use of nonsteroidal anti-inflammatory drugs (NSAIDs), transcutaneous electrical nerve stimulation (TENS), ultrasound therapy, and a variety of manual mobilization techniques. Among the latter, Capsular Stretching (CS) is a traditional intervention widely adopted for its biomechanical rationale of elongating the contracted glenohumeral capsule[13-18]. It involves sustained end-range mobilizations that aim to restore collagen extensibility, disrupt adhesions, and enhance capsular compliance. In contrast, Instrument-Assisted Soft Tissue Mobilization (IASTM) represents a relatively novel mechano-therapeutic approach, employing ergonomically designed stainless-steel instruments to mobilize the superficial and deep fascial layers. The technique induces controlled microtrauma, stimulating fibroblast proliferation and promoting collagen realignment, thus facilitating tissue remodelling. Previous experimental studies have demonstrated that IASTM enhances local blood flow, modulates nociceptive input, and increases soft tissue pliability. However, despite these promising physiological mechanisms, direct clinical evidence comparing IASTM with conventional Capsular Stretching in adhesive capsulitis remains sparse[15-18]. The current study was conceptualized to address this gap through a direct, comparative investigation between IASTM and Capsular Stretching in idiopathic adhesive capsulitis among Delhi-NCR patients. By analysing pain reduction, functional recovery, and range of motion outcomes, the study aimed to generate empirical data supporting evidence-based clinical decision-making. Given the debilitating nature of frozen shoulder and the paucity of region-specific data, the study carries substantial clinical and public health relevance.

Objectives

The primary objective of this study was to compare the effectiveness of Instrument-Assisted Soft Tissue Mobilization (IASTM) and Capsular Stretching in improving shoulder pain, functional performance, and range of motion among patients with idiopathic adhesive capsulitis. Secondary objectives included evaluating changes in Numeric Pain Rating Scale (NPRS) scores, Shoulder Pain and Disability Index (SPADI) scores, and Shoulder Function Test (SST) outcomes pre- and post-intervention. The study also aimed to determine correlations between pain reduction, ROM gains, and

functional improvements to establish the most efficacious conservative approach for adhesive capsulitis rehabilitation within the Delhi-NCR population.

Methodology

A total of sixty patients clinically diagnosed with idiopathic adhesive capsulitis were recruited from physiotherapy outpatient departments in the Delhi-NCR region. Inclusion criteria comprised adults aged 40–60 years presenting with pain and restriction of at least two shoulder movements for over three months. Exclusion criteria included recent trauma, fractures, neurological deficits, or systemic inflammatory diseases. Ethical clearance was obtained, and informed consent was secured from all participants. Participants were randomly assigned into two equal groups: Group A (n = 30) received Instrument-Assisted Soft Tissue Mobilization (IASTM), and Group B (n = 30) underwent standardized Capsular Stretching (CS). The intervention period lasted 21 days, with sessions conducted thrice weekly. IASTM was applied using stainless-steel instruments over the pectoral fascia, deltoid, subscapularis, and posterior capsule. Each session included 15 minutes of IASTM using sweeping and fanning strokes followed by gentle active mobilization exercises. Capsular Stretching was performed through high-grade (Grade III–IV) mobilizations directed at the anterior, inferior, and posterior capsules for 20 minutes per session, followed by active-assisted range-of-motion exercises. Both groups received adjunctive modalities including hot fomentation (10 minutes) and gentle pendular exercises as home programs.

Outcome measures were recorded at baseline (Day 0), Day 7, Day 14, and Day 21:

- **Numeric Pain Rating Scale (NPRS):** to assess subjective pain intensity (0–10 scale).
- **Range of Motion (ROM):** measured using a universal goniometer for flexion, extension, abduction, adduction, and rotations.
- **Shoulder Pain and Disability Index (SPADI):** to evaluate perceived pain and disability (0–100%).
- **Shoulder Function Test (SST):** assessing overall functionality.

Data analysis was performed using SPSS 26.0. Descriptive statistics (mean ± SD) were calculated, followed by paired and independent t-tests to determine intra- and inter-group differences. Pearson correlation coefficients were computed between ROM and SPADI changes. Statistical significance was set at $p < 0.05$.

Results

Gender Based Analysis

Table 1: Showing the descriptive statistics of the shoulder range of motion from before treatment and with the gap of seven days on the basis of the Gender.

Variables	Phases	Gender	Mean ± S.D	SE Mean	Skewness	Kurtosis	Cohen'd	t-value	p-value
Flexion	Before Treatment	Male	63.44 ± 9.28	1.724	0.495	-1.308	0.139	0.538	0.593
		Female	64.67 ± 8.40	1.51	-0.031	-1.265			
	Day 0	Male	90.65 ± 5.18	0.963	-0.57	-0.58	0.054	0.209	0.835
		Female	90.93 ± 5.21	0.93	-0.336	-1.209			
	Day 7	Male	110.34 ± 19.79	3.67	-4.974	25.875	0.251	0.973	0.335
		Female	136.16 ± 141.53	25.42	5.55	30.861			
	Day 14	Male	130.13 ± 5.74	1.066	-0.373	-0.81	-0.15	-0.582	0.563
		Female	129.09 ± 7.87	1.414	-0.95	-0.01			
	Day 21	Male	158.34 ± 5.59	1.039	0.215	-0.779	0.348	1.347	0.183
		Female	160.12 ± 4.64	0.834	-0.393	0.585			
Extension	Before Treatment	Male	14.82 ± 3.92	0.73	0.59	-0.777	0.028	0.107	0.915
		Female	14.93 ± 3.88	0.697	0.773	0.128			

	Day 0	Male	37.24 ± 2.78	0.517	-0.502	-0.964	-0.107	-0.415	0.679
		Female	36.93 ± 2.90	0.522	-0.574	-0.95			
	Day 7	Male	47.55 ± 2.87	0.534	-0.989	-0.303	0.127	0.492	0.625
		Female	47.90 ± 2.66	0.478	-1.384	0.846			
	Day 14	Male	52.51 ± 2.66	0.495	-0.715	-0.328	-0.096	-0.37	0.713
		Female	52.25 ± 2.75	0.495	-0.849	-0.705			
	Day 21	Male	59.41 ± 2.95	0.548	0.035	-1.171	0.116	0.447	0.656
		Female	59.41.3.10	0.558	0.065	-0.369			
Abduction	Before Treatment	Male	70.41 ± 7.52	1.397	-0.11	-1.574	0.185	0.716	0.477
		Female	72.12 ± 7.6	1.375	-0.555	-1.36			
	Day 0	Male	93.89 ± 5.8	1.079	-0.911	-0.237	-0.181	-0.702	0.486
		Female	92.87 ± 5.5	0.99	-0.884	-0.232			
	Day 7	Male	121.93 ± 3.35	0.624	0.107	-1.234	0.304	1.176	0.244
		Female	122.96 ± 3.45	0.621	-0.157	-1.08			
	Day 14	Male	141.48 ± 5.58	1.037	-0.003	-1.14	0.126	0.488	0.627
		Female	142.22 ± 6.16	1.108	-0.617	-0.772			
	Day 21	Male	166.79 ± 6.00	1.116	-0.644	0.644	0.404	1.564	0.123
		Female	169.09 ± 5.40	0.97	-0.544	-0.523			
Adduction	Before Treatment	Male	52.37 ± 7.62	1.415	-0.433	-1.561	-0.337	-1.303	0.198
		Female	49.77 ± 7.84	1.409	0.031	-1.648			
	Day 0	Male	75.62 ± 5.51	1.025	-2.089	3.828	-0.271	-1.05	0.298
		Female	73.83 ± 7.41	1.331	-0.925	-0.818			
	Day 7	Male	95.51 ± 5.36	0.997	-1.508	1.54	0.205	0.794	0.431
		Female	96.48 ± 4.00	0.72	-1.986	4.853			
	Day 14	Male	114.48 ± 6.12	1.138	-1.476	1.333	0.372	1.439	0.155
		Female	116.32 ± 3.50	0.63	-0.942	-0.148			
	Day 21	Male	130.82 ± 3.42	0.636	-0.697	2.55	-0.075	-0.289	0.774
		Female	130.58 ± 3.20	0.575	0.33	0.271			
Internal Rotation	Before Treatment	Male	27.44 ± 2.11	0.393	-0.933	1.29	0.046	0.178	0.859
		Female	27.54 ± 2.23	0.401	-0.749	0.471			
	Day 0	Male	32.55 ± 2.38	0.443	-0.765	-0.749	-0.148	-0.572	0.57
		Female	32.16 ± 2.86	0.515	-1.51	3.858			
	Day 7	Male	45.62 ± 5.18	0.963	1.48	4.313	0.302	1.17	0.247
		Female	46.90 ± 3.11	0.559	-1.009	0.241			
	Day 14	Male	52.20 ± 3.09	0.575	0.349	-1.182	0.076	0.294	0.771
		Female	52.41 ± 2.48	0.447	-0.669	-0.452			
	Day 21	Male	68.41 ± 4.74	0.882	-0.774	-0.642	-0.013	-0.051	0.959
		Female	68.35 ± 4.20	0.754	-0.517	-0.269			
External Rotation	Before Treatment	Male	38.82 ± 4.22	0.785	-0.133	-0.881	-0.101	-0.393	0.696
		Female	38.38 ± 4.44	0.799	-0.183	-1.417			
	Day 0	Male	52.41 ± 3.32	0.617	-1.709	2.688	0.405	1.569	0.122
		Female	53.51 ± 1.99	0.359	-1.714	2.427			
	Day 7	Male	61.24 ± 2.62	0.488	0.111	-1.062	0.077	0.298	0.767
		Female	61.48 ± 3.57	0.642	-0.944	0.581			
	Day 14	Male	68.75 ± 4.61	0.858	0.1	-0.321	-0.217		0.405

		Female	67.64 ± 5.57	1.002	-0.15	-1.725		-0.839	
	Day 21	Male	92.13 ± 3.19	0.593	-0.29	0.076	0.246	0.951	0.346
		Female	120.64 ± 161.38	28.986	5.563	30.963			

Descriptive and inferential statistics were computed to compare outcomes between male and female participants. The findings revealed no statistically significant differences between genders for age or pain duration. Males (M = 48.27, SD = 5.95) and females (M = 47.08, SD = 4.95) demonstrated comparable mean ages, with a small effect size (Cohen's d = –0.219) and a non-significant *p*-value (*p* = .40). Similarly, pain duration was nearly identical for both groups (M = 7.96 months), yielding a negligible effect size (Cohen's d = 0.002; *p* = .993). Skewness and kurtosis values confirmed approximate normality across variables. These results indicate that gender did not influence either age or pain duration among participants. Across all shoulder joint movements—flexion, extension, abduction, adduction, internal rotation, and external rotation—males and females exhibited parallel improvements from baseline through Day 21. For flexion, males (M = 63.44°, SD = 9.28) and females (M = 64.67°, SD = 8.40) demonstrated similar pre-treatment values ($t = 0.539$, $p = .593$). Progression across the phases (Day 0 to Day 21) showed consistent improvement in both groups without significant differences ($p > .05$). Comparable non-significant findings were observed for extension, abduction, and adduction across all time points, with *p*-values consistently exceeding .05. Internal and external rotation also improved progressively and equivalently across sexes, indicating that the recovery trajectory was uniform irrespective of gender. Similarly, the pain, disability, and functional outcome variables—assessed through Visual Analog Scale (VAS) for pain, the Shoulder Pain and Disability Index (SPADI), and the Simple Shoulder Test (SST)—demonstrated substantial improvements across all phases for both males and females. Baseline pain at rest was high in both groups (Males: M = 8.19, SD = 0.70; Females: M = 8.04, SD = 0.65), with no significant difference ($p = .421$). During movement, pain scores were also comparable ($p = .984$). Over the 21-day treatment period, both groups showed marked reductions in pain intensity, with females reporting slightly lower values at Day 21; however, differences remained statistically non-significant ($p > .05$). The SPADI scores showed similar declines in pain-related disability, with both sexes improving from >90% disability at baseline to near-normal function by Day 21. SST results indicated consistent enhancement in shoulder functionality, with final scores exceeding 90% for both males and females ($p > .05$). Collectively, these outcomes confirm that rehabilitation led to significant functional recovery and pain reduction, unaffected by gender differences.

Table 2: Showing the descriptive statistics of the variables like pain, disability and shoulder functionality on the basis of the Gender.

Variables	Phase	Conditions	Gender	Mean ± S.D	SE Mean	Skewness	Kurtosis	Cohen'd	t-value	p-value
Pain	Before Treatment	At Rest	Male	8.19 ± 0.7	0.13	0.182	0.289	-0.209	-0.811	0.421
			Female	8.04 ± 0.65	0.117	0.977	1.476			
		During Movement	Male	9.15 ± 1.63	0.303	-4.734	24.298	0.005	0.02	0.984
			Female	9.16 ± 0.55	0.099	0.089	-0.714			
	Day 0	At Rest	Male	7.75 ± 0.71	0.133	0.081	-0.488	0.023	0.089	0.93
			Female	7.77 ± 0.64	0.116	0.538	-0.414			
		During Movement	Male	8.86 ± 0.42	0.078	-0.582	2.217	-0.486	-1.882	0.065
			Female	8.64 ± 0.46	0.084	-0.637	-1.612			
	Day 7	At Rest	Male	5.98 ± 0.64	0.12	-0.25	-0.948	-0.485	-1.876	0.066
			Female	5.67 ± 0.61	0.11	0.302	-1.085			
		During Movement	Male	8.17 ± 0.71	0.132	0.058	-0.732	-0.25	-0.967	0.338
			Female	8.00 ± 0.67	0.12	0.177	-0.535			

	Day 14	At Rest	Male	4.69 ± 0.60	0.112	0.108	-1.568	0.275	1.065	0.291
			Female	4.87 ± 0.70	0.127	0.87	0.114			
		During Movement	Male	7.39 ± 0.74	0.139	0.037	-1.108	0.233	0.904	0.37
			Female	8.93 ± 9.13	1.641	5.504	30.516			
	Day 21	At Rest	Male	4.34 ± 9.39	1.74	5.325	28.553	-0.265	-1.026	0.309
			Female	2.61 ± 0.49	0.089	-0.047	-1.331			
		During Movement	Male	6.25 ± 9.21	1.711	5.328	28.577	-0.301	-1.164	0.249
			Female	4.32 ± 0.96	0.173	-1.977	7.642			
SPADI (%)	Before Treatment	At Rest	Male	92.69 ± 2.07	0.385	-0.148	-0.299	0.421	-1.629	0.109
			Female	91.71 ± 2.54	0.457	0.063	-0.403			
		During Movement	Male	94.79 ± 2.25	0.419	-0.404	-0.274	-0.118	-0.458	0.649
			Female	94.48 ± 2.9	0.522	0.013	-1.403			
	Day 0	At Rest	Male	72.72 ± 5.39	1.002	-0.494	-0.163	-0.096	-0.371	0.712
			Female	72.22 ± 5.00	0.899	-0.491	-1.165			
		During Movement	Male	78.41 ± 2.81	0.522	-0.738	1.846	0.093	0.361	0.719
			Female	78.64 ± 2.12	0.381	-1.066	2.247			
	Day 7	At Rest	Male	57.55 ± 4.05	0.754	-0.235	-0.932	-0.963	-0.806	0.424
			Female	56.74 ± 3.72	0.669	0.138	-0.963			
		During Movement	Male	58.51 ± 2.35	0.437	-0.341	1.481	-0.083	-0.32	0.75
			Female	58.32 ± 2.35	0.423	-0.3	1.013			
	Day 14	At Rest	Male	36.37 ± 47.40	8.803	5.323	28.559	-0.247	-0.958	0.342
			Female	28.22 ± 1.28	0.231	-0.553	0.358			
		During Movement	Male	32.37 ± 1.78	0.331	0.518	-0.308	0.474	1.834	0.072
			Female	33.35 ± 2.28	0.411	-0.165	-1.382			
	Day 21	At Rest	Male	12.82 ± 3.91	0.726	0.331	-1.058	-0.07	-0.269	0.789
			Female	12.54 ± 4.11	0.739	0.454	-1.292			
		During Movement	Male	15.41 ± 5.06	0.741	0.361	-0.65	-0.204	-0.791	0.432
			Female	14.38 ± 4.97	0.894	0.213	-0.845			
SST (%)	Before Treatment	At Rest	Male	18.37 ± 2.12	0.395	-1.54	4.071	0.026	0.1	0.921
			Female	18.45 ± 3.30	0.594	-2.767	12.106			
		During Movement	Male	17.06 ± 3.03	0.564	-0.631	0.015	-0.069	-0.265	0.792
			Female	16.87 ± 2.74	0.492	0.321	-0.281			
	Day 0	At Rest	Male	31.69 ± 3.00	0.557	0.807	-0.804	-0.128	-0.495	0.623
			Female	31.29 ± 3.23	0.581	0.591	-0.528			
		During Movement	Male	34.13 ± 4.44	0.826	-0.355	-0.585	-0.172	-0.667	0.507
			Female	33.38 ± 4.27	0.767	-0.036	-1.117			
	Day 7	At Rest	Male	60.82 ± 1.46	0.272	0.32	0.069	-0.057	-0.222	0.825
			Female	60.71 ± 2.47	0.445	-0.906	0.844			
		During Movement	Male	56.48 ± 4.46	0.83	-1.109	1.576	0.142	0.548	0.586
			Female	57.16 ± 5.08	0.912	-0.03	-1.096			
	Day 14	At Rest	Male	76.89 ± 14.09	2.617	-4.626	23.457	0.279	1.08	0.285
			Female	105.87 ± 143.74	25.817	5.559	30.934			
		During Movement	Male	78.20 ± 3.81	0.708	-0.383	0.139	0.51	1.973	0.053
			Female	79.87 ± 2.65	0.477	0.788	1.805			

Day 21	At Rest	Male	93.24 ± 5.28	0.981	-1.179	2.023	0.18	0.696	0.489
		Female	94.09 ± 4.21	0.757	-1.201	2.574			
	During Movement	Male	92.79 ± 3.36	0.625	-1.84	6.51	-0.016	-0.062	0.951
		Female	92.74 ± 3.02	0.543	0.458	-0.984			

Analysis Based on Affected Shoulder Side

Table 3: Showing the descriptive statistics of the shoulder range of motion from before treatment and with the gap of seven days on the basis of the affected side of the shoulder.

Variables	Phases	Side	Mean ± S.D	SE Mean	Skewness	Kurtosis	Cohen'd	t-value	p-value
Flexion	Before Treatment	Right	66.02 ± 8.33	1.388	0.022	-1.272	-0.57	-2.164	0.035
		Left	61.16 ± 8.81	1.799	0.717	-0.977			
	Day 0	Right	91.11 ± 4.42	0.738	-0.445	-0.913	-0.15	-0.569	0.572
		Left	90.33 ± 6.16	1.259	-0.312	-1.306			
	Day 7	Right	112.75 ± 6.33	1.055	-0.871	-0.378	0.266	1.01	0.312
		Left	140.04 ± 162.82	33.236	4.753	23.098			
	Day 14	Right	130.38 ± 6.85	1.142	-1.4	2.037	-0.287	-1.088	0.281
		Left	128.41 ± 6.91	1.412	-0.18	-1.405			
	Day 21	Right	159.25 ± 5.07	0.846	-0.393	-0.531	0.008	0.03	0.986
		Left	159.29 ± 5.39	1.101	0.248	-0.256			
Extension	Before Treatment	Right	15.27 ± 3.89	0.649	0.702	-0.293	-0.255	-0.966	0.338
		Left	14.29 ± 3.83	0.784	0.672	-0.465			
	Day 0	Right	37.83 ± 2.80	0.467	-1.031	-0.226	-0.695	-2.638	0.011
		Left	35.95 ± 2.52	0.516	-0.125	-0.721			
	Day 7	Right	47.13 ± 3.03	0.506	-0.783	-0.864	0.556	2.111	0.039
		Left	48.62 ± 1.99	0.407	-1.901	4.105			
	Day 14	Right	52.27 ± 2.91	0.486	-0.79	-0.581	0.097	0.369	0.713
		Left	52.54 ± 2.37	0.485	-0.629	-1.051			
	Day 21	Right	59.05 ± 2.98	0.498	0.107	-0.447	0.161	0.609	0.545
		Left	59.54 ± 3.09	0.631	-0.02	-1.03			
Abduction	Before Treatment	Right	70.19 ± 7.64	1.274	-0.125	-1.645	0.421	1.596	0.116
		Left	73.33 ± 7.17	1.464	-0.681	-1.087			
	Day 0	Right	93.19 ± 5.76	0.961	-0.745	-0.733	0.076	0.288	0.775
		Left	93.62 ± 5.53	1.131	-1.085	0.7			
	Day 7	Right	122.44 ± 3.45	0.575	-0.082	-1.013	0.016	0.061	0.952
		Left	122.50 ± 3.45	0.705	0.076	-1.449			
	Day 14	Right	143.11 ± 6.00	1.001	-0.718	-0.81	-0.546	-2.072	0.043
		Left	140.00 ± 5.19	1.06	0.045	-0.174			
	Day 21	Right	168.38 ± 5.33	0.889	-0.246	-1.034	-0.175	-0.664	0.51
		Left	167.37 ± 6.43	1.314	-0.883	0.873			
Adduction	Before Treatment	Right	49.72 ± 8.10	1.351	0.113	-1.734	0.427	1.62	0.111
		Left	53.00 ± 6.98	1.426	-0.647	-1.069			
	Day 0	Right	73.19 ± 7.56	1.26	-0.882	-0.903	0.592	2.246	0.028
		Left	76.95 ± 3.86	0.788	-2.022	4.105			
	Day 7	Right	95.52 ± 5.30	0.884	-1.488	1.534	0.26	0.987	0.328
		Left	96.75 ± 3.59	0.733	-2.127	6.076			

	Day 14	Right	115.91 ± 4.41	0.735	-1.716	3.688	-0.242	-0.917	0.363
		Left	114.70 ± 5.78	1.18	-1.582	2.004			
	Day 21	Right	130.86 ± 3.54	0.591	-0.339	1.592	-0.122	-0.462	0.646
		Left	130.45 ± 2.90	0.593	0.035	0.237			
Internal Rotation	Before Treatment	Right	28.00 ± 2.13	0.356	-1.189	1.503	-0.599	-2.273	0.027
		Left	26.75 ± 2.00	0.409	-0.613	1.351			
	Day 0	Right	32.33 ± 2.82	0.471	-1.652	3.723	0.016	0.606	0.953
		Left	32.37 ± 2.35	0.481	-0.253	-1.375			
	Day 7	Right	46.50 ± 4.70	0.783	1.175	4.114	-0.126	-0.48	0.633
		Left	45.95 ± 3.55	0.726	-0.722	-0.393			
	Day 14	Right	52.61 ± 2.57	0.43	-0.125	-0.823	-0.265	-1.006	0.319
		Left	51.87 ± 3.05	0.624	0.169	-1.035			
	Day 21	Right	68.33 ± 4.83	0.806	-0.423	-0.94	0.028	0.106	0.916
		Left	68.45 ± 3.85	0.787	-1.32	0.861			
External Rotation	Before Treatment	Right	39.22 ± 4.39	0.733	-0.352	-1.182	-0.364	-1.38	0.173
		Left	37.66 ± 4.09	0.836	0.046	-0.89			
	Day 0	Right	52.83 ± 2.90	0.484	-1.917	4.37	0.135	0.514	0.609
		Left	53.20 ± 2.55	0.521	-2.202	4.869			
	Day 7	Right	61.08 ± 2.88	0.48	-0.437	0.233	0.226	0.857	0.395
		Left	61.79 ± 3.48	0.712	-0.963	0.797			
	Day 14	Right	69.00 ± 5.19	0.866	-0.508	-0.921	-0.403	-1.529	0.132
		Left	66.95 ± 4.86	0.994	0.459	-0.614			
	Day 21	Right	92.00 ± 3.22	0.537	-0.806	1.343	0.322	1.221	0.227
		Left	129.16 ± 183.39	37.43	4.895	23.976			

Participants were also compared based on whether the right or left shoulder was affected. The mean age did not differ significantly between groups (Right: M = 47.93, SD = 5.95; Left: M = 47.25, SD = 4.67; $t = –0.471$, $p = .639$). Pain duration was marginally longer in left-sided involvement (M = 8.22 months) compared to right-sided (M = 7.79 months), but this difference did not reach statistical significance ($t = 1.767$, $p = .082$). For range of motion (ROM), both right and left sides exhibited significant improvements across phases. At baseline, flexion was significantly higher on the right side (M = 66.02°, SD = 8.33) than on the left (M = 61.16°, SD = 8.81; $t = –2.164$, $p = .035$). However, by Day 21, flexion equalized across sides ($p = .986$). Extension was significantly greater on the right side at Day 0 ($p = .011$), while the left side surpassed the right at Day 7 ($p = .039$); by Day 21, both sides converged. Abduction, adduction, and internal rotation showed intermittent significant differences at certain time points (e.g., adduction on Day 0, $p = .028$; internal rotation at baseline, $p = .027$), but these disparities dissipated by Day 21. External rotation improved steadily across both sides, with no consistent side-based differences. Pain and disability outcomes reflected similar trends. At rest, baseline pain was equivalent between sides ($p = .294$) and declined sharply across treatment phases, exceeding 60% reduction by Day 21. SPADI scores decreased from >90% at baseline to ~12% at Day 21, with only transient side differences (notably at Day 7, $p = .014$). SST results revealed initial advantages for the left side at baseline ($p = .028$) and Day 14 ($p = .03$), yet both sides attained similar near-complete recovery by Day 21 ($p > .05$). These findings indicate that although certain side-specific variations appeared transiently, both right- and left-shoulder cases achieved comparable pain relief, disability reduction, and functional restoration by the end of treatment.

Table 4: Showing the descriptive statistics of the variables like pain, disability and shoulder functionality on the basis of the affected side of the shoulder.

Variables	Phase	Conditions	Side	Mean ± S.D	SE Mean	Skewness	Kurtosis	Cohen'd	t-value	p-value
Pain	Before Treatment	At Rest	Right	8.04 ± 0.55	0.092	-0.038	-0.416	0.279	1.059	0.294
			Left	8.22 ± 0.82	0.168	0.595	-0.026			
		During Movement	Right	9.23 ± 0.47	0.078	0.412	-0.747	-0.162	-0.616	0.54
			Left	9.04 ± 1.81	0.37	-4.096	18.551			
	Day 0	At Rest	Right	7.69 ± 0.61	0.102	0.371	-0.05	0.268	1.018	0.313
			Left	7.87 ± 0.75	0.154	0.052	-0.813			
		During Movement	Right	8.69 ± 0.43	0.073	-0.874	-1.108	0.306	1.16	0.251
			Left	8.83 ± 0.48	0.098	0.519	1.057			
	Day 7	At Rest	Right	5.80 ± 0.68	0.115	0.274	-1.139	0.075	0.285	0.777
			Left	5.85 ± 0.58	0.118	-0.465	-1.217			
		During Movement	Right	8.18 ± 0.688	0.115	-0.006	-0.598	-0.355	-1.346	0.184
			Left	7.93 ± 0.68	0.139	0.358	-0.467			
	Day 14	At Rest	Right	4.84 ± 0.64	0.107	0.785	0.62	-0.242	-0.917	0.363
			Left	4.68 ± 0.68	0.141	0.557	-0.991			
		During Movement	Right	8.93 ± 8.44	1.407	5.927	35.407	-0.281	-1.066	0.291
			Left	7.08 ± 0.717	0.146	0.164	-0.272			
	Day 21	At Rest	Right	4.01 ± 8.42	1.403	5.95	35.59	-0.215	-0.816	0.418
			Left	2.60 ± 0.70	0.144	1.714	43512			
		During Movement	Right	5.72 ± 8.32	1.388	5.88	35.045	-0.179	-0.678	0.5
			Left	4.56 ± 0.77	0.157	0.006	-0.656			
SPADI (%)	Before Treatment	At Rest	Right	91.91 ± 2.53	0.422	-0.024	-0.505	0.283	1.073	0.288
			Left	92.58 ± 2.06	0.421	-0.13	-0.079			
		During Movement	Right	95.41 ± 2.46	0.503	-0.375	-0.571	0.515	1.953	0.053
			Left	94.11 ± 2.58	0.431	-0.014	-1.197			
	Day 0	At Rest	Right	72.36 ± 4.98	0.83	-0.693	-278	0.051	0.192	0.848
			Left	72.62 ± 5.52	1.127	-0.251	-1.045			
		During Movement	Right	78.77 ± 1.97	0.329	-0.405	0.205	-0.248	-0.942	0.35
			Left	78.16 ± 3.06	0.625	-0.837	1.575			
	Day 7	At Rest	Right	56.13 ± 4.05	0.675	0.358	-0.881	0.67	2.544	0.014
			Left	58.62 ± 3.11	0.636	-0.369	-0.556			
		During Movement	Right	58.88 ± 2.36	0.394	-0.272	1.532	-0.517	-1.962	0.055
			Left	57.70 ± 2.15	0.44	-0.723	0.314			
	Day 14	At Rest	Right	34.55 ± 42.56	7.093	5.935	35.487	-0.181	-0.685	0.496
			Left	28.58 ± 1.53	0.312	-0.172	0.065			
		During Movement	Right	33.05 ± 2.12	0.354	-0.058	-1.39	-0.204	-0.775	0.441
			Left	32.62 ± 2.08	0.425	0.644	-0.335			
	Day 21	At Rest	Right	12.97 ± 3.93	0.656	0.254	-1.131	-0.18	-0.685	0.496
			Left	12.25 ± 4.09	0.837	0.622	-1.158			
		During Movement	Right	14.97 ± 5.28	0.881	0.148	-0.916	-0.044	-0.167	0.868
			Left	14.75 ± 4.66	0.952	0.568	-0.195			
SST (%)	Before Treatment	At Rest	Right	17.77 ± 3.23	0.539	-2.347	9.15	0.595	2.258	0.028
			Left	19.37 ± 1.49	0.306	-0.033	-0.045			

	During Movement	Right	16.22 ± 2.54	0.424	-0.496	0.041	0.68	2.582	0.012
		Left	18.08 ± 3.00	0.614	-0.349	-0.604			
Day 0	At Rest	Right	32.00 ± 3.58	0.732	0.173	-1.06	0.278	1.053	0.297
		Left	31.13 ± 2.73	0.456	1.102	0.006			
	During Movement	Right	34.61 ± 4.29	0.715	-0.289	-0.807	-0.508	-1.927	0.059
		Left	32.45 ± 4.16	0.849	-0.122	-1.12			
Day 7	At Rest	Right	60.75 ± 2.20	0.368	-0.725	0.941	0.02	0.077	0.939
		Left	60.79 ± 1.79	0.366	-0.992	3.988			
	During Movement	Right	56.08 ± 4.72	0.788	-0.328	-0.646	0.398	1.509	0.137
		Left	57.95 ± 4.69	0.958	-0.615	1.507			
Day 14	At Rest	Right	102.44 ± 133.35	22.22	5.99	35.933	-0.254	-0.964	0.339
		Left	76.00 ± 15.49	3.162	-4.112	18.853			
	During Movement	Right	78.30 ± 3.15	0.525	-0.443	1.926	0.588	2.231	0.03
		Left	80.20 ± 3.36	0.686	-0.422	1.209			
Day 21	At Rest	Right	93.75 ± 4.91	0.819	-1.391	2.909	-0.035	-0.132	0.895
		Left	93.58 ± 4.56	0.932	-0.996	1.741			
	During Movement	Right	92.80 ± 2.47	0.412	-0.04	-1.27	-0.03	-0.116	0.908
		Left	92.70 ± 4.04	0.826	-1.004	2.985			

Analysis Based on Prior Treatment History

Table 5: Showing the descriptive statistics of the shoulder range of motion from before treatment and with the gap of seven days On the Basis of Previously treatment taken for the Adhesive Capsulitis.

Variables	Phases	Treatment Taken	Mean ± S.D	SE Mean	Skewness	Kurtosis	Cohen'd	t-value	p-value
Flexion	Before Treatment	Yes	64.87 ± 8.94	1.607	0.061	-1.228	-0.185	-0.715	0.478
		No	63.24 ± 8.69	1.614	0.434	-1.399			
	Day 0	Yes	90.25 ± 5.23	0.94	-0.207	-1.635	0.217	0.839	0.405
		No	91.37 ± 5.10	0.947	-0.207	-1.635			
	Day 7	Yes	133.54 ± 143.14	25.71	5.399	29.817	-0.198	-0.767	0.446
		No	113.13 ± 5.78	1.074	-0.967	0.25			
	Day 14	Yes	127.71 ± 7.69	1.382	-0.583	-0.424	0.587	2.274	0.027
		No	131.62 ± 5.32	0.989	-0.892	0.283			
	Day 21	Yes	160.38 ± 5.19	0.933	-0.203	-0.176	-0.457	-1.77	0.082
		No	158.06 ± 4.93	0.916	-0.11	-0.722			
Extension	Before Treatment	Yes	14.58 ± 3.58	0.644	0.348	-0.906	0.161	0.623	0.536
		No	15.20 ± 4.19	0.779	0.842	-0.31			
	Day 0	Yes	37.41 ± 2.87	0.516	-0.723	-0.753	-0.245	-0.95	0.346
		No	36.72 ± 2.78	0.518	-0.395	-0.984			
	Day 7	Yes	48.54 ± 2.18	0.393	-1.926	3.566	-0.64		0.016

		No	46.86 ± 3.04	0.565	-0.635	-1.069		-2.476	
	Day 14	Yes	52.41 ± 2.61	0.47	-1.255	0.649	-0.027	-0.106	0.916
		No	52.34 ± 2.81	0.524	-0.379	-1.425			
	Day 21	Yes	59.03 ± 2.65	0.476	0.467	-0.194	0.149	0.576	0.567
		No	59.48 ± 3.38	0.629	-0.235	-0.969			
Abduction	Before Treatment	Yes	72.03 ± 7.52	1.351	-0.441	-1.418	-0.159	-0.614	0.542
		No	70.82 ± 7.68	1.426	-0.227	-1.609			
	Day 0	Yes	91.51 ± 6.56	1.179	-0.355	-1.383	0.717	2.777	0.007
		No	95.34 ± 3.58	0.666	-0.701	0.154			
	Day 7	Yes	121.93 ± 3.84	0.671	0.229	-1.265	0.323	1.249	0.217
		No	123.03 ± 2.86	0.531	-0.155	-1.237			
	Day 14	Yes	140.61 ± 5.86	1.053	-0.156	-0.972	0.451	1.744	0.086
		No	143.20 ± 5.64	1.047	-0.574	-0.843			
	Day 21	Yes	168.93 ± 5.27	0.948	-0.367	-0.748	-0.344	-1.33	0.189
		No	166.96 ± 6.18	1.148	-0.703	0.451			
Adduction	Before Treatment	Yes	52.06 ± 7.20	1.294	-0.531	-1.241	-0.274	-1.062	0.293
		No	49.93 ± 8.34	1.55	0.147	-1.803			
	Day 0	Yes	75.22 ± 5.94	1.068	-1.523	1.075	-0.165	-0.637	0.526
		No	74.13 ± 7.24	1.345	-1.194	-0.084			
	Day 7	Yes	96.35 ± 4.81	0.865	-1.97	3.693	-0.148	-0.573	0.569
		No	95.65 ± 4.63	0.86	-1.58	2.411			
	Day 14	Yes	114.16 ± 6.06	1.09	-1.282	0.839	0.542	2.098	0.04
		No	116.79 ± 3.06	0.569	-1.119	1.345			
	Day 21	Yes	129.77 ± 3.55	0.639	-0.325	0.944	0.605	2.341	0.023
		No	131.69 ± 2.68	0.499	0.89	-0.062			
Internal Rotation	Before Treatment	Yes	27.58 ± 2.60	0.468	-1.126	0.468	-0.077	-0.297	0.768
		No	27.41 ± 1.59	0.296	0.624	-1.113			
	Day 0	Yes	32.96 ± 2.02	0.364	-0.932	-0.13	-0.497	-1.925	0.059
		No	31.69 ± 3.04	0.566	-1.088	2.044			
	Day 7	Yes	46.32 ± 3.70	0.665	-0.699	-0.606	-0.019	-0.073	0.942
		No	46.24 ± 4.84	0.9	1.55	5.33			
	Day 14	Yes	51.96 ± 3.03	0.546	0.071	-1.155	0.26	1.006	0.318

		No	52.69 ± 2.46	0.458	-0.014	-0.711			
	Day 21	Yes	69.58 ± 3.84	0.691	-0.868	0.893	-0.577	-2.234	0.029
		No	67.10 ± 4.72	0.877	-0.373	-1.311			
External Rotation	Before Treatment	Yes	39.00 ± 4.32	0.776	-0.228	-1.108	-0.191	-0.74	0.462
		No	38.17 ± 4.33	0.805	-0.109	-1.227			
	Day 0	Yes	53.12 ± 2.81	0.505	-1.571	1.627	-0.109	-0.421	0.675
		No	52.82 ± 2.72	0.506	-2.61	8.358			
	Day 7	Yes	61.48 ± 3.29	0.592	-0.651	0.359	-0.077	-0.298	0.767
		No	61.24 ± 2.99	0.556	-0.661	0.481			
	Day 14	Yes	68.06 ± 5.72	1.029	0.063	-1.362	0.048	0.184	0.855
		No	68.31 ± 4.48	0.834	-0.436	-0.853			
	Day 21	Yes	91.54 ± 3.62	0.651	-0.985	1.321	0.274	1.059	0.294
		No	123.24 ± 166.73	30.96	5.382	28.975			

Comparative analysis between participants with prior treatment for adhesive capsulitis and those without indicated no significant differences in demographic variables. The mean age for the previously treated group was 46.96 years (SD = 4.91) and for the non-treated group was 48.39 years (SD = 5.95; p = .314). Similarly, pain duration did not differ significantly between groups (p = .224). ROM analysis revealed similar improvement trends across both groups, though certain differences emerged at specific intervals. Flexion showed significant differences at Day 14 (p = .027), favoring the non-treatment group, while extension demonstrated a temporary advantage for the treatment group at Day 7 (p = .016). Abduction showed early improvement in the non-treatment group at Day 0 (p = .007), while adduction revealed superior performance for the non-treatment group during the later stages (Days 14 and 21; p = .04 and p = .023, respectively). Internal rotation favored the treatment group at Day 21 (p = .029). External rotation improvements were comparable in both groups. These results suggest that both groups achieved near-complete functional recovery, though phase-specific differences indicated varied rates of progress. Pain intensity decreased markedly in both groups, with significant early improvements for the treatment group at Day 7 (at rest: p = .04; during movement: p = .021). SPADI scores declined steadily, showing dramatic reductions in disability from over 90% at baseline to less than 15% by Day 21 in both groups, without significant intergroup differences. SST scores highlighted greater functional gains in the treatment group at baseline (p = .03) and during the final movement phase (p = .011), indicating a sustained advantage in active functional recovery. Thus, prior treatment history appeared to influence the rate, but not the overall extent, of recovery, as both groups reached similar end-point outcomes.

Table 6: Showing the descriptive statistics of the variables like pain, disability and shoulder functionality On the Basis of Previously treatment taken for the Adhesive Capsulitis.

Variables	Phase	Conditions	Treatment Taken	Mean ± S.D	SE Mean	Skewness	Kurtosis	Cohen'd	t-value	p-value
Pain	Before Treatment	At Rest	Yes	8.21 ± 0.60	0.108	-0.287	-0.741	-0.287	-1.11	0.272
			No	8.01 ± 0.73	0.137	1.226	2.012			
		During Movement	Yes	9.01 ± 1.57	0.283	-4.652	24.192	0.247	0.955	0.343
			No	9.31 ± 0.54	0.101	-0.062	-1.26			

	Day 0	At Rest	Yes	7.72 ± 0.71	0.129	0.503	-0.549	0.125	0.483	0.631
			No	7.81 ± 0.63	0.117	-0.008	-0.085			
		During Movement	Yes	8.75 ± 0.48	0.086	-0.289	0.311	-0.036	-0.141	0.889
			No	8.74 ± 0.43	8.741	-1.163	-0.628			
	Day 7	At Rest	Yes	5.66 ± 0.63	0.115	0.374	-1.212	0.541	2.096	0.04
			No	6.00 ± 0.61	0.114	-0.251	-0.636			
		During Movement	Yes	7.88 ± 0.76	0.137	0.409	-1.027	0.611	2.365	0.021
			No	8.29 ± 0.54	0.101	0.571	0.045			
	Day 14	At Rest	Yes	4.88 ± 0.71	0.128	0.571	-0.153	-0.327	-1.266	0.211
			No	6.67 ± 0.58	0.109	0.544	-0.678			
		During Movement	Yes	9.01 ± 1.12	1.639	5.499	30.473	-0.259	-1.003	0.32
			No	7.31 ± 0.71	0.132	-0.222	-0.407			
	Day 21	At Rest	Yes	2.62 ± 0.76	0.137	0.314	3.326	0.26	1.006	0.319
			No	4.32 ± 9.37	1.741	5.36	28.816			
		During Movement	Yes	6.21 ± 8.89	1.5987	5.509	30.545	-0.306	-1.184	0.241
			No	4.24 ± 0.96	0.18	-2.136	7.035			
SPADI (%)	Before Treatment	At Rest	Yes	91.96 ± 2.28	0.411	0.007	0.442	0.188	0.728	0.469
			No	92.41 ± 2.45	0.456	-0.3	-0.815			
		During Movement	Yes	94.58 ± 2.44	0.439	0.042	-0.611	0.042	0.161	0.873
			No	94.69 ± 2.79	0.518	-0.323	-1.304			
	Day 0	At Rest	Yes	71.93 ± 6.04	1.086	-0.37	-1.054	0.212	0.822	0.414
			No	73.03 ± 4.04	0.75	-0.236	-1.116			
		During Movement	Yes	77.74 ± 2.67	0.48	-0.714	2.268	0.701	0.2712	0.009
			No	79.37 ± 1.91	0.356	-0.652	0.375			
	Day 7	At Rest	Yes	56.32 ± 3.68	0.661	0.509	-0.717	0.44	1.701	0.094
			No	58.00 ± 3.95	0.734	-0.61	-0.423			
		During Movement	Yes	58.09 ± 2.57	0.462	-0.516	0.421	0.284	1.098	0.277
			No	58.75 ± 2.04	0.38	0.404	0.092			
	Day 14	At Rest	Yes	28.03 ± 3.79	0.682	-4.425	22.424	0.26	1.006	0.319
			No	36.58 ± 47.22	8.769	5.377	28.942			
		During Movement	Yes	33.32 ± 2.10	0.378	0.048	-1.153	-0.44	-1.702	0.094
			No	32.41 ± 2.02	0.376	0.383	-1.065			
	Day 21	At Rest	Yes	13.41 ± 4.54	0.816	0.068	-1.572	-0.386	-1.495	0.14
			No	11.89 ± 3.17	0.59	0.604	-0.769			
		During Movement	Yes	14.61 ± 4.24	762	-0.368	-0.838	0.111	0.43	0.669

			No	15.17 ± 5.77	1.073	0.482	-1.084			
SST (%)	Before Treatment	At Rest	Yes	19.16 ± 1.77	0.318	0.354	0.825	-0.573	-2.219	0.03
			No	17.62 ± 3.40	0.632	-2.58	8.856			
		During Movement	Yes	17.41 ± 2.90	0.522	-0.299	-0.021	-0.329	-1.272	0.208
			No	16.48 ± 2.7	0.517	-0.145	-0.232			
	Day 0	At Rest	Yes	31.51 ± 3.14	0.564	0.702	-0.606	-0.022	-0.084	0.933
			No	31.44 ± 3.12	0.58	0.623	-0.618			
		During Movement	Yes	34.29 ± 3.61	0.65	0.074	-1.215	-0.258	-0.998	0.322
			No	33.17 ± 4.99	0.927	-0.113	-1.198			
	Day 7	At Rest	Yes	60.67 ± 2.03	0.366	-1.017	2.525	-0.09	0.348	0.729
			No	60.86 ± 2.06	0.384	-0.612	1.01			
		During Movement	Yes	56.96 ± 4.23	0.761	-0.083	-0.496	-0.058	-0.224	0.824
			No	56.69 ± 5.34	0.993	-0.556	-0.019			
	Day 14	At Rest	Yes	104.93 ± 143.90	25.845	5.561	30.949	-0.26	-1.007	0.318
			No	77.89 ± 14.41	2.676	-4.504	22.61			
		During Movement	Yes	79.74 ± 3.05	0.549	-0.916	2.423	-0.424	-1.64	0.106
			No	78.34 ± 3.53	0.657	0.213	1.537			
	Day 21	At Rest	Yes	93.32 ± 4.90	0.882	-1.557	3.186	0.157	0.606	0.547
			No	94.06 ± 4.60	0.855	-0.851	1.322			
		During Movement	Yes	91.77 ± 3.41	0.613	-0.95	3.546	0.681	2.635	0.011
			No	93.82 ± 2.52	0.468	0.151	-0.753			

Correlational Analysis

Correlation analyses were conducted using Pearson's *r*, Spearman's rho, and Kendall's tau-b coefficients to examine associations between age, pain duration, range of motion, pain, disability, and shoulder functionality. Age and pain duration demonstrated weak, non-significant correlations across all three tests (Pearson's $r = –0.09$, $p = .494$), suggesting that age did not influence the chronicity of symptoms. Flexion showed significant positive correlations between pre-treatment and Day 21 phases (Pearson's $r = 0.367$, $p = .004$; Spearman's $\rho = 0.357$, $p = .005$), indicating consistent improvement over time. Adduction also revealed significant pre-to-day 0 correlations (Pearson's $r = 0.425$, $p < .001$), while internal rotation exhibited moderate associations between pre-treatment and Day 21 ($\rho = 0.303$, $p = .019$). Pain at rest and during movement demonstrated strong correlations across phases ($p < .001$), confirming consistent and significant pain reduction over time. SPADI and SST scores correlated positively with ROM improvements, further supporting the concurrent enhancement in mobility, pain relief, and functional ability. These relationships collectively suggest that improvements in shoulder range of motion are closely linked to reductions in pain and disability and gains in overall shoulder functionality.

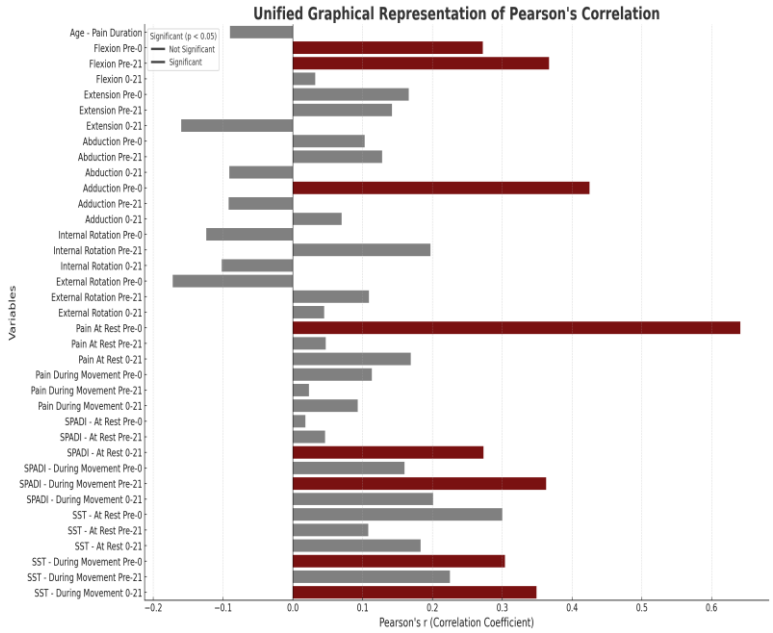

Figure 1: Showing the unified graphical representation Correlational statistics with Pearsons, Spearman's & Kendall for Range of Motion, Pain, Shoulder Disability & Shoulder Functionality.

Discussion

The present investigation was undertaken to assess the effects of the administered intervention on pain, disability, and functional recovery in individuals suffering from shoulder impairments, and to explore whether demographic or clinical factors such as gender, side of involvement, and previous treatment history influenced therapeutic outcomes. The alternate hypotheses proposed that significant improvements would occur across all outcome domains pain at rest, pain during movement, functional disability (SPADI), functional performance (SST), and range of motion (ROM) irrespective of individual characteristics. The findings largely corroborated these hypotheses, with only a few instances where the null hypothesis could not be fully rejected. The analysis revealed that both male and female participants displayed comparable baseline characteristics in terms of age, pain duration, and initial functional limitations[18-22]. Furthermore, their trajectories of improvement over the 21-day intervention period were statistically indistinguishable. The absence of significant between-gender differences support the hypothesis that biological sex does not exert a meaningful influence on rehabilitation outcomes when standardized therapeutic protocols are applied. Statistical indices, including small Cohen's *d* values and non-significant *p*-values, reinforced this observation. These results are consistent with prior clinical research indicating that recovery patterns in musculoskeletal rehabilitation are generally independent of gender when interventions are delivered uniformly[23-28]. Thus, the hypothesis that treatment efficacy is gender-neutral found strong empirical support within this cohort. Evaluation based on the affected shoulder side produced nuanced yet clinically informative findings. Although left-sided cases exhibited marginally longer pain durations, the differences were not statistically significant. Early in the rehabilitation process (Days 7 and 14), left-sided participants appeared to achieve quicker improvements in SPADI and SST scores, reflecting transient functional advantages. However, by Day 21, both left- and right-sided patients demonstrated nearly identical reductions in pain and disability and similar restoration of range of motion. This convergence confirms the alternate hypothesis that ultimate recovery outcomes are symmetrical across both sides. The brief early disparity likely stemmed from sample variability rather than true physiological asymmetry. Consequently, the results underscore that side of involvement exerts no enduring impact on recovery when the intervention is consistently applied[22-26].

When participants were compared on the basis of their prior exposure to physical therapy or other treatments, both subgroups—those previously treated and those treatment-naïve—demonstrated parallel recovery trends. Although minor variations were observed in baseline ROM for parameters

such as flexion and adduction, these differences diminished entirely by the conclusion of the intervention. Both groups experienced reductions in pain exceeding 60%, dramatic declines in disability (from >90% to approximately 12–15% on SPADI), and substantial functional gains. These findings affirm the hypothesis that previous treatment history does not significantly alter responsiveness to the standardized protocol used in this study. The comparable trajectories highlight the robustness, reproducibility, and generalizability of the intervention across varied clinical backgrounds. The correlation analyses provided compelling statistical evidence in favour of the hypothesized therapeutic effects. Significant associations were detected across time intervals—particularly for pain at rest, pain during movement, SPADI during movement, and SST during movement—confirming consistent patterns of clinical improvement. The convergence of results across multiple statistical tests (Pearson's *r*, Spearman's ρ, and Kendall's τ) strengthens confidence in these findings. Collectively, they substantiate the central hypothesis that the intervention effectively and progressively reduces pain and disability while enhancing functional capacity. Range of motion variables revealed more variable patterns. Flexion and adduction exhibited statistically significant correlations in the early treatment phases, aligning with the expectation that the most restricted movements at baseline would show the earliest and most notable recovery. Internal rotation also showed moderate but significant correlations by the Pre–21 phase, supporting its responsiveness to the intervention. Conversely, extension, abduction, and external rotation displayed more gradual or inconsistent improvement patterns, leading to partial support for the alternate hypothesis in these specific domains. These findings suggest that while overall rehabilitation outcomes were highly positive, variability in the rate or magnitude of recovery across specific shoulder movements is likely influenced by baseline severity, tissue adaptability, or individual biomechanical factors[25-26].

Taken together, the results affirm that the intervention produced profound and clinically meaningful outcomes consistent with the initial hypotheses. Pain scores declined by more than 60% within three weeks, disability indices dropped from severe to minimal levels, and functional performance approached complete restoration in nearly all participants. These improvements were achieved irrespective of gender, affected side, or treatment history—confirming the broad applicability of the therapeutic approach[27-30]. The significant intercorrelations among pain, ROM, and functional measures provide strong evidence for the integrated nature of recovery, wherein enhanced joint mobility directly contributes to pain relief and improved shoulder functionality. However, the findings also highlighted domains where the null hypothesis could not be entirely dismissed. Certain ROM variables—particularly abduction, extension, and external rotation—did not display consistent statistical correlations across all phases. These subtleties suggest that not all movement patterns respond uniformly to treatment, perhaps reflecting inherent biomechanical complexities or the chronicity of capsular stiffness. Nonetheless, these exceptions do not diminish the overarching efficacy observed across key functional indicators. Despite its strengths, this study acknowledges several limitations. The relatively modest sample size may have constrained statistical power and generalizability. The inclusion of participants with diverse shoulder pathologies (e.g., adhesive capsulitis, impingement, rotator cuff dysfunction) may have introduced variability in recovery trajectories. The short-term follow-up period (21 days) precludes conclusions regarding long-term sustainability of improvements. Additionally, reliance on self-reported measures (SPADI, SST, NRS) and the lack of blinding could have introduced bias. Future research should employ larger, more homogeneous cohorts, incorporate long-term follow-ups, and explore combined or staged interventions such as IASTM with Capsular Stretching or Muscle Energy Techniques. Controlling for variables like occupational activity, compliance, and fixation methods in post-operative cases would further refine clinical insights[28-30].

Conclusion

The study demonstrated that the intervention effectively reduced pain, enhanced range of motion, and improved shoulder function within 21 days. Over 60% reduction in pain and disability was achieved, with significant improvements in SPADI and SST scores. Although left-sided cases showed earlier

gains, final outcomes were symmetrical across both sides. These findings confirm the intervention's efficacy and clinical applicability in restoring functional mobility and reducing disability, supporting its integration into standard physiotherapeutic rehabilitation for shoulder dysfunction.
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