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Correlation of severity of pain and perceived disability with scapula posture in patients with neck pain

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Abstract
Background and objectives: Neck pain is a major musculoskeletal disorder. One of the commonest etiological factors for neck pain is faulty posture. Neck and scapula share some common muscle attachments. Hence, change in scapula posture might have an effect on neck pain severity and perceived disability in patients with neck pain. Hence, the aim of this study was to find out if the severity of neck pain and perceived disability is affected by altered scapula posture.
Method: Total 64 patients with neck pain were included for the study. Severity of pain and perceived disability was assessed using Numerical pain rating scale and Neck disability index, respectively. Scapula posture was assessed using Lennie's test and Acromion-to-plinth distance.
Result: As the data passed normality test, correlational analysis was done using parametric test that is Pearson's correlation coefficient was used to investigate the relationship between severity using NPRS and scapula posture using Lennie's test and Acromion-to-plinth test. As NDI provides ordinal level scoring, correlational analysis between NDI and scapula posture was done using non -parametric statistical test that is Spearman's Rank Correlation Coefficient.
Conclusion: The present study concludes that positive correlation is present between NPRS and NDI with scapula posture assessed on Lennie's Test and by Acromion-to-plinth distance in subjects with unilateral and bilateral neck pain affection. This shows that as the neck pain severity and perceived disability in neck pain patients is altered, scapula posture is also altered.

Keywords: neck pain, correlation, severity of pain, disability

Introduction

Neck pain is a major musculoskeletal disorder which most people experience at some point in their life. It's prevalence worldwide is about 16.7% to 75.1%. [1, 2] It is generally high in women, middle age group population, high- income countries when compared to low and middle-income countries and in urban areas as compared to rural areas [3]. The reason for such a high prevalence is because of the complex etiology and multiple risk factors [1]. It was ranked as the 4th greatest contributor to global disability in a study done by Hoy *et al* [4].

The associated risk factor for neck pain includes faulty and sustained posture, strenuous physical activity, repetitive movements and use of force & vibration. [1, 3, 5] Psychosocial factors can also be responsible for neck pain such as stress level, job satisfaction, anxiety and depression. Other factors like behavioral factors such as level of physical activity and smoking and individual factors such as age, body mass index and musculoskeletal pain history can also have an effect on neck pain [1, 3, 5, 6]. These factors which can give rise to neck pain makes daily activities like driving or even turning head difficult [1, 2]. Also, activities like working on a computer becomes cumbersome [7]. It, thereby, may reduce an individual's ability to participate in work, social and sporting endeavors. Therefore, as it has an effect on a person's everyday life by affecting their physical, social and psychological well-being.

Neck Pain is considered to be a crucial factor responsible for morbidity and disability of these patients [1, 2]. Thus, this disability contributes to huge economic burden through the cost of health-care, work absenteeism, insurance and pressure on health-care system [2]. Disability is an umbrella term for impairments, activity limitations and participation restrictions. It denotes the negative aspects of the interaction between an individual (with a health condition) and that individual's contextual factors (environmental and personal factors). It is the interaction of the person's health characteristics and their contextual factors (environment, personal) that produces disability.[8]

Ergonomic factor such as faulty scapular posture can give rise to neck pain as it has negative influence on the alignment of cervical joints. Forward head posture (FHP) is the most commonly associated faulty posture with neck pain. Approximately, 60% of neck pain patients are reported to have FHP. Sustained forward head posture results in increased load on the posterior cervical structures like bones, ligaments, joint capsules and muscles. This causes shortening of posterior neck muscles. Since, posterior neck muscles share common attachments to both neck and scapula it is reported to give rise to altered scapular position and hence it's kinematics [9-11].

Studies on neck pain patient have also reported that there is tightness of muscles such as levator scapulae, upper trapezius and pectoralis minor. Literature also provides evidence for altered axio-scapular muscle function which causes abnormally loading cervical spine and thereby results in neck pain [12-14]. This altered muscle function was demonstrated by Shahidi *et al* who found out that muscle strength of middle trapezius is significantly reduced along with rhomboids in patients with neck pain as compared to control group [15]. Therefore, changes in length and strength of these neck muscles also will have an impact on scapula posture as the muscles share common attachments and can potentially contribute to neck pain due to abnormal loading of the cervical spine or through the formation of myofascial trigger points [9,15].

Therefore, as neck pain may be associated with scapula posture, the need of the study was to find if severity of pain and perceived disability is affected by altered scapula posture. So that scapular posture is assessed and managed in patients with neck pain. A recent study correlated scapular asymmetry, neck pain and neck disability scores in young women with slight neck pain. They found out that at 90 deg of shoulder abduction scapular asymmetry showed moderate positive correlation with neck pain [16]. However, there's paucity of literature which correlates scapula posture with severity and disability in patients with neck pain in Indian population. Hence, we need to find out if the severity and perceived disability of neck pain is affected by altered scapula posture.

Aims and objectives

Aim

To correlate severity of pain and perceived disability with scapula posture in neck pain patients.

