INTI JOURNAL | Vol.2024:30
eISSN:2600-7320

Effect of Extracorporeal Shock Wave Therapy in Conjunction with Kinetic Chain Based Exercises on Pain, Kinesiophobia, and Functional Outcome in Chronic Subacromial Pain Syndrome Participants -A Case Series

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Abstract

Background and Objectives: Chronic Subacromial Pain Syndrome (CSAPS) is a common condition characterized by persistent shoulder pain and functional limitations. Despite existing non-operative treatments, patients often experience chronic pain, fear of movement (kinesiophobia) and impact shoulder function. The primary objective of this study is to evaluate the effects of extracorporeal shock wave therapy in conjunction with kinetic chain-based exercises on pain, kinesiophobia, and shoulder functional outcomes in individuals with CSAPS.
Methodology: This case series included ten participants with unilateral shoulder pain lasting at least three months. Participants received extracorporeal shock wave therapy biweekly for six weeks alongside a structured kinetic chain exercise program. Outcome measures included the Numeric Pain Rating Scale for pain, the Tampa Scale for fear of movement, and the Shoulder Pain and Disability Index for functional assessment. Pre- and post-intervention data were analyzed using paired t-tests to determine statistical significance.
Results and Discussion: Statistically significant improvements ($p<0.05$) were observed after the intervention. The average NPRS score reduced from 7.5±0.84 to 1.90±0.99, showing a significant reduction in pain. The SPADI scores exhibited a significant improvement, decreasing from 66.79±9.48 to 51.90±8.90, indicating a reduction in both shoulder pain and disability. The TSK scores decreased from 48.10±3.03 to 37.60±4.47, indicating a decrease in kinesiophobia.
Conclusion: The combination of ESWT and kinetic chain exercises resulted in significant enhancements in pain reduction, reduction in fear of movement, and improvement in shoulder function. This demonstrates the potential effectiveness of this integrated strategy in controlling CSAPS.

Keywords

Extracorporeal shock wave, Kinetic chain, Kinesiophobia, Subacromial pain

Submission: 22 July 2024; **Acceptance:** 19 August 2024

Introduction

Chronic Subacromial pain syndrome (CSAPS) is characterized by shoulder problems that cause pain around the acromion for three months, typically unilateral and non-traumatic. The Dutch Orthopaedic Association and the Royal Netherlands Association of Physical Therapy recommend non-operative treatment for subacromial discomfort syndrome. Exercise therapy that emphasizes low intensity and high frequency is recommended. This therapy should include eccentric training, relaxation techniques, posture awareness, myofascial trigger point treatment (including muscle stretching), and addressing calcifications in the coracoacromial ligament. These calcifications can impact the structure of the acromion process and result in subacromial impingement (Yeşilyaprak et al., 2023). The accumulation of calcifications in the ligament between coracoids and acromion process is credited to degeneration and bone growth in the acromion. Extracorporeal Shock Wave Therapy (ESWT), a treatment method that uses high-amplitude sound waves focused on the affected area, has gained popularity in various musculoskeletal conditions, including tendinopathy, enthesopathy, and calcifications (McLintock, 2020).

The "kinetic chain" concept involves the sequential activation of body segments during functional movements, promoting efficient energy transfer and enhancing overall bodily function (Chu et al., 2016). Scapular posture and spinal alignment are crucial for proper shoulder girdle function due to the muscular connections between these structures. During scapular plane abduction, the scapula must provide stability while allowing arm movement, and any alteration in scapular positioning can disrupt this integrated movement pattern (Gebauer et al., 2023). Consequently, shoulder rehabilitation programs often include lower extremity and trunk exercises to optimize energy transfer within the kinetic chain. Incorporating the myokinetic chain in rehabilitation may enhance axioscapular muscle recruitment, lower trapezius muscle activation, and reduce rotator cuff strain (Kamonseki et al., 2023; Richardson et al., 2020).

Additionally, in a systematic review it reveals that ESWT increases the expression of transforming growth factor 1 and insulin-like growth factor, which mediate the mitogenic and anabolic responses of tenocytes and neovascularization that heals tendinitis (Huisstede et al., 2011). Chronic SAPS sufferers have strong kinesiophobia, particularly fear avoidance beliefs that combine with a dread of movement to induce increasing mobility restriction and pain, creating a vicious cycle that contributes to the emergence of a chronic state (Günay Uçurum, 2019).

Approximately 10% of patients in the musculoskeletal department present with subacromial pain and restricted movement, often diagnosed as impingement syndromes. These conditions, involving internal or external impingements with possible rotator cuff involvement, necessitate an evidence-based treatment protocol tailored to the Indian population. This study aimed to evaluate whether combining extracorporeal shock wave therapy (ESWT) with kinetic chain-based exercises would significantly reduce pain, decrease kinesiophobia, and improve function in individuals with subacromial pain syndrome.

Methodology

Participants

Participants aged 25 to 80 with unilateral shoulder pain for at least 3 months, positive Hawkins or Neer tests, painful arc sign, and weakness in the Jobe "empty can" test were included. Those with prior shoulder surgery, neck pain, adhesive capsulitis, or shoulder instability were excluded. A comprehensive physical assessment by the principal investigator included evaluating upper body range of motion, muscle strength (teres minor, infraspinatus, subscapularis, trapezius, serratus anterior), reflexes, and postural alignment of the cervicothoracic area using the spring test between C7 and T9 spinous processes. The complete study procedure received approval from the institutional Research and ethical committee. Participants enrolled in the study provided informed consent and the study objectives were clearly explained. They were also informed that they had the freedom to withdraw from the study at any time.

Outcome Measurement

The Numeric Pain Rating Scale (NPRS) is commonly utilised to assess the level of pain, wherein patients are instructed to indicate a numerical value (ranging from 0 to 10) that corresponds to the degree of their suffering. Neuropsychological rating scales (NPRS) offer reliable scores and are associated with patient-reported outcome measures that assess multiple aspects of a patient's condition (Modarresi et al., 2022). Kinesiophobia was assessed using the Tampa Scale of Kinesiophobia (TSK), a self-reported questionnaire that measures fear of movement. The TSK consists of 17 items, scored on a 4-point Likert scale, with 13 items scored positively and 4 items reverse-scored. Total scores range from 17 to 68, with higher scores indicating greater fear of movement. The TSK has exhibited excellent test-retest dependability (Swinkels-Meewisse et al., 2003). SPADI was among the initial patient-reported outcome measures specifically designed for assessing shoulder-related pain and disability. The SPADI questionnaire consists of 13 items, with five items directly addressing pain and eight items focusing on disability (Kc et al., 2021). The experimental group of ten subjects received ESWT targeting the subacromial region, with 3000 pulses at 15Hz, 0.11mJ/mm² energy density, and 3 bars of pressure, administered biweekly for six weeks. Additionally, participants followed a three-phase kinetic chain exercise routine.

Table 1: Exercise protocol for the participants

WEEK/PHASES	EXERCISE PROTOCOL
0-2nd week **Phase 1**	1.Ipsilateral anterior step-up with shoulder flexion to achieve full hip extension (15 reps/set x 3 sets). 2.Chin tucks, thoracic extension with scapular retraction and posterior capsular stretching are included
3rd & 4th week **Phase 2**	1.Gravity-assisted scapular protraction position (15 reps/set x 3 sets). 2. Bilateral scapular retraction is performed while flexing and extending the thoracic spine in a standing position. (15 reps/set x 3 sets). 3. In a lateral lunge stance, the participant reaches for a laterally resisted rope with a handle using the involved arm (lateral fencing). (15 reps/set x 3 sets). 4. In a stride standing position, a contralateral forward stride is accompanied by a forward punch, and an ipsilateral lateral stride is accompanied by a lateral punch (punches with dumbbells).

5 & 6th week (Incorporates kinetic chain exercises) **Phase 3**	1.scapular elevation, depression, protraction, and retraction were done in a hand elevated position. (15 reps/set x 5 sets). 2.Assuming an athletic stance, the hand is placed on a ball positioned on a table. The patient stabilizes their hands on the ball, loading the scapular region. During these static exercises, the hips and trunk can be loaded to promote proximal-to-distal activation (ball stabilization exercises) (15 reps/set x 5 sets).

Statistical Analysis

Data analysis was conducted using utilizing Statistical Package for Social Sciences (SPSS) version 27.0. Continuous data were reported as means and standard deviations, while categorical data were expressed as frequencies and percentages. The Shapiro-Wilk test confirmed that the data followed a normal distribution. A paired t-test was used to compare mean differences between two observations within the group, with statistical significance set at $p<0.05$.

Results and Discussion

Table 2. Demographic of the participants

	N=10
	Mean±SD
Age	60.6±7.53
Height	5.7±0.126
Weight	70.8±6.33
BMI	24.44±2.066

BMI-Body mass index, SD- Standard deviation.

Table 3. Comparison of Pre and Post- intervention of variables

Outcomes	**Pre-Intervention**	**Post-Intervention**	**95% Confidence Interval of the Difference**		**T statistic (df)**	***P*-value**
	Mean±SD		**Lower**	**Upper**		
NPRS	7.5±0.84	1.90±0.99	4.9089	6.2911	18.33(9)	0.000*
SPADI	66.79±9.48	51.90±8.90	12.543	17.057	14.833(9)	0.000*
TSK	48.10±3.03	37.60±4.47	9.3689	11.6311	21(9)	0.000*

NPRS-Numerical pain rating scale, SPADI- Shoulder Pain and Disability Index**P*-value < 0.05
SD-Standard deviation

Ten participants who met the eligibility requirements for the study were enrolled, and pre- and post-data for each outcome measure were evaluated. The participant's demographic information is shown in Table 2.

Table 3 shows that there have been notable improvements when comparing the pre- and post-intervention results. The mean NPRS score decreased significantly from 7.5±0.84 to 1.90±0.99, suggesting a significant reduction in pain levels. The mean SPADI score decreased from 66.79±9.48 to 51.90±8.90, indicating a decrease in shoulder discomfort and impairment. TSK scores also showed a decline, going from 48.10±3.03 to 37.60±4.47, indicating a decrease in

kinesiophobia. With P-values of 0.000, the declines in all three metrics were statistically significant.

This study evaluated the combined effect of ESWT and kinetic chain-based exercises in ten participants with chronic subacromial pain syndrome (SAPS), focusing on pain intensity, fear of movement, and functional ability. Participants reported pain worsened by overhead activities and lying on the affected shoulder. Incorporating the Tampa Scale for Kinesiophobia (TSK) adds value by addressing psychological factors in SAPS management. To date, no studies have combined ESWT and kinetic chain-based exercises in participants with chronic SAPS (Kromer et al., 2014).

Among physical modalities, ESWT has demonstrated efficacy in the treatment of calcified, chronic tendinitis in the shoulder, both with focused and radial ESWT (Kour & Alasmri, 2022; Li et al., 2017). In our study, combining ESWT with kinetic chain exercises led to significant improvements in pain (NPRS), fear of movement (TSK), and shoulder function (SPADI) scores. ESWT effectively reduced pain and fear of movement, while the integration of kinetic chain exercises enhanced overall shoulder girdle function through improved vertebral and humero-scapular alignment. These findings align with previous research, which shows that combining such exercises with ESWT yields better outcomes in rotator cuff lesions (Santamato et al., 2016; Richardson et al., 2020).

The kinetic chain model, which analyzes the interdependent segments of the body, suggests that normal, efficient motion occurs in a proximal-to-distal sequence. Kinetic chain rehabilitation, incorporating biomechanical and motor control theories, utilizes closed kinetic chain exercises to restore function by focusing on abnormal kinematics, postural abnormalities, muscle performance deficits, and the degenerative process of tendons (McMullen & Uhl, 2000). When ESWT was combined with kinetic chain exercises, participants experienced a statistically significant reduction in pain and fear associated with movements. This is the first study of its kind to combine electrotherapeutic effects with kinetic chain-based rehabilitation in SAPS. The inclusion of fear of movement (kinesiophobia) as an outcome measure is significant, as reducing kinesiophobia can contribute to early recovery. However, there are limitations to this study, including its case series design, being in a preliminary stage, and the need for further generalization studies. Additionally, the trial also lacked a placebo control group, had a short follow-up period, and had a tiny sample size.

Conclusion

Combining ESWT with kinetic exercises significantly reduced movement-related pain and fear in SAPS patients, leading to improved function. Kinetic exercises specifically targeted deficits in rotator cuff and scapular muscles, while ESWT addressed calcific tendinitis and degenerative tendon issues. Overall, this combination resulted in greater pain reduction, improved kinesiophobia, and enhanced functional recovery.

Acknowledgements

This research is supported by Srinivas University, Mangalore, India.

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