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Effect of Conventional Tens and Resisted Exercise Training on Shoulder Dysfunction in Head and Neck Cancer Survivors- A Pre- Post Experimental Study

Caeteana C. Moniz,Post Graduate (PG) Student, Department of Oncology Physiotherapy, KAHER Institute of Physiotherapy, Nehrunagar- Belagavi.

Renu Pattanshetty, Associate Professor and Head, Department of Oncology Physiotherapy, KAHER Institute of Physiotherapy, Nehrunagar- Belagavi.

Correspondence Author: Caeteana C. Moniz, Post Graduate (PG) Student, Department of Oncology Physiotherapy, KAHER Institute of Physiotherapy, Nehrunagar- Belagavi.

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Introduction

According to the American Cancer Society, cancer is the second most common cause of death in the US and accounts for nearly 1 of every 4 deaths with head and neck cancers playing a significant role in the overall incidence and deaths due to cancer. In India, head and neck cancers are accounted for 30% of the total cancers with around 40,000 pharyngeal and 29,000 laryngeal cancers occurring every year. [1]

Depending on the type, stage and extent of spread of cancer, the treatment options for head and neck cancers include radiation therapy, chemotherapy, targeted therapy, immunotherapy and surgery.[2] Surgical interventions aiming to achieve local control of the tumour often aim at tumour removal through a neck dissection surgery. The perseveration or sacrifice of the spinal accessory nerve during a neck dissection is of utmost importance for optimal recovery of the patience and to minimize secondary complications post -surgery. The various types of neck dissections commonly carried out in clinical practise include radical neck dissections wherein the spinal accessory nerve is sacrificed and modified radical and selective neck dissections in which the spinal accessory nerve is spared although there is some amount of functional impairment of the spinal accessory nerve even after it is spared following neck dissection.[3]

Shoulder dysfunction is a common complication after dissection in head and cancer survivors and may contribute to significant morbidity as the survival rates increase in these patients. During the course of surgery, there are varying degrees of damage to the spinal accessory nerve depending on the type of dissection thus leading to denervation of the trapezius and sternocleidomastoid muscles subsequently compromising shoulder functions due to loss of muscle function .This may lead to a secondary sequelae encompassing myofascial pain, rotator cuff impingement, adhesive capsulitis and atrophy of the denervated muscles.[4]

The role of the physiotherapist is of utmost importance to prevent residual deformities and dysfunctions in post-operative head and neck cancer patients. Common interventions carried out in the rehabilitation process include mobility training to enhance exercise tolerance, maintenance and independence; Hot Moist Pack(HMP) and Transcutaneous Electrical Nerve Stimulation(TENS) for pain control; active / passive range of motion exercises

to prevent contractions and maintain joint integrity; and individually tailored programmes.[5,6] Transcutaneous electrical nerve stimulation is used worldwide as a non-pharmacological approach by health professionals to provide pain relief for a wide range of conditions including labour pain, postoperative pain etc.. The popularity of TENS has grown because it is non-invasive, easy to administer and has few side effects or drug interactions. The various forms of TENS include Conventional TENS, Intense TENS, Acupuncture-like TENS (AL-TENS). Conventional TENS has been proven to be effective in reducing post operative pain by selective activation of non-noxious cutaneous afferents and is widely used in cancer patients as well.[7]

Exercises are a beneficial tool in the reduction of shoulder dysfunction post head and neck cancer surgeries as they help in maintaining the joint and muscle integrity and function and improve the shoulder biomechanics. The common exercises administered include mobility exercises for the neck and shoulder and resistance exercise training with weights and tubes.[8,9]

Although new and improvised surgical techniques are being carried out to try and preserve the functioning of the spinal accessory nerve, some amount of damage to the nerve is inevitable causing impairment to the trapezius and sternocleidomastoid muscles leading to shoulder pain and altered shoulder biomechanics causing shoulder dysfunction. Very few studies have been carried out to establish new treatment regimens to aid the rehabilitation process. There is a dearth of literature highlighting the combined use of Conventional TENS and resisted exercise training to the scapular muscles in head and neck cancer survivors, hence the present study was taken up with the hypothesis that there will be an effect of Conventional TENS and Resisted Exercise Training on Shoulder Dysfunction in Head And Neck Cancer survivorsin terms of pain(VAS), range of motion(shoulder), manual muscle testing, disability(DASH) and quality of life(FACT-H&N).