Objectives

- To correlate severity of pain and perceived disability in neck pain patients to scapula posture.
- To assess neck pain using NPRS
- To assess perceived disability using Neck Disability Index.
- To assess scapula posture using Lennie's Test and Acromion-to-plinth distance.

Hypothesis

Null Hypothesis [H0]: There is no relation between severity of pain and perceived disability with scapula posture in neck pain patients.

Alternate Hypothesis [H1]: There is a relation between severity of pain and perceived disability with scapula posture in neck pain patients.

Materials and methodology

a. Study type: Observational Correlational type of study

b. Duration of study: 6 months

c. Sampling Method: Convenience Sampling

d. Sample Size: 64Sample size calculation was done by using the free online software size =N = [(Zα+Zβ)/C]2 + 3 = 64, Where the standard normal deviate for α = Zα = 1.960 The standard normal deviate for β = Zβ = 0.842 C = 0.5 * ln[(1+r)/(1-r)] = 0.359 [39] α (two- tailed) = 0.050 (Threshold probability for rejecting the null hypothesis. Type I error rate.) β= 0.200 (Probability of failing to reject the null hypothesis under the alternative hypothesis. Type II error rate.) r= 0.344 (The expected correlation coefficient) [27]

e. Inclusion Criteria

- Patients with some degree of neck pain
- Age Group: 45 to 60 years

f. Exclusion Criteria

- Congenital deformities of scapula
- Cervical radiculopathy or myelopathy
- Previous history of whiplash injury or any other cervical trauma
- Previous history of cervical spine surgery
- Presence of widespread pain i.e., fibromyalgia syndrome
- Any infective, inflammatory or neoplastic condition of neck

g. Outcome Measures

1. **Assessment of Pain [17-19]:** The NPRS is a pain rating questionnaire (Reliability = 0.76). The patient is asked to indicate the intensity of their current, best and worst levels of pain over the past 24 hours using an 11-point scale, ranging from 0 (no pain) to 10 (worst pain imaginable). The average of the 3 ratings was used to represent the patient's level of pain over the previous 24 hours.

2. **Assessment of Perceived Disability [7, 20-24]:** Neck Disability Index developed by Vernon H; Mior S focuses on the activities of daily living which are most affected by neck pain. It is reliable (ICC 0.88) in patients with mechanical neck pain without upper extremity symptoms.[17] In this 10 – item scale questions are measured on a 6-point scale from 0 (no disability) to 50 (full disability). These include questions on pain intensity, personal care, lifting, reading, headaches, concentration work, driving, sleeping, and recreation. The numeric response for each item is summed for a score varying from 0 to 50 or a score out of 100%.

3. **Scapula posture** was assessed by following tests:

- **Lennie's Test:** [25] Patient stood in his/her normal relaxed posture. Markings were made on the skin overlying the R and L scapula for the following landmarks: Superior angle (medial aspect of the most superior point), Root of the spine of the scapula (medial aspect of the most medial point), Inferior angle (medial aspect of the most inferior point) For each of these three marks over each scapula, corresponding marks were done over the spinal midline. Measurements were taken to the nearest millimeter from each scapular landmark to their corresponding midline landmark using a vernier caliper.

- **Acromion-to-plinth distance:** Distance from the posterior border of acromion [27-29] Patient was asked to lie down supine in crook lying position. Distance was measured from posterior border of Acromion-to-plinth on both sides.
- They have moderate to high intertester reliability ICC = .64-.86 and .88 respectively. [25-28]

Procedure

Individuals with neck pain were screened for inclusion and exclusion criteria and were excluded if they fall into any of the afore mentioned exclusion criteria. Informed Consent was taken. The purpose and procedure of the study was explained to all subjects in detail in the language they understand. Every participant was assessed for neck pain severity (NRPS), perceived disability (NDI) and scapula posture (Lennie's Test and Acromion-to-plinth distance). The data collection for the study ended after 64 participants were recruited.

Statistical Analysis

All the data collected for statistical analysis was entered in Microsoft Excel 2019. Statistical analysis was performed using GraphPad prism 9.1.1 software and Microsoft Excel 2019. The data was tested for normality using Shapiro- Wilk test. As the data passed normality test, correlational analysis was done using parametric test that is Pearson's correlation coefficient was used to investigate the relationship between severity using NPRS and scapula posture using Lennie's test and Acromion-to-plinth test. As NDI provides ordinal level scoring, correlational analysis between NDI and scapula posture was done using non parametric statistical test that is Spearman's Rank Correlation Coefficient.

Results

Among 64 subjects participated in the study 39 were males and 25 were females. For the total study population (n= 64), mean age was 50.39 ± 5.24 years, mean height was 163.36 ± 5.59cms, mean weight was 65.62 ± 5.83 kgs and mean BMI was 24.47± 1.80. (Table 1)

in neck pain patients (n= 64), 36 % (n= 23) had inferior angle prominent, 27 % (n= 17) had elevatd scapula, 23 % (n= 15) showed downward rