A Pilot Randomized Controlled Trial Comparing the Effectiveness of Extracorporeal Shock Wave Therapy and Short-Wave Diathermy in the Management of Adhesive Capsulitis

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ABSTRACT:

Back Ground: Adhesive Capsulitis (Frozen Shoulder) is a painful condition marked by progressive shoulder stiffness due to joint capsule fibrosis. It affects 2–5% of the population and may take 1–3 years to resolve. While treatments like Extracorporeal Shock Wave Therapy (ESWT) and Short-Wave Diathermy (SWD) show promise, limited evidence exists comparing their effectiveness in managing this condition.

Aim of the Study: To evaluate and compare the effectiveness of ESWT and SWD in reducing pain, improving shoulder Range of Motion (ROM), and alleviating functional disability in participants with Adhesive Capsulitis, across baseline (t0), post-treatment (t1), and 2-week follow-up phases (t2).

Methodology: Twenty participants diagnosed with AC were randomized into two equal groups. Group A received ESWT (2000 pulses/session, 0.06–0.14 mJ/mm², 8 Hz) plus Spencer Muscle Energy Technique (SME Technique) and a Home Exercise Program (HEP). Group B received SWD (continuous mode, 27.12 MHz, 20 minutes) with the same SME Technique and HEP. Interventions were provided thrice weekly for 2 weeks. Outcomes—pain (NPRS), ROM (goniometer), and functional disability (SPADI)—were assessed at t_0, t_1, and t_2.

Result: Both groups showed significant within-group improvements across all outcome measures ($p < 0.00001$). However, ESWT demonstrated significantly greater improvements in pain reduction ($p < 0.01$), range of motion (flexion, abduction, rotation; $p < 0.01$), and functional disability (SPADI; $p = 0.023$) compared to SWD.

Conclusion: ESWT and SWD are both effective in managing AC, but ESWT offers superior clinical outcomes. These findings support the need for larger, long-term studies to validate ESWT's advantages.

Key words: adhesive capsulitis, extracorporeal shock wave therapy and short-wave diathermy

INTRODUCTION:

Adhesive capsulitis (AC), often referred to as frozen shoulder, is characterized by painful and progressive shoulder motion loss due to fibrotic joint capsule changes.[1] The term was initially introduced by Codman in 1934 and subsequently refined by Julius Neviaser in 1945, who coined the phrase "adhesive capsulitis" to refer to alterations in the synovium of the glenohumeral joint.[2] AC can be categorized as primary/idiopathic or secondary, arising from various predisposing factors such as Diabetes, Hyperthyroidism, Dupuytren Contracture, treatments for Breast Cancer, Cerebral Vascular Disease, Myocardial Infarction, Hyperlipidaemia, and Autoimmune Disease. Although the precise pathophysiological mechanisms underlying AC remain unclear, it is predominantly marked by inflammation within the capsule. Cytokines facilitate the proliferation of fibroblasts and their transformation into myofibroblasts, leading to capsular hyperplasia and fibrosis, which in turn causes contracture and motion restriction.[3] AC progresses through three overlapping stages: 1. Painful Freezing Phase: lasting 2 to 9 months, characterized by pain and stiffness around the shoulder, often exacerbated at night; 2. Adhesive Phase: lasting 4 to 12 months, marked by limited range of motion (ROM) and gradual alleviation of pain; 3. Resolution Phase: lasting 12 to 42 months, featuring spontaneous improvement in ROM.[4]

AC is expected to impact 2% to 5% of the overall population.[5] Some research has characterized AC as a self-limiting condition that typically resolves within 1 to 3 years. [6] AC is estimated to affect 2%–5% of the general population.[5] Some studies described AC as self-limiting disorder that will resolve in 1-3 years[6]

Various management options exist for the treatment of AC, including Medication (both non-steroidal anti-inflammatory drugs and steroids), Physical Therapy, Joint Manipulation, Chiropractic intervention, Extracorporeal Shock Wave Therapy, Therapeutic Ultrasound, Short-Wave Diathermy, Stretching, Massage, and Acupuncture,[7] out of these, Extracorporeal Shock Wave Therapy (ESWT) and Short-Wave Diathermy (SWD) is a very promising treatment for the management of AC. However, there is still limited evidence to support it comparative effectiveness on AC.

Thus, in this pilot study, we firstly aim to evaluate and compare the effectiveness of Extracorporeal Shock Wave Therapy (ESWT) and Short-Wave Diathermy (SWD) in reducing pain, improving shoulder range of motion (ROM), and alleviating functional disability in participants with Adhesive Capsulitis, across baseline (t0), after completing 2 weeks of treatment (t1), and follow-up post 2 weeks (t2), with an objectives to assess the within-group effect of ESWT and SWD on: Pain (measured using NPRS), Range of Motion (measured using goniometer) and Functional Disability (measured using SPADI), at t0, t1, and t2. To compare the between-group effectiveness of ESWT vs. SWD on the same outcomes over time.

Operational Definition:

Extracorporeal Shock Wave Therapy (ESWT): employs pulsed sound waves characterized by short duration and high-pressure amplitude. This therapy facilitates revascularization and encourages the healing of connective tissues, thereby reducing pain and enhancing shoulder function. [8-9]

Short-Wave Diathermy (SWD): utilizes high-frequency electromagnetic energy at a frequency of 27.12MHz and a wavelength of 11.6 meters to produce deep heat, which improves blood circulation and alleviates pain and stiffness.[10-11]

Spencer Muscle Energy Technique (SME Technique): known as the Spencer technique, is a form of Osteopathic Manipulative Treatment (OMT) that incorporates positioning, sequencing, and gentle stretching of the shoulder complex within pain-free limits. It employs the Muscle Energy Technique (MET) to enhance the mobility of the glenohumeral and scapulothoracic joints through soft tissue mobilization.[12]

Key words: Adhesive Capsulitis, Extracorporeal Shock Wave Therapy and Short-Wave Diathermy

METHODS AND DESIGN:

Study design & Sample size: This pilot study was a, randomized controlled trial (RCT) designed to compare the effectiveness of ESWT and SWD in managing adhesive capsulitis. A total of 20 participants were enrolled, with 10 allocated to each group. The sample size was adapted from the main RCT to assess the feasibility.

Participant Recruitment Site and Eligibility Criteria: Participants were recruited from the Orthopaedics Outpatient Department (OPD) at Uttar Pradesh University of Medical Sciences (UPUMS), Saifai, Etawah. Eligibility was determined by an orthopaedic specialist using predefined criteria. Participants aged 35–60 years, of either sex, with a clinical diagnosis of adhesive capsulitis (painful, restricted shoulder movement >2 months), and willing to attend follow-ups were included. Exclusion criteria included prior shoulder surgery, active infections, abscesses, untreated dislocations or fractures, and contraindications to ESWT or SWD (e.g., pregnancy, malignancy, pacemaker, osteoporosis, or heat sensitivity).

Treatment Schedule:

After confirming eligibility, participants were randomized using a computer-generated random number list. All 10 participants in group A (Experimental) received radial ESWT (2000 pulses/session, 0.06–0.14 mJ/mm² energy flux (pain-adjusted), with pressure of 4 bars and frequency of 8 Hz) over the anterior shoulder[13], followed by SME Technique (seven mobilization steps with 5-second isometric holds)[12]. Home exercise program (HEP) included pendulum, wall climbing, pulley, and wand exercises (3 times/day, 5 reps each)[14], preceded by 15 minutes of hot fomentation. Whereas, 10 participants in group B (Control) received continuous-mode SWD at 27.12 MHz for 20 minutes using contra-planar electrodes, with intensity adjusted to comfortable warmth, followed by the same SME Technique[12] and HEP[14] as group A and both groups received treatment session 3 times a week for 2 weeks.

Outcome Measures:

For all participants outcome measures were assessed at three time points: baseline (t_0), after completing the 2 weeks of treatment (t_1), and follow-up post 2 weeks (t_2). These includes: Pain Intensity measured using the Numerical Pain Rating Scale (NPRS, 0–10), Shoulder Range of Motion (ROM) assessed with a goniometer for flexion, extension, abduction, adduction, internal and external rotation and Functional Disability evaluated using the 13-item Shoulder Pain and Disability Index (SPADI), to assess changes within and between groups.

STATISTICAL ANALYSIS:

Data were analysed using SPSS software, with significance set at $p < 0.05$. Descriptive statistics mean ± SD were reported for each group (ESWT and SWD) at t_0, t_1, and t. Within-group changes over time were analysed using Repeated Measures ANOVA with Bonferroni correction And Between-group comparisons were conducted using, Repeated Measures ANOVA to assess Group × Time interaction for normal data.

TABLE 1: Demographic Characteristics of Participants:

Characteristics:	Group A:	Group B:
Sample size (n)	10	10
Age (Years) Mean ± SD	48.6 ± 7.0	47.6 ± 8.2
Sex (Male/Female)	4/6	4/6
Affected side (Right/Left)	4/6	3/7

TABLE 2: Descriptive analysis:

Parameter	Group A (Mean ± SD)	Group B (Mean ± SD)
Pain	4.17 ± 2.13	4.67 ± 1.75
Flexion (ROM)	126.07 ± 24.31	123.83 ± 23.41
Extension (ROM)	32.60 ± 10.56	32.50 ± 10.75
Abduction (ROM)	117.17 ± 25.46	115.83 ± 23.93
Adduction (ROM)	35.43 ± 8.67	34.20 ± 8.80
Internal Rotation (ROM)	44.17 ± 13.08	45.40 ± 13.25
External Rotation (ROM)	40.53 ± 12.34	39.63 ± 12.92
Functional Disability (SPADI)	47.63 ± 21.84	55.40 ± 17.55

TABLE 3: Within- Effects of Group A (ESWT):

Outcome Measure	t0 (Mean ± SD)	t1 (Mean ± SD)	t2 (Mean ± SD)	F-ratio	p-value
Pain (NPRS)	6.7 ± 1.25	3.5 ± 0.97	2.3 ± 0.82	179.08	< .00001
ROM – Flexion (°)	100.2 ± 16.28	134.8 ± 15.38	143.2 ± 15.77	744.44	< .00001
ROM – Extension (°)	21 ± 6.20	35.4 ± 6.19	41.4 ± 6.20	335.73	< .00001
ROM – Abduction (°)	90.8 ± 18.41	126.1 ± 17.92	134.6 ± 15.15	422.07	< .00001
ROM – Adduction (°)	25.2 ± 4.44	38.5 ± 4.45	42.6 ± 4.30	2567.90	< .00001
ROM – Internal Rotation (°)	29.3 ± 7.93	48.9 ± 7.22	54.3 ± 7.21	451.88	< .00001
ROM – External Rotation (°)	25.9 ± 5.92	45.6 ± 6.65	50.1 ± 6.59	708.86	< .00001
Functional disability (SPADI)	75.4 ± 8.33	39.1 ± 7.95	28.4 ± 7.50	8578.70	< .00001

TABLE 4: Within-Group Effects of Group B (SWD)

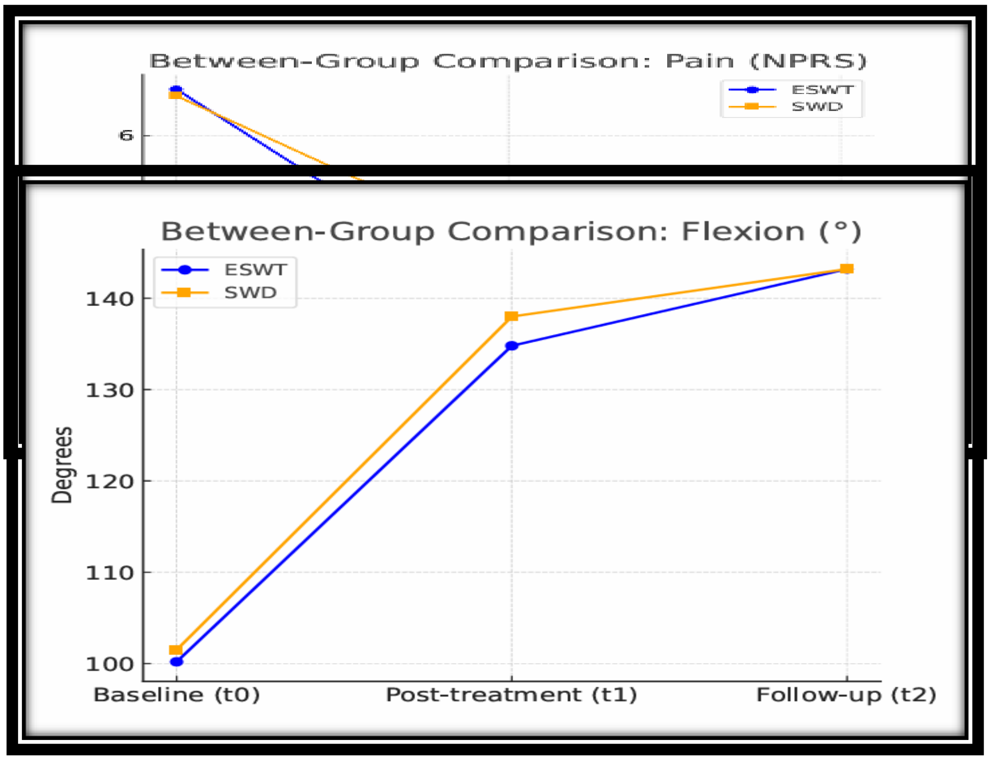
Outcome Measure	t0 (Mean ± SD)	t1 (Mean ± SD)	t2 (Mean ± SD)	F-ratio	p-value
Pain (NPRS)	6.6 ± 1.17	4.3 ± 0.95	3.1 ± 0.74	275.52	< .00001
ROM – Flexion (°)	101.5 ± 16.00	132 ± 18.09	138 ± 18.19	746.81	< .00001
ROM – Extension (°)	22.7 ± 8.06	34.4 ± 8.02	40.4 ± 7.95	871.64	< .00001
ROM – Abduction (°)	92.4 ± 16.23	124.9 ± 17.89	130.2 ± 18.18	270.49	< .00001
ROM – Adduction (°)	26.9 ± 7.00	35.7 ± 7.27	40 ± 6.98	1065.42	< .00001
ROM – Internal Rotation (°)	33.3 ± 9.92	48.8 ± 10.38	54.1 ± 9.98	1569.36	< .00001
ROM – External Rotation (°)	27.2 ± 8.48	42.9 ± 9.47	48.8 ± 9.95	433.12	< .00001
Functional disability (SPADI)	75.6 ± 8.53	50.1 ± 9.61	40.5 ± 9.82	2172.34	< .00001

TABLE 5: Between Group Effects of ESWT vs. SWD

Outcome Measure	Factor B: Between Treatments (Columns)	F (df1, df2)	P-value	Interpretation
Pain (NPRS)	SS = 1640.33, MS = 820.17	F(2,2) = 60.75	0.016	Significant difference (ESWT > SWD)
Flexion (ROM)	SS = 179427, MS = 89713.5	F(2,2) = 166.08	0.006	Significant difference (ESWT > SWD)
Extension (ROM)	SS = 37947, MS = 18973.5	F(2,2) = 156.16	0.0064	Significant difference (ESWT > SWD)
Abduction (ROM)	SS = 190764, MS = 95382	F(2,2) = 211.65	0.0047	Significant difference (ESWT > SWD)
Adduction (ROM)	SS = 24820.33, MS = 12410.17	F(2,2) = 38.40	0.025	Significant difference (ESWT > SWD)
Internal Rotation (ROM)	SS = 57402.33, MS = 28701.17	F(2,2) = 99.95	0.0099	Significant difference (ESWT > SWD)
External Rotation (ROM)	SS = 57649.33, MS = 28824.67	F(2,2) = 139.93	0.0071	Significant difference (ESWT > SWD)
Functional Disability (SPADI)	SS = 182862.33, MS = 91431.17	F(2,2) = 42.29	0.023	Significant difference (ESWT > SWD)

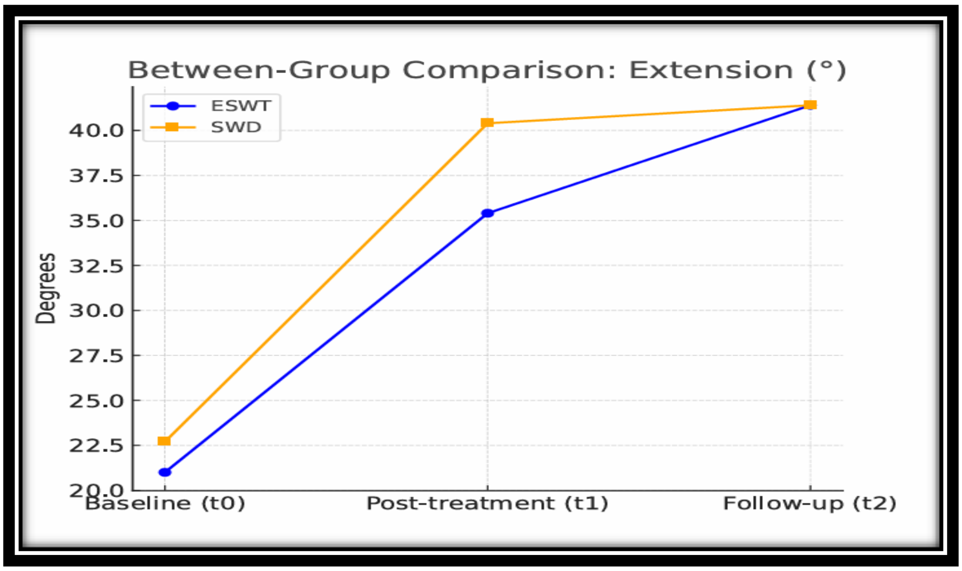
Note: SS = Sum of Squares, MS = Mean Square, F = F-statistic, df = degrees of freedom Conclusion: ESWT showed significantly greater improvement than SWD in all measured parameters (pain, ROM, and functional disability).

GRAPH 1: Pain (NPRS), Both groups showed a reduction in pain from baseline to post-treatment and follow-up. However, the ESWT group demonstrated greater and more sustained pain reduction compared to the SWD group, indicating superior effectiveness of ESWT in relieving pain.

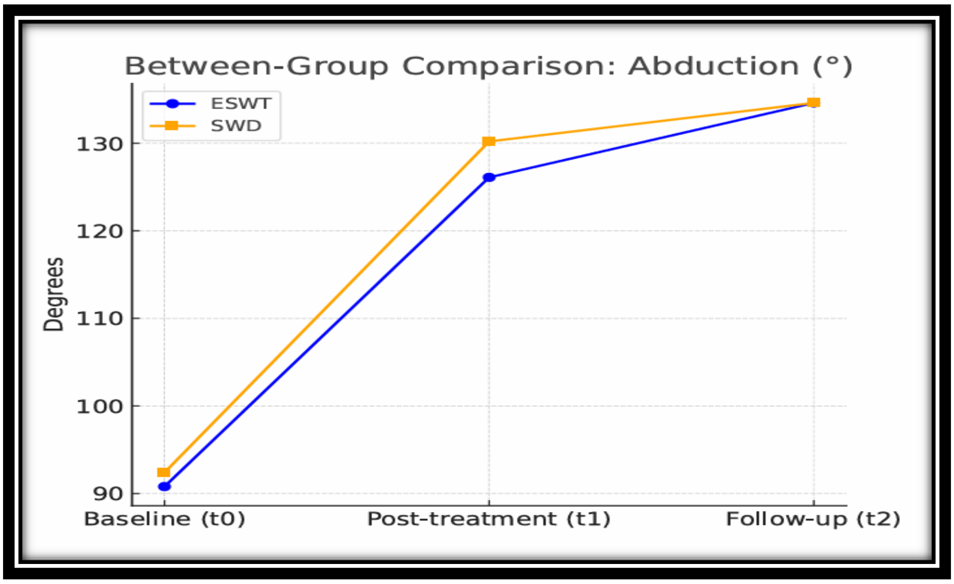


GRAPH 2: Shoulder flexion range of motion improved in both groups from baseline to post-treatment and follow-up. The improvement was greater in the ESWT group, indicating better enhancement of flexion ROM compared to the SWD group.

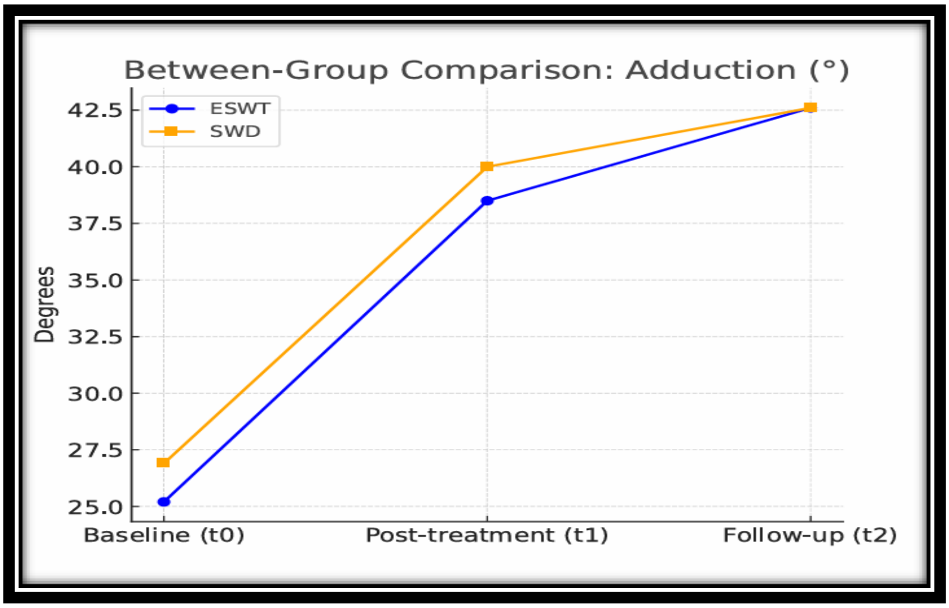
GRAPH 3: Shoulder extension range of motion increased in both groups from baseline to post-treatment and follow-up. However, the ESWT group demonstrated greater overall improvement compared to the SWD group.



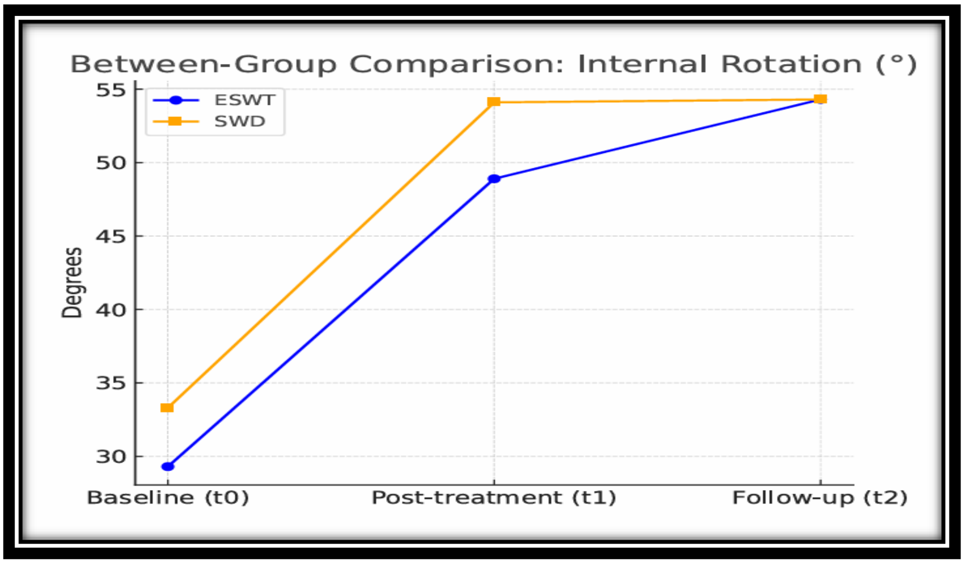
GRAPH 4: Abduction range of motion improved in both groups across all time points. The ESWT group showed greater improvement compared to the SWD group, indicating superior gains in shoulder abduction.



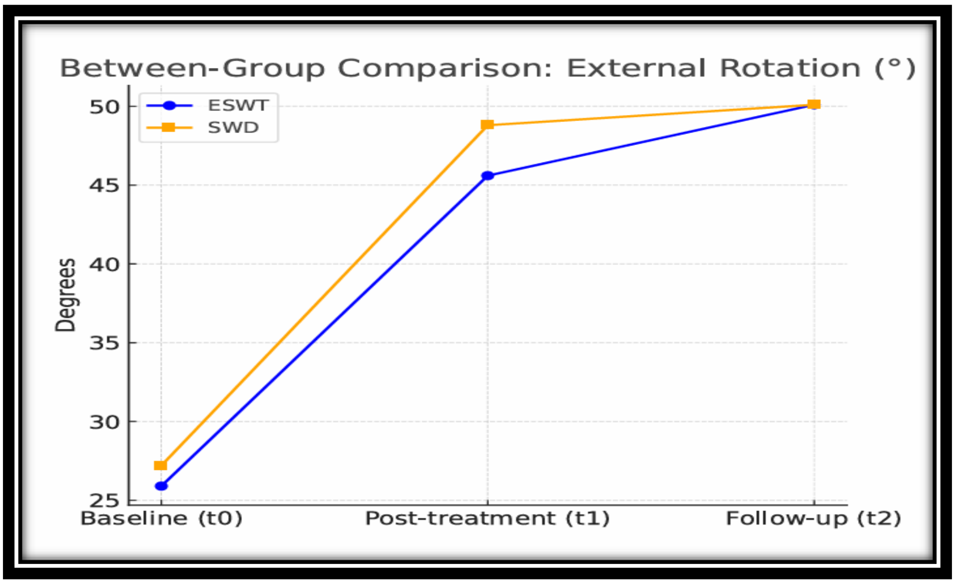
GRAPH 5: Adduction range of motion increased in both groups from baseline to follow-up. The ESWT group demonstrated slightly greater improvement compared to the SWD group.



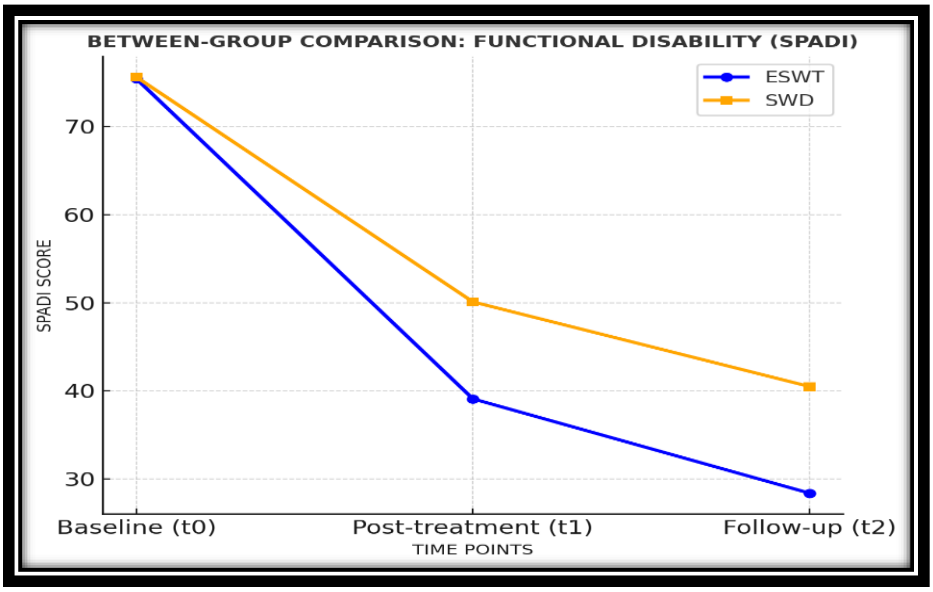
GRAPH 6: Internal rotation range of motion improved in both groups from baseline to post-treatment and follow-up. However, the ESWT group showed greater overall improvement compared to the SWD group, indicating better restoration of internal rotation.



GRAPH 7: External rotation range of motion improved in both groups across all time points, with the ESWT group demonstrating greater overall improvement compared to the SWD group.



GRAPH 8: Functional disability decreased in both groups from baseline to post-treatment and follow-up. However, the ESWT group showed a greater reduction in SPADI scores compared to the SWD group, indicating superior improvement in functional ability.



RESULTS:

Participant Characteristics: A total of 20 participants (10 in each group) completed the treatment in which Both groups were homogenous at baseline regarding demographic and clinical characteristics. The mean age was approximately 48 years in both groups, with a nearly equal male-to-female ratio and left-side predominance of involvement.

Within-Group Effects

Repeated Measures ANOVA showed significant improvements ($p < 0.00001$) in pain, range of motion (ROM), and functional disability (SPADI) across all time points (t0, t1, t2) in both groups.

- In the **ESWT group**, pain decreased from 6.7 ± 1.25 to 2.3 ± 0.82, and SPADI improved from 75.4 ± 8.33 to 28.4 ± 7.50.
- In the **SWD group**, pain reduced from 6.6 ± 1.17 to 3.1 ± 0.74, and SPADI improved from 75.6 ± 8.53 to 40.5 ± 9.82.

  Both groups showed significant ROM gains in all directions.

Between-Group Effects

Between-group analysis revealed a significant Group × Time interaction ($p < 0.05$) for all parameters. ESWT produced greater improvements in pain, ROM, and SPADI scores compared to SWD, indicating superior therapeutic effectiveness.

HYPOTHESIS:

At $\alpha = 0.05$, repeated-measures ANOVA (with Bonferroni correction) shows significant within-group improvements for both ESWT and SWD ($p < .00001$) and a significant Group × Time interaction favouring ESWT for pain, all ROM measures, and SPADI (all reported $p \leq 0.025$); therefore, the null hypotheses of no time effect and no group × time interaction are rejected, supporting the hypothesis that ESWT is more effective than SWD in managing Adhesive Capsulitis.

DISCUSSION:

This pilot RCT found that both ESWT and SWD significantly reduced pain and improved shoulder range of motion and reduce functional disability in participants with Adhesive Capsulitis. However, ESWT consistently demonstrated superior outcomes across all measures. These findings are in line with Ramzy et al. (2024)[15], Hameedi et al. (2023)[16], and Elerian et al. (2021)[17], and are further supported by Patel et al. (2025), who reported significant improvements in pain, ROM, and SPADI following ESWT combined with Spencer Muscle Energy Technique and a Home Exercise Program.[4] The superior effectiveness of ESWT may be attributed to its mechanical stimulation, which promotes tissue regeneration and reduces capsular fibrosis.

While SWD also showed significant clinical benefits, as supported by A H et al. (2022)[14] and Nazar et al. (2020)[10], its effects were comparatively less robust. SWD's therapeutic impact is primarily thermal, improving circulation and reducing stiffness, but it may lack the regenerative influence seen with ESWT.

Overall, this study adds to existing evidence supporting the superior clinical efficacy of ESWT over SWD in managing Adhesive Capsulitis. These findings are further supported by rehabilitation literature, including D et al. (2025), which emphasizes that evidence-based physiotherapy interventions lead to better functional outcomes,[18] thereby reinforcing the rationale for using advanced modalities such as ESWT.

CONCLUSION:

The findings of the present study demonstrated that both ESWT and SWD improved pain, ROM, and functional disability, with ESWT had shown superior outcomes and may be utilized as an effective management for AC. These findings support the need for larger trials to confirm ESWT's clinical advantage and long-term effects.

LIMITATION:

Despite promising findings, this study has limitations such as: small sample size, short follow-up, and lack of blinding should be considered. Nevertheless, the randomized design and use of validated outcome measures (NPRS, Goniometry, SPADI) strengthen the internal validity of the study.

ABBREVIATIONS:

- Adhesive Capsulitis (AC)
- Extracorporeal Shock Wave Therapy (ESWT)
- Short Wave Diathermy (SWD)
- Spencer Muscle Energy Technique (SME Technique)
- Range of Motion (ROM)
- Shoulder Pain and Disability Index (SPADI)
- Home Exercise Program (HEP)
- Base line (t0)
- After completing 2 weeks of treatment (t1)
- Follow-up post 2 weeks (t2)

Conflict of Interest: There is no Conflict of Interest in this Study.

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