Materials and Methods

Design

The present study was a single centric, Pre- Post Experimental Study, conducted at a tertiary healthcare hospital, which evaluated the effect of conventional tens and resisted exercise training in shoulder dysfunction in head and neck cancer survivors. An ethical clearance was obtained from the Institutional Review Committee (IRC) prior to the commencement of the study. Thirty(30) patients were recruited from Tertiary Care Hospital of 2 centres in Belagavi- Karnataka, India. A written informed consent was obtained from the patients prior to the commencement of the study.

Study participants

The patients were recruited into the study if they were in the age group of 18- 60 years, diagnosed with head and neck cancers(Stage 1, 2 or 3 as per TNM staging) and undergone head and neck dissection surgeries, currently undergoing chemotherapy treatment, willing to give consent for participation in the study and presented with Shoulder dysfunction with $\geq$ 2 of the following signs: atrophy of the upper trapezius muscle, shoulder droop, scapular malalignment (including lateral drift and rotation of the scapula), winging of the scapula with elevation of the arm and limitation in shoulder abduction range of motion.[9] The patients were excluded if they had any history of shoulder or neck pathology not related to cancer treatment, sensory deficits, any comorbid medical illness or psychiatric illness that would impede completion or interfere with the treatment protocol, Evidence of distant metastasis and currently undergoing radiotherapy treatment.

Intervention

All the patients were administered conventional TENS which is high frequency low intensity, Amplitude: low,

Duration 100-200µs, Frequency:10-200pps,Pattern: Continuous for 15 minutes. TENS was applied Electrodes 4 electrodes wherein 2 electrodes were placed over the shoulder where the patient is experiencing pain and 2 electrodes were placed over the fibres of the upper and middle trapezius muscle fibres respectively. The position of the patient was semi-fowler or sitting position according to the convenience of the patient. The exercise regimen comprised of warm up of 5 minutes consisting of light stretches of the shoulder muscles and mild range of motion exercises for the shoulder, resisted exercises with a yellow coloured Theraband signifying least resistance, consisting of 2 sets of 5 repetitions each with 2 minute rest in between with the exercises being:

Forward scapular punch: In standing position, the patient held the theraband and placed it behind his/her back and grabbed it with both hands while placing it beside the body. At the beginning, the elbow and scapula of both arms were fully flexed and retracted. The motion was initiated by flexing the shoulders and extending the elbow. With a fully protracted scapula a punching motion was initiated and then the patient returned back to the starting position.

Retraining of the lower trapezius(scapular retraction):In standing position, the patient held the theraband at waist level. The elbows were held in extension at the side and the hands were pulled away from the body. Hold for 3–5 seconds.

Shrugs in standing: In standing position, the patient stepped on the middle of the theraband and grabbed both sides of the band tightly. The shoulders were then rolled back and held for 3–5 seconds.

Sword pulling: In standing position, the patient stepped on one side of the theraband with one foot. The other side of the band was held with the other hand. The theraband did not have any slack in this starting position. It was positioned in front of the opposite part of the hand grasping the theraband. Thetheraband was stretched so it makes a semi-circle movement until the patient extended his/her arm behind the back. The movement is similar to pulling a sword. Hold for 3-5 secs.

Forward elevation: In standing position, while stepping on the middle of the theraband and holding both sides of the band, both arms were elevated upward and forwards, being careful not to roll shoulders. Hold for 3–5 seconds.[3]

The cool down period was of 5 minutes consisting of breathing exercises and mild range of motion exercises of the shoulder. All the theraband exercises were performed first by the therapist and then the patient performed the same.

Outcome measures

The outcome measures were disabilities of arm, shoulder and hand (DASH) questionnaire; pain at rest and on activity assessed by the visual analogue scale(VAS), shoulder range of motion in terms of flexion, extension, abduction, adduction, internal rotation and external rotation, muscle strength by manual muscle testing of trapezius, rhomboids and pectoralis muscles and quality of life by Functional Assessment of Cancer Therapy—Head and Neck (FACT H&N) questionnaire. All the outcome measures were computed at baseline and after completion of the intervention protocol.

1. Disabilities of Arm Shoulder and Hand Questionnaire: This questionnaire asks the patient about his/her symptoms as well as their ability to do certain activities through 30 questions. All the questions must be answered based on the patients condition in the last week, by circling the appropriate number. Score was reliable with Cronbach's α=0.93, test-retest reliability=0.78.[10]
2. Functional Assessment Of Cancer Therapy Head&Neck Questionnaire: This questionnaire is specially developed for patients afflicted with head and neck cancer and comprises of 4 domains namely:

physical, social, emotional and functional well-being with a series of questions in each domain depicting the quality of life of the patient. [11]

3. Visual Analogue Scale: The Visual Analogue Scale of pain consists of a line, usually 10 cms long, with each end of the line labelled with descriptors representing the extremes of pain intensity (eg: no pain, extreme pain). Respondents place a mark on the line that represents his or her pain intensity level, and the distance measured from the "no pain" end to the mark is that person's VAS pain score (R=0.54). [12]

Statistical analysis

Statistical analysis was done manually as well as using statistical package of social sciences(SPSS) version 21 so as to verify the results obtained. Various statistical measures such as mean, mean difference, standard error, standard deviation were used. Nominal data such as patient's demographic data i.e. Age, BMI(kg/m^2), height(metres), weight(kgs) distribution were analyzed. Normality of all the parameters was determined by Kolmogorov Smirnov test. Since the data followed a normal distribution, dependent t-test was used for analysis of the Disabilities Of Arm, Shoulder and Hand (DASH) questionnaire; visual analogue scale(VAS), shoulder range of motion, muscle strength and Functional Assessment of Cancer Therapy—Head and Neck (FACT H&N) questionnaire. With study power of 80%, probability values of less than or equal to $p \leq 0.05$ were considered statistically significant.

Results

Pretest and posttest scores of components of Functional Assessment of Cancer Therapy—Head and Neck (FACT H & N)of all patients in the study showed statistically significant differences in all the components of the questionnaire with physical, emotional and functional components demonstrating the highest significance with p=0.0001, followed by additional concerns with p=0.0028. However, the social component of FACT H & N showed lesser significance compared to the other components with p=0.0179. The comparison of pretest and posttest scores of Visual analogue scale at rest and on activity of all patients in the study demonstrated statistically significant difference in all the patients in terms of pain at rest and on activity after the intervention protocol with p=0.0001. All the shoulder ranges showed statistically significant improvements in terms of shoulder flexion, extension, abduction, adduction, internal rotation and external rotation with p=0.0001. Amongst all the muscles that were assessed for strength, trapezius upper and middle fibres, rhomboidus major and rhomboidus minor muscles demonstrated the maximum improvements in terms of strength with statistical significance of p=0.0001, followed by pectoralis major with p=0.0007 and trapezius lower fibres with p=0.0032.

Discussion

The present study was undertaken to evaluate the combined effects of conventional TENS and resisted exercise training on shoulder dysfunction in head and neck cancer survivors. The study findings prove the alternate hypothesis as the intervention protocol was effective in reducing shoulder dysfunction in all the patients in the study. The clinically relevant observation in the present study was improvement in range of motion of shoulder in terms of shoulder flexion, extension, abduction, adduction, internal rotation and external rotation of all the patients with a p-value of 0.0001 which is accordance with a study that demonstrated increments in range of motion after neuromuscular electrical stimulation and exercises for reducing trapezius muscle dysfunction.[13] Reduced range of motion and shoulder dysfunction is mainly due to pain and reduced voluntary control of the trapezius muscle which is caused due to damage of the SAN during surgery. The improvement in shoulder range of motion can be attributed to the exercise regimen administered in the

present study that was forward scapular punch, scapular retraction, shoulder shrugs, sword pulling and forward elevation hands using a yellow theraband. These exercises aimed to strengthen the trapezius and scapular muscles thus providing scapular stability and improving range of motion. During movement, the trapezius plays an important role in stabilizing and controlling the scapula; reduced trapezius strength disrupts the biomechanics of scapular movement resulting in decreased shoulder ROM and increased shoulder pain. Hence, trapezius control has shown to improve upward rotation of the scapula, scapulohumeral rhythm and shoulder ROM.[14,15,16] Also, early mobilisation after surgery avoids the development of secondary complications such as joint fibrosis, adhesive capsulitis etc. hence increasing range of motion. [8,9,17,18]

Increments in muscle strength were observed maximally in trapezius upper and middle fibres, rhomboidus major and minor with p-value of 0.0001 followed by pectoralis major and lower fibres of trapezius p-values of 0.0007 and 0.0032 respectively. This could be due to the resisted exercises performed with a yellow theraband by the patients. Resistance training has shown to be beneficial in improving muscle strength and maintaining body composition in cancer patients undergoing neo-adjuvant and adjuvant therapy in the early rehabilitation phase.[19] The improvement in muscular strength can be attributed to the effects of resistance training which include enhanced muscle performance due to restoration and improvement in muscle power and endurance, increased strength of connective tissues and possible improvements in capacity to repair and heal damaged soft tissue due to positive impact on tissue remodelling.[20]

Shoulder pain after head and neck dissection surgery is thought to arise from a multitude of factors including muscle imbalance, impingement and poor recruitment patterns around the shoulder complex which alter scapular position and scapulohumeral rhythm.[16,21] Reduction in the levels of pain according to the visual analogue scale (VAS) both at rest and on activity was another highlight of this study p-value of 0.0001. Margaret et al stated a similar outcome in terms of upper extremity pain reduction in fifty-two(52) head and neck cancer survivors with progressive resisted exercise training. This could have occurred due to the strengthening exercise regimen. Pain at the shoulder complex may arise secondary to atrophy of the trapezius which inevitably leads to lateral and downward displacement of the scapula and hence drooping of the shoulder. Increased levels of strength and endurance of the scapular musculature improves the biomechanics of the shoulder complex by facilitating proper scapular positioning and thus may contribute to pain alleviation.[9]

Disability of arm, shoulder and hand questionnaire demonstrated significant changes after the administered intervention protocol thus depicting a reduction in disability levels in the patients and an improved functional outcome p-value of 0.0001. The significant reduction in the disability scores may be due to the cumulative effects of improved muscular strength, increased range of motion of the shoulder and pain alleviation. A study also suggested that pain reduction and early recovery of passive mobilisation by physiotherapy are of vital importance since once complete passive range of motion is achieved, active mobility recovers spontaneously if there is no irreversible nerve damage thus reducing disability.[17]

Quality of life(QOL) of all the patients in the present study have demonstrated improvements according to the FACT H&N questionnaire with significant improvements in all components of the questionnaire namely physical, emotional, functional, social and additional concerns. Improvement in quality of life can be attributed to the integrated effect of physical exercise and TENS. Exercise is known to influence QOL by reducing the incidence of

nausea, weight gain, muscle wasting and fatigue. Exercise may also dampen the feelings of depression, tension, anxiety, anger, hostility, helplessness and pessimism. It also provides structured, purposeful activity and encourages interaction with others, thereby enhancing the social dimension of QOL. Furthermore, improvements in the other QOL dimensions facilitated by regular physical exercise may provide increased energy levels and a clearer focus to tend to more spiritual issues.[6,22,23] These findings are well supported by a study conducted on fifty-two(52)H&N cancer survivors in which progressive resisted exercise training was associated with improved functioning and QOL. [9]

To conclude, the results of the present study have demonstrated significant improvements in terms of shoulder range of motion in terms of flexion, extension, abduction, adduction, internal rotation and external rotation; an increase in strength of shoulder and scapular musculature; a reduction in disability according to the disabilities of arm, shoulder and hand (DASH) questionnaire; alleviation of pain both at rest and on activity assessed by the visual analogue scale(VAS) and improvement in quality of life by the FACT H&N questionnaire. However, the present study also suggests that similar studies need to be conducted in similar clinical settings to generalise the clinical findings.

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Figure 1: Flow chart of patient recruitment process for the study

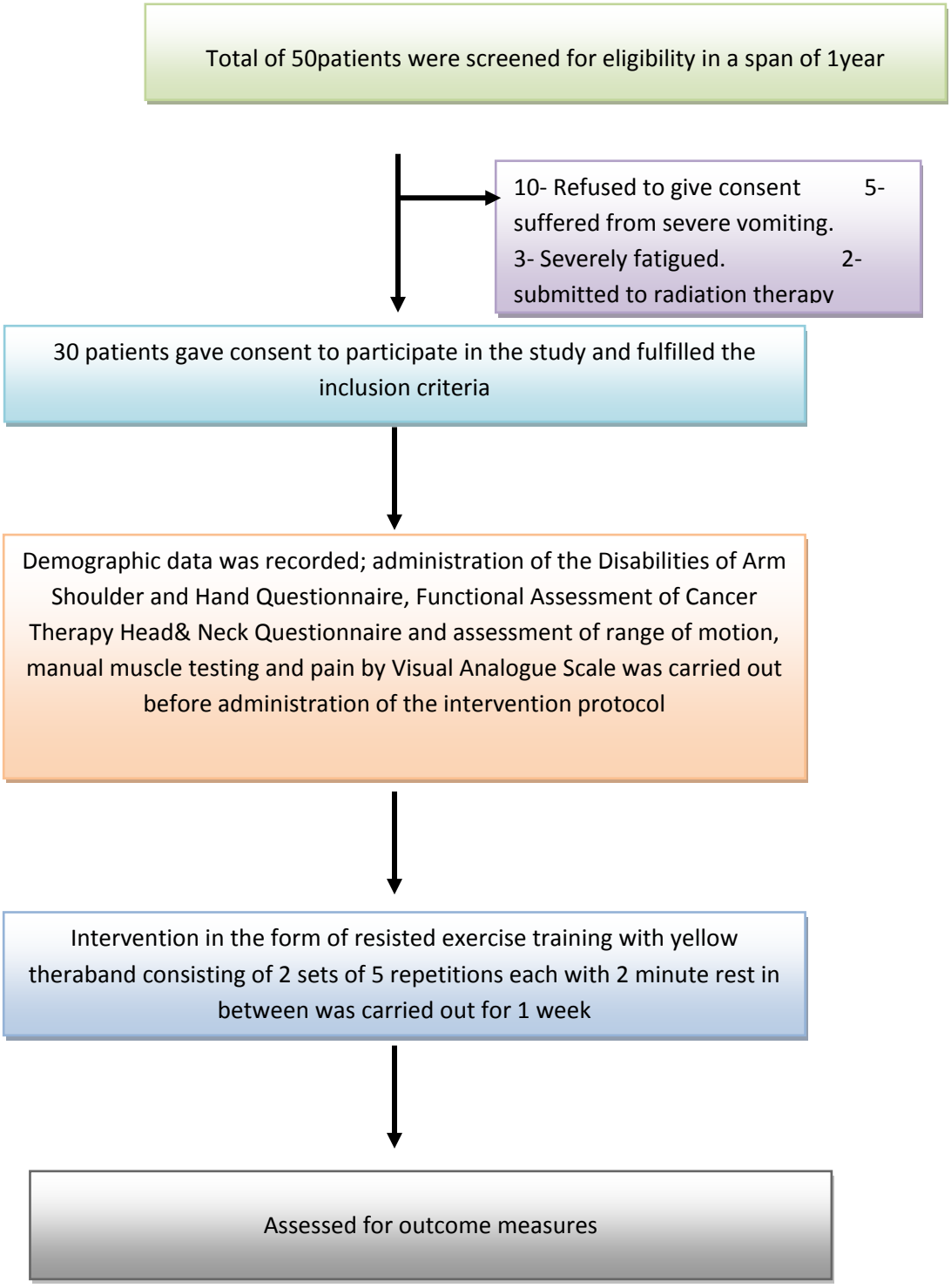

Table 1: Demographic data of all the patients in the study

Variable	N	Mean ± SD	%
Age(years)	30	46.77±8.67	
Gender –Male Female	20 10		66.67 33.33
Weight (kgs)	10	50.48±11.55	
Height(metres)	10	1.49±0.12	
BMI(kg/m^2)	10	22.84±4.92	
Cancer Diagnosis			
CA Buccal mucosa stage I	3		10
CA Buccal mucosa stage II	10		33.33
CA Buccal mucosa stage III	6		20
CA Thyroid stage I	1		3.33
CA Thyroid stage II	1		3.33
CA Thyroid stage III	3		10
CA Larynx stage III	1		3.33
CA Parotid gland stage II	1		3.33
Squamous cell CA stage II	2		6.66
Parathyroid adenoma	1		3.33
CA Tongue stage II	1		3.33

Table 2: Comparison of pretest and posttest Disabilities Of Arm, Shoulder And Hand Questionnaire (DASH) scores of all the patients in the study.

Time	Mean ±SD.	% of change	Paired t	P-value
Pretest	96.13 ±19.32			
Posttest	67.40 ±18.50	29.89	11.2673	0.0001*

*Level Of Significance p≤ 0.05

Table 3: Comparison of pretest and posttest scores of components of Functional Assessment of Cancer Therapy—Head and Neck (FACT H & N) of all patients in the study

Variables	Time	Mean ±SD.	% of change	Student's Paired t	P-value
Physical	Pretest	20.03±10.97			
	Posttest	11.93±4.24	40.43	4.3746	0.0001*
Social	Pretest	11.63±4.60			
	Posttest	13.57±3.53	-16.62	-2.5107	0.0179*
Emotional	Pretest	14.50±3.80			
	Posttest	10.13± 3.18	30.11	7.1229	0.0001*
Functional	Pretest	10.60±5.00			
	Posttest	15.27±4.78	-44.03	-5.6829	0.0001*
Additional concerns	Pretest	20.40±4.84			
	Posttest	16.67±3.66	18.30	3.2731	0.0028*

* Level Of Significance p≤ 0.05

Table 4: Comparison of pretest and posttest scores of Visual analogue scale of all patients in the study

Variables	Time	Mean ± SD.	% of change	Student's Paired t	P-value
At rest	Pretest	6.77±1.33			
	Posttest	4.27± 1.51	36.95	9.1113	0.0001*
On activity	Pretest	7.50±1.25			
	Posttest	4.87±1.11	35.11	11.3337	0.0001*

* Level Of Significance p≤ 0.05

Table 5: Comparisons of pretest and posttest scores of Shoulder range of motion(ROM in degrees) of all patients in the study.

Variables	Time	Mean ± SD.	% of change	Z-value	P-value
Flexion	Pretest	93.70±22.07			
	Posttest	145.37±30.06	-55.14	4.7821	0.0001*
Extension	Pretest	34.00±22.41			
	Posttest	52.93±19.58	-55.69	4.1857	0.0001*
Abduction	Pretest	90.73±22.69			
	Posttest	137.53±29.84	-51.58	4.7821	0.0001*
Adduction	Pretest	90.73±22.69			
	Posttest	137.53±29.84	-51.58	4.7821	0.0001*
Internal rotation	Pretest	41.87±12.95			
	Posttest	56.90±12.26	-35.91	4.5407	0.0001*
External rotation	Pretest	41.10±12.37			

	Posttest	58.77±12.78	-42.98	4.7030	0.0001*

*Level Of Significance p≤ 0.05

Table 6: Comparison of pretest and posttest scores of Manual muscle testing of Trapezius , Rhomboids And Pectoralis muscles of all the patients in the study.

Variables	Time	Mean± SD	% of change	Z-value	P-value
Trapezius upper Fibres	Pretest	5.20±1.37			
	Posttest	6.83±1.34	-31.41	4.1973	0.0001*
Trapezius middle Fibres	Pretest	5.57±1.04			
	Posttest	7.17±1.09	-28.74	4.4573	0.0001*
Trapezius lower Fibres	Pretest	5.70±1.06			
	Posttest	7.47±1.28	-30.99	2.9493	0.0032*
Rhomboidus major	Pretest	5.20±1.27			
	Posttest	6.70±1.29	-28.85	4.2857	0.0001*
Rhomboidusminor	Pretest	5.63±1.43			
	Posttest	7.10±1.16	-26.04	4.0420	0.0001
Pectoralis major	Pretest	5.63±1.87			
	Posttest	6.60±1.48	-17.16	3.3869	0.0007*

*Level Of Significance p≤ 0.05

List of Figures: