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RESEARCH ARTICLE

Effect of Structured Core Stabilization Exercise Program on Pain and Muscle Performance in Individuals with Scapular Dyskinesia

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Abstract
Purpose: The purpose of this research was to determine the effect of structured core stabilization exercise program on pain and muscle performance in individuals with scapular dyskinesis. **Methods:** The study commenced obtaining ethical clearance from an institutional committee, briefing participants about the research and intervention, and obtaining informed consent. In accordance with the inclusion and exclusion criteria, 90 participants were enrolled for the research among which 80 participants enrolled in this study and were allocated into 2 groups at random- Group A (Control group) as well as Group B (Experimental group) by using the envelope method. Treatment was provided for about 6 weeks to both groups.Pre and post test examination was done using Individual Muscle Testing (IMT), core strength testing with Pressure Biofeedback (PB), shoulder joint range of motion (ROM) with Goniometry, in addition with Visual Analogue Scale (VAS) for pain. Statistical methods were utilised to analyse the results. **Findings:** This research found substantial improvements in pain, individual muscle testing and shoulder range of motion for flexion and abduction in two groups (p-value <0.0001), whereas, for internal and external rotation, group A showed p value of 0.0193 and 0.0098, whereas, group B showed p value of <0.0001 and 0.2399.Group B showed more improvement in pressure biofeedback unit (p<0.0001) as compared to Group A (p value 0.0208). **Conclusion:** The present research observed that a structured core stabilization exercise program had shown a significantly enhanced improving muscle performance and reducing pain in individuals with scapular dyskinesis.

Keywords
Frozen Shoulder, Kinetic Chain, Pressure Biofeedback, Quality of life, Scapular Dyskinesia

INTRODUCTION

Scapular dyskinesis is defined as alteration or deviation of resting or active position of scapula during shoulder movement (Roche et. al., 2015; Struyf et. al., 2014). Also shoulder pain secondary to Scapular Dyskinesia causes the highest burden with prevalence of 41.9% (Sağlam & Telli et. al., 2022). For physical functioning, the upper extremity is acrucial component of our body. The upper extremity is used for several daily tasks, including picking up objects, transferring objects, combing,bathing, and many other tasks (Shinde et. al., 2023). In normal upper extremity function, the scapula provides a stable base due to which gleno-humeral mobility occurs. The functioning of the Scapulothoracic joint depends on coordinated motions of the surrounding musculature. Efficient glenohumeral mobility requires the scapula muscles to dynamically place the glenoid. When weakness or dysfunction of the scapular musculature is present, normal scapular positioning and mechanics may get altered (Paine & Voight1993; Kibler, 1998).Scapula muscles work together to stabilise and regulate the scapula's position during active arm movements. This allows the scapula-humeral muscles to maintain a stable length-tension relationship while stabilizing and moving the humerus. The humeral muscles efficacy declines without the scapula's positioning control. The

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moment the upper extremity is raised, the anterior serratus muscles protract the scapula onto the chest, positioning it with flexion actions.The lower and upper trapezius turn scapula upwards in tandem. During the extension of the arm or pulling tasks, the Rhomboids work through the Latissimus Dorsi, the Teres Major, and Rotator Cuff Muscles to turn and retract the scapula downwards. Each of these stabilizing muscles also exerts eccentric control over the acceleration of forward rotation and protraction of the scapula (Kisner et. al., 2017; Micoogullari et. al., 2023).

The scapula serves four biomechanical roles: It is the humerus's centre of rotation, acts as the humerus' anchor to the thoracic wall, prevents the acromion from impeding its movement upon the humerus in both abduction and flexion, resulting in no impingement, and transmits forces from the core to the arm (Paine &Voight,1993; Panagiotopoulos & Crowther, 2008). The scapular stabilising muscles position the scapula for proper glenohumeral functions while offering a firm base of support. Faulty alignment and dyskinesia contribute to variety of syndromes affecting Upper Extremity and Trunk which are caused by fatigue, weakness, neurologic dysfunction or inhibition by intra-articular glenohumeral or subacromial processes (Roche et. al., 2015; Panagiotopoulos & Crowther, 2008). However core stability relates to the musculature's capacity to generate contractile force, core strength implies to an ability to stabilise the spine through muscular activity. In order to control movement and generate force at the extremities, maintaining stability in the core musculature entails regulating the position and motion of the trunk (Huxel & Anderson, 2013; Bliven & Anderson, 2013).

Major core muscles such as Transverse Abdominals anteriorly, Multifidus posteriorly, Pelvic floor muscles inferiorly and Diaphragm superiorly and Minor core muscles such as Lattisimus dorsi, Gluteus Maximus, Trapezius help to stabilize the trunk so that upper extremity can have efficient and strong mobility (Crosbie et. al., 2008; Saini et. al., 2020; Henning, 2016). Neutral spine alignment and regulated movement within that alignment are required for stabilization. The erect spine is frequently, but improperly, correlated with the flat-backed posture. The neutral Spine doesn't have a single fixed position. Instead, it falls in the middle of the joint's range of motion and is usually a comfortable position (Bliss & Teeple, 2005). Besides reducing the strain on the spine, core stabilization increases the stability and endurance of the peripheral joints and permits the transfer of energy to the distal segments. The core serves as the initiator of all voluntary movements, so it's crucial to train it properly (Oliver & Adams, 2010).

The Scapula is a key component in the chain of kinetics, serving as a funnel for the transfer of forces and energy from the lower extremity and core to the upper extremity. Because of their biomechanical dependency, scapular dyskinesia and core stabilization are closely related conditions. The back, pelvis, and abdomen comprise the core muscles, which provide the basis of all body movement. These muscles cause the shoulders and shoulder blades, or scapulae, to adapt in response to weakness or instability. The movement abnormalities associated with scapular dyskinesia can be exacerbated by a weakening or unstable core. Movement flow is disrupted by disruptions in the core, which affect the upper extremities. Scapular dyskinesia can be exacerbated by a weak core, which causes disproportionate shoulder motions when lifting or reaching. Additionally, overstretching the muscles around the shoulder complex due to core weakness can cause abnormal patterns such as excessive upward rotation or protraction, as well as distort scapular movement (Saini et. al., 2020; Brumitt & Dale, 2009; Ellenbecker & Aoki, 2020).

Core muscles' structural organization and proper activation exacerbate intra-abdominal pressure, leading to a stable trunk. Proper functioning stabilizes the trunk before transferring the upper limbs. The hip and pelvis account for over half of kinetic energy in dynamic overhead movements. Trunk flexors, trunk rotationators, and hip extenders help position the spine and accommodate scapular movements, enhancing the stability of the trunk (Henning, 2016).Trunk muscules activates in a feedforward manner during upper or lower limb movements (Ellenbecker & Aoki, 2020; Willard et. al., 2012). This feed-forward process develops as the human body prepares for the possibility of a disruption in spinal stability when its extremities begin to move (Maenhout et. al., 2010). It was recently discovered that after glenohumeral elevation, the Thoracic Spine, in specific, is disturbed (Paine &Voight, 1993). The area of the body that consists of the hips, pelvis, spine, abdomen, and proximal lower limb is called the core. Two purposes of the core musculature are force generation and transfer and lumbar support stability (Park & Yu, 2013). According to kinetic chain theory, the trunk's position and motion around the lower part of the body facilitate the most effective creation, exchange, and regulation of motion and force to the termination segments (Ellenbecker & Aoki, 2020; Willard et. al., 2012).

The thoracolumbar fascia connects the lower and upper limbs to combine the superior/ inferior and right/left parts of the Kinetics Chain (Willard et. al., 2012). The anterior, the middle, and posterior layers make up the thoracolumbar fascia. To transfer load and energy among the lower and upper limbs, the right and left lobes of the body, and the wall of the abdomen and the lumbar region, for example, these layers play a crucial biomechanical role. Numerous muscle groups are covered by this cover, including the pectoral muscles major and minor, rhomboids major and minor, trapezius, and serratus anterior, which reaches the latissimus dorsi and gluteus maximus towards the distal end (Maenhout et. al., 2010). This situation could indicate a beneficial relationship among core stabilisers in the deep lamina and scapula stabilisers in the superficial lamina (Park & Yu, 2013; Lee, 2021). According to the serape effect, the muscles that form the body have a crisscross design. It takes place with the interaction of Rhomboids Minor, Rhomboids Major, Serratus Anterior, and Oblique Abdominal Muscle (Paine &Voight1993). The concept of transforming accumulated energy towards potential energy is included in the serape phenomenon (Bliss & Teeple, 2005). The musculoskeletal system is fairly adaptable and to maintain function it may create inappropriate movement patterns which causes core weakness in the muscles in people with scapular dyskinesia as it serves a major part within the Kinetic Chain. The proximal segments must function efficiently to provide proximate the stability for distal upper-limb mobility. This requires adequate strength, stability, and mobility of the Trunk, Pelvis, Hips, and Legs (Maenhout et. al., 2010; Lee, 2021; Atta et. al., 2018).

To maintain functional stability during limb movement, muscular strength is required surrounding the Lumbar Spine. This area is known as the core. During the upper limb movement, the Core muscles engage in a Feed-Forward pattern. This process occurs when the body of an individual adapts for the possibility of a disruption in the spinal stability when movement begins. In daily activities requiring different degrees of overhead skill, the core serves as a foundation for upper and lower extremity muscles (Pires & Camargo, 2018; Kaur et. al., 2014). Key stabiliser muscles are activated about 50 milliseconds prior to the primary movement muscles, ensuring inter and intra-segmental stability. This triggering sequence supports both proximal equilibrium and distal movement. The primary source of upper limb movement is the first phase of body stabilisation. When exercising, the effectiveness of motion is more crucial than the quantity, so one should concentrate on motor control (Lee, 2021). An interruption in motor function raises the likelihood of injuries by leading to inappropriate accessory glides in the joints during overhead activities. The A locomotive System is a relatively adaptable framework that produces compensatory motions to preserve function. Nevertheless, this often causes tissue damage. Furthermore, weak core muscles have been linked to injuries from overuse, low performance, and shoulder pain (Lee, 2021; Pires & Camargo, 2018; Kaur et. al., 2014).

The purpose of Core Stabilisation exercise is to establish a firm foundation for precise movement control while guaranteeing proper muscular stability within the Lumbo-Pelvic-Hip complex, forming a rigid cylinder over body perturbations (Kika, 2018; Çelenay & Kaya, 2017). These are known as Neuromuscular Retraining exercises, and they primarily emphasise on increasing the activation of the Local Stabilisers (Transversus Abdominis and Multifidus), Global Stabilizers (External and Internal Obliques), Global Mobilisers (Rectus Abdominus and Iliocostalis), and Load Transferers (i.e., Hip Adductors , Gluteus Medius, Gluteus Maximus, Hip Adductors, Rectus Femoris, Iliopsoas, Latissimus Dorsi, Trapezius, Pectoralis Major ,Deltoid) muscles (Jildeh et. al., 2021). Hence, to enhance neuromuscular control of the local supports, a typical Core Stabilization program begins with exercises such as abdominal drawing-in (also known as abdominal hollowing) or abdominal bracing (also known as co-contraction). Next, it moves on to closed-chain segmented control exercises, which further improve neuromuscular influence and joint stabilization, and finally, it progresses to open kinetic chain activities, that increase distal mobility (Hazar et. al., 2014; Cortell-Tormo et. al., 2017; Biscarini et. al., 2019).

According to current evidences it has been seen that Scapular Stabilization and Rotator Cuff Strengthening are the main choice of treatment for treating Scapular Dyskinesia (Mattson et. al., 2012). There is need of finding the protocol that will focus on integrated activity of both scapular and core stabilization and hence it will help in effective force production during upper extremity movements and allow great range of motion and strength to carry out daily activities. There is paucity of literature on core stabilization program as an equally important part of intervention. As stated Scapular Dyskinesia induced problems are progressive in nature and early and timely rehabilitation will help to reduce long term complications like muscle weakness and loss of mobility. Hence the study has been taken to concentrate upon the Kinetic Chain as it serves as a prime component of treatment and thereby Core Stabilisation exercise program will focus on reducing pain, improving ROM and thereby improving strength of scapular stabilizing muscle and core muscles which will help in effective functioning of the Kinetic Chain. The aim of this research is to determine the effect of structured core stablization exercise program on pain and muscle performance in individuals with scapular dyskinesia.

MATERIALS AND METHODS

Ethical authorization was granted by means of the institutional ethical committee of KVVDU, Karad (Protocol No.: 116/2022-2023). Participant provided informed consent, with the volunteer form covering research details, risks, benefits, confidentiality, and participant rights. The research strictly adhered to the ethical principles of the Declaration of Helsinki, prioritizing participant's rights and well-being in design, procedures, and confidentiality measures.

The present experimental study was carried out at Karad's Krishna College of Physiotherapy. Subjects were admitted based on the inclusion and exclusion standards. Both male and female, aged between 34 to 60 years, scapular dyskinesia diagnosed with lateral scapular slide test, scapular dyskinesia secondary to adhesive capsulitis, other shoulder pathologies were assessed in detail based on clinical assessment and radiographic classification, individuals unable to maintain baseline pressure of 40±5 mmHg for 10 seconds on pressure biofeedback unit, individuals willing to participate were included in this study. İndividuals with any history of recent fractures, surgery, trauma or cancer, with severe morbidity associated with cardio-pulmonary problems and neurological impairments and with any congenital or acquired deformities were excluded.

The subjects received explanations about the aim and methodology of the study. According to ICMR guidelines COVID-19 precautions were taken while assessing the participants. Procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional or regional) and with the Helsinki Declaration of 1975.The subjects completed a well-informed written consent form. Before the assessment, the subjects will be given a brief assessment. Total 90 participants were enrolled for the research, among which 80 participants were recruited in the study and were allocated into 2 groups at random. Group A and Group B by using the envelope method. 2 envelopes containing the group name– A and B were made and participants asked to pick an envelope just before the commencement of the intervention. Pre-test outcome measure assessment included shoulder range of motion, visual analogue scale (VAS), pressure biofeedback unit, individual muscle testing. The intervention allocated to participants in the envelope was given to the participant. Participants in group A received conventional treatment. Participants in group B received conventional physiotherapy treatment with core stabilization exercises (Table 1,2).

Group A (Control Group)

Subjects in Group A (n=40) were given conventional treatment protocol comprising of Hot moist pack, TENS for about 15 minutes and exercises (Table1).

Group B (Experimental Group)

Subjects in Group B (n=40) were given core stabilisation exercise in addition to the conventional treatment protocol (Table2).

Table1. Exercise Program for Group A

Week	Exercise	Repetition
Week 1 (1to 7 days)	Pendular exercisesFlexion-Extension Abduction-Adduction Circumduction	10 Repetitions
	Shoulder isometric exercises	10 repetitions x 5 seconds
	Cross arm stretch	3 repetitions x 15 seconds
	Scapular clock exercises	10 repetitions x 1 set.
Week 2 (Day 8 to 14)	Cross arm stretch	3 repetition x 30 seconds
	Shoulder protraction and retraction	10 repetition x 1 set
	Scapular clock exercises	10 repetition x 2 set
	Wand exercises: • Shoulder flexion • Shoulder extension • Shoulder abduction in scaption • Shoulder external rotation	10 repetition x 1 set
	Cross arm stretch	3 repetition x 30 seconds
	Wand exercises	10 repetition x 2 set
	Wall push up	10 repetition x 1 set
	Resisted shoulder internal rotation (Yellow Thera band)	10 repetition x 1 set
	Resisted shoulder external rotation (Yellow Theraband)	10 repetition x 1 set
Week 4 (22-28 days)	Cross arm stretch	3 reps x 30 seconds hold
	Wall push up	10 repetition x 1 set
	Resisted shoulder internal rotation	10 repetition x 1 set
	Resisted shoulder external rotation	10 repetition x 1 set
	Y,T,W exercises	10 repetition x 1 set
Week 5 -6	Cross arm stretch	3 reps x 30 seconds hold
	Wall push up	10 reps x 2 set
	Resisted shoulder internal rotation (Red Thera band)	10 reps x 1 set
	Resisted shoulder external rotation (Red Thera band)	10 reps x 1 set
	Y,T,W exercises	10 reps x 2 set

(Kisner et.al., 2017).

Table 2. Exercises for Group B

Week	Exercise	Repetition
Week 1 (Day 1 to 7)	Abdominal drawing in manoeuvre	10 reps x 5 seconds hold
	Pelvic bridging	10 reps x 5 seconds hold
	Abdominal drawing-in with alternating lower extremity movement	10 reps x 5 seconds hold
Week 2 (Day 8 to 14)	Abdominal drawing in manoeuvre	10 reps x 10 seconds hold
	Pelvic bridging	10 reps x 10 seconds hold
	Abdominal drawing-in with alternating lower extremity movement	10 reps x 10 seconds hold
Week 3 (Day 15 to 21)	Abdominal drawing in manoeuvre with alternate arm and leg lift	10 reps x 5 seconds hold
	Alternate leg and arm raise in quadruped position	10 reps x 5 seconds hold
	Pelvic bridging with arm lift	10 reps x 5 seconds hold
Week 4 (22-28 days)	Abdominal drawing in manoeuvre with alternate arm and leg lift	10 reps x 10 seconds hold
	Alternate leg and arm raise in quadruped position	10 reps x 10 seconds hold
	Pelvic bridging with arm lift	10 reps x 10 seconds hold
Week 5	Swiss ball alternate arm and leg extension	10 reps x 5 seconds hold
	Swiss ball wall squat	10 reps x 5 seconds hold
	Sitting on ball and carrying out diagonal arm pattern	10 reps x 5 seconds hold
Week 6	Swiss ball alternate arm and leg extension	10 reps x 10 seconds hold
	Swiss ball wall squat	10 reps x 10 seconds hold
	Sitting on ball and carrying out diagonal arm pattern	10 reps x 10 seconds hold

(Hertling & Kessler, 2006).

Outcome Measures

Visual Analog Scale (VAS)

It is a scale which have range from 0 to 10. Zero indicates "no pain" and ten indicates "worst pain imaginable". Participants asked to mark on scale the rate of pain they have from 0 to 10 at rest and on activity. Intra class co-relation score 0.97 (95% CI=0.96 to 0.98) (Boonstra et. al., 2008; Shah & Shinde, 2018; Shinde et. al., 2022).

Goniometry

Goniometry is frequently employed in clinical studies for people experiencing shoulder problems to measure ROM. Goniometry is a reliable and valid method for measuring shoulder ROM, as well as a simple and easily available measure of outcome for clinical studies and therapeutic practice (van et. al., 2015).

Pressure Biofeedback (PBU)

PBU is used to check the strength of back muscles. For the strength assessment, they placed the PBU and inflated the bulb up to 40 mmHg, which is the baseline pressure, and asked the participants to do an abdominal drawing in maneuver. They were supposed to hold it for 10 seconds. The 3 trials are taken, and the best reading is taken into consideration. Measurements are expressed in terms of mmHg (Kumar et. al., 2015; Shinde).

Individual Muscle Testing

It is a procedure used to evaluate the strength of a person's muscle or muscle group, depending on the performance of a movement in regard to the forces of gravity or manual resistance through the available ROM. The examiner in the application of pressure to the participants resistance evaluates the muscle being studied as subjectively "weak" or "strong" on a 5- point scale. Individual muscle testing will be employed to evaluate the scapular stabilisers, including the serratus anterior, upper, and lower trapezius muscles (Vijian et. al., 2023).

Statistical Analysis

Applying SPSS software version 26.0, an analysis of statistics of the recorded data was conducted. For each outcome measure, the mean and the standard deviation were computed. By adding up all of the values and dividing the entire number of values, the mean of the arithmetic was calculated. The software was utilised to calculate different percentages and to draw a variety of graphs with predetermined frequencies using the Excel programme from Microsoft.

RESULTS

The study included 80 individuals who were assigned to two distinct groups of 40 each, group A and B by simple random sampling. Group A acquired conventional exercise program while group B received core stabilisation exercises for 5 times a week for 6 weeks. The study found substantial reduction in pain, improvement in individual muscle testing and shoulder range of motion for flexion and abduction in two groups (p-value <0.0001), whereas, for internal and external rotation, group A showed p value of 0.0193 and 0.0098, whereas, group B showed p value of <0.0001 and 0.2399.Group B showed more improvement in pressure biofeedback unit (p<0.0001) as compared to Group A (p value 0.0208).

Interpretation

Table 3 interpret that among 80 participants with scapular dyskinesia, the age of 47-60 years was found to be commonly affected. Thirty-seven were females and fourty-three were males.

Table 3. Demographic Variables

Variables	Number of subjects
Age (Years)	
34-46	36
47-60	44
Gender	
Female	37
Male	43

Interpretation

Table 4 intertret that the mean VAS values at the rest and during activity were recorded for individuals with scapular dyskinesia in both groups A and group B.Both the groups were found to be statistically extremely significant (p<0.0001).

Table 4. Comparison of the VAS (at rest and during activity) pre- and post-test mean scores within groups A and B

VAS(at rest)	Pre test	Post test	Mean Diff	p–value
Group A	3.66±0.76	1.09±1.03	2.57	<0.0001
Group B	5.17 ± 1.94	0.42±0.58	4.75	<0.0001
VAS (on activity)				
Group A	7.45±0.88	1.28±1.08	6.17	<0.0001
Group B	7.61±0.86	0.74±0.61	6.87	<0.0001

Interpretation

Table 5 interpret that pre-test and post-test ROM values were parameters were acquired for each group A and B, shoulder flexion and abduction is extremely significant (p<0.0001). For internal rotation group A is significant (p=0.0193) while B group is extremely significant (p<0.0001). For external rotation group A is very significant (0.0098) and for group B it isn't significant (p value of 0.2399).

Table 5. Comparison of both pre and post-test mean range of motion scores within groups A and B.

ROM (Shoulder)	Pre test	Post test	Mean Diff	P Value
Flexion				
Group A	95.875±12.064	136.6±17.539	-40.725	<0.0001
Group B	92.775±12.255	145.57±14.903	-47.795	<0.0001
Abduction				
Group A	82.1±11.147	127.97±27.309	-45.87	<0.0001
Group B	80.875±10.37	140.22±12.495	-59.345	<0.0001
Internal rotation				
Group A	55.15±7.020	66.775±5.899	-11.62	<0.0001
Group B	63.225±7.78	81.175±6.710	-17.95	0.0193
External Rotation				
Group A	54.27±7.020	64.975±6.616	-10.70	0.2399
Group B	58.675±9.40	69.475±8.464	-10.86	0.0098

Table 6. Comparison of the individual muscle testing (IMT) pre- and post-test mean scores for groups A and B

IMT	Pre test	Post test	Mean diff	P value
Serratus anterior				
Group A	2.425±0.50	3.20±0.79	0.775	p<0.0001
Group B	2.475±0.50	4.425±0.67	-1.95	p<0.0001
Upper Trapezius				
Group A	2.400±0.49	2.950±0.74	-0.55	P=0.0002
Group B	2.300±0.46	4.375±0.70	-2.075	p<0.0001
Lower Trapezius				
Group A	2.375±0.49	2.975±0.69	-0.6	p<0.0001
Group B	2.425±0.50	4.550±0.63	-2.125	p<0.0001

Interpretation

Table 6 interpret that the pre and post-test IMT score values for patients with scapular dyskinesia which was compared within the groups, it was discovered that both groups' results were very significant (p < 0.0001). For serratus anterior, group A mean pre-test score was 2.425±0.50, and it grew to 3.20±0.79 on the post-test. In contrast, group B pre-test score was 2.475±0.50, and it increased to 4.425±0.67 on the post-test. Group B mean for the upper trapezius was 2.300±0.46 on the pre-test and climbed to 4.375±0.70 on the post-test, whereas

Group A mean was 2.400±0.49 on the pre-test and increased to 2.950±0.74 on the post-test. Group A had a lower trapezius mean of 2.375±0.49 on pre-test and increased to 2.975±0.69 on post-test, while Group B had a mean of 2.425±0.50 on pre-test and 4.550±0.63 on post-test.

Table 7. Comparison of pre test and post test mean scores of pressure biofeedback unit within group A and group B.

Pressure biofeedback	Pre test	Post test	Mean diff	P value
Group A	39.6	39.4	-0.23	p=0.0208
Group B	39.37	36.07	-3.33	p<0.0001

Interpretation

The pre and post-test values of Pressure Biofeedback unit for individuals with scapular dyskinesia was seen for two, the group A and B respectively. For group A it is not significant (p=0.0208) , while group B is considered extremely significant (p<0.0001) (Table 7).

DISCUSSION

The objective of the research was to determine the "Effect of a Structured Core Stabilization Exercise Program on Pain and Muscle Performance in Individuals with Scapular Dyskinesia." The core of the body consists of the pelvis, spine, and proximal lower limb, as well as abdominal structures. The muscles of the pelvis and spine form the core musculature, providing stability to spine and muscles. These core muscles generate energy and transfer it from large body parts to small body parts during various daily activities. In addition to energy generation and stabilizing the hip, pelvis, and spine, the proximal lower limb core muscles are also involved in almost all extremity activities such as running, throwing, and kicking (Roche et. al., 2015). "The capacity to regulate trunk movement and position in order to produce, transfer, and regulate pressures from and to the terminal parts as efficiently as possible during functional tasks is known as 'core stability.' The structure of the scapula is essential for proper shoulder function. The coordinated movements within the scapula and core together provide efficiency for shoulder functioning (Struyf et. al., 2014; Sağlam & Telli et. al., 2022). Core stabilization plays a crucial role in enhancing shoulder joint movement. It achieves this by increasing intra-abdominal pressure**,** which results from the structural organization and activation of core muscles. These core muscles include the multifidi, internal oblique, transverse abdominis, diaphragm, and pelvic floor muscles**.** While performing properly, they form a solid foundation in the trunk. Before initiating movement in the upper limbs, these muscles stabilize the trunk. The study primarily focused on these core components within the kinetic chain, facilitating early rehabilitation and preventing adverse outcomes such as reduced muscle strength and stiffness (Burkhart et. al., 2003; McClure et. al., 2006).

The study's findings revealed that there is very significant effect on pain and extremely significant effect on range of motion of shoulder joint, there is extremely significant effect on the strength of both scapular stabilizing muscle and the core muscles. The study's analysis was conducted using the paired t test. Mean age of the Group A participants was 58.52 ± 3.955 whereas for Group B was 58.767 ± 4.424. The research has suggested a number of core stability training regimens targeted at lowering back discomfort and avoiding injuries. Our goal was to enhance core stability by giving participants more control concerning the core area of the body (Mattson et. al., 2012). The initial exercise was the abdomen drawing in manuever, which was designed to activate the transverse abdominis and oblique muscles, just like in each of the other core stability exercise programmes (Ellenbecker & Aoki, 2020). Other workouts added dynamic movements to the upper and lower extremities to enhance recruitment of muscles as well as distal stability, all while aiming at offering proper lumbo-pelvic control (Kibler, 1998; Oliver & Adams-Blair, 2010; Brumitt & Dale, 2009).

The findings from the current study highlight the effectiveness of a six-week core stabilization exercise program in correcting scapular positioning within the experimental group, leading to statistically significant improvements in shoulder range of motion**.** Statistical analysis values of ROM score for patients are, in between the group A and B, for flexion it showed quite significant (p=0.0525), for abduction it is considered significant (p=0.0304), for internal rotation is extremely significant (p<0.0001) and for external rotation is considered significant (p=0.0271). Additional research demonstrating a strong correlation between shoulder and stability in the core supports this conclusion. The impact of exercises for the shoulders on the stability of the core has been researched thoroughly which reported that the hip and pelvis provide over half of the energy that is kinetic and force associated with dynamic overhead movements. It was noted that strength of the trunk flexor, trunk rotators, hip extensor help positioning of the spine and thereby accommodate appropriate scapular movements (Henning, 2016; Bliss & Teeple, 2005). In this study, the pressure biofeedback section was employed to assess core muscle strength. Group B (Experimental) showed significant improvement in the PBU values after intervention. Statistical analysis in between two group was was found to be extremely significant (p value <0.0001). Weakness of trunk muscles is directly proportional to the variance in the upper extremity's musculature and vice versa. As the strength improves trunk muscles helps in improving functional abilities and ranges (Maenhout et. al., 2010; Park & Yu, 2013; Lee, 2021).

According to Jason Brumitt and S R. Barry Dale, trunk muscles activates in a feed forward manner during the upper or lower-limb movements (Paine & Voight, 1993; McClure et. al., 2001). The feed-forward process in the human body anticipates potential disruptions in spinal equilibrium as the extremities initiate movement (Mattson et. al., 2012). Additionally, a study by Gamze Cobanoglu and colleagues highlighted a strong relationship between Scapular Strength Test and Core Strength Test**.** The conclusion drawn from this is that muscular strength associated with the scapula and the core is critical for productivity and injury risk assessment. It is clear that in athletes, scapular muscular strength improves along with core muscle strength (Vijian et. al., 2023). Current study included combined core and shoulder exercises. In this study the group B which received core stabilization exercise program showed statistically significant improvement in both core muscle strength and scapular stabilizing muscle strength**.** Statistical analysis of among groups A and group B of IMT score for individuals with scapular dyskinesia revealed an extremely significant difference with p<0.0001. Results showed improved muscle strength of serratus anterior, lower trapezius and upper trapezius in group B. This improvement is seen because the core activation also helped in recruitment of muscle fibres of above-mentioned muscles as they two of them constitute the part of kinetic chain in addition to the thoracolumbar fascia.

Another case study by Kelly Kika examined the the effectiveness of trunk stabilisation as the primary treatment choice for pain in the shoulder provoked by Scapular Dyskinesia and Subacromial Impingement Syndrome. The patient showed reduced rib flare during shoulder flexion and reduced trunk rotation during stability tests were indicators of improvements in trunk stabilisation. By the conclusion of the therapy, improvements in shoulder and scapular strength, improvements in trunk stabilisation and less shoulder pain after ten physical therapy sessions were also observed. This study done for shorter period of time and with limited participant and only focused on abdominals as a part of treatment (Kika, 2018). In this present study, we focused on both flexors and extensors as part of the treatment protocol. This exercise program aimed to stabilize the entire trunk, thereby reducing compensatory movement patterns around the shoulder caused by muscle imbalances. The results also demonstrated significant pain reduction in both groups. Participants in two groups underwent conventional method of treatments, such as hot moist packs and TENS (Transcutaneous Electrical Nerve Stimulation). The combination of these treatments likely contributed to the greater reduction in VAS (Visual Analog Scale) scores**.** The mechanism behind pain reduction by TENS involves stimulating large-diameter nerve fibers in the central nervous system. This stimulation further activates inhibitory pathways**,** leading to pain relief.

In the context of treatment, a study by TuçezekliMsrlolu et al. investigated the immediate impact of core muscle activation postures on maximally voluntarily isometric muscle contraction (MVIC) strength in the area of the shoulder. They also explored the effectiveness of core stability exercises. Participants underwent a six-week core stabilization exercise program. Following a home-based fitness routine, the MVIC readings showed significant improvement**.** The study concluded that this six-week core stability training program substantially increased shoulder MVIC strength**.** These findings support the use of core-strengthening exercises during the initial stages of shoulder treatment, especially when traditional shoulder exercises for muscle strengthening may cause discomfort (Bliven et. al., 2013; Saini et. al., 2020). In this research, based on statistical analysis, the findings showed improvement in both groups**.** However, when comparing the conventional group (Group A) with the interventional group (Group B)**,** which included a core stabilization exercising program, **s**ubstantial variations were observed in improving range of motion assessed and strength by using pressure biofeedback, individual muscle testing and goniometry. Pain was significantly reduced in both the groups.

The limitations of this research include the inclusion of just those with scapular dyskinesia recognised by lateral scapular slide test and an intermediate assessment. The long-lasting effect of a core stabilisation programme on individuals with scapular dyskinesia was not studied. This research was carried out at just one medical centre that might restrict its applicability to wider populations or geographical regions.

The results might assist medical professionals in creating customized rehabilitation plans for scapular dyskinesia patients, with the goals of reducing pain and improving strength, and endurance of the muscles. Better shoulder mechanics may be mitigated by improved core stability and alignment, which could improve functional results and general quality of life. The results of this study could also influence evidence-based treatment standards, which would facilitate more effective rehabilitation and long-term care plans for this difficult condition.

Suggestions

It is advised to conduct a long-term study with several assessments spaced out over extended follow-up periods. Moreover, more research should be done to see whether core stabilisation exercises are beneficial for patients with various shoulder or spine issues, such as rotator cuff injuries, cervical lordosis, excessive thoracic kyphosis and shoulder impingement.

Conclusion

Based on statistical analysis, the current study observed that both core stabilization and conventional exercises were effective in reducing pain in patients with scapular dyskinesia. The study's findings concluded that when comparing both techniques, the experimental group showed greater significant results in terms of reduction in pain, improvement in range of motion, enhanced core strength, increased scapular stabilizers strength, core stabilization exercises and scapular stabilization are beneficial in treating scapular dyskinesia because they facilitate effective upper extremity movement. Additionally, the transition from early rehabilitation activities to advanced functional rehabilitation exercises can be facilitated by incorporating combined shoulder and core workouts.

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Conflict of İnterest

There are no conflicting relationships or activities.

Ethics Statement

This research followed ethical standards and received approval from the Institutional Ethical Committee of Krishna Vishwa Vidyapeeth, KIMSDU dated 10/08/2022 and numbered 116/2022-2023.

Author Contributions

Design of the Study, SS and SS; Data Gathering, PJ; Statistical Evaluation, SS; Data interpreting PJ and SS; Writing of the Manuscript, PJ and SS; and Search of the Literature, PJ and SS. Each author has reviewed the final draft of the manuscript and given their approval.

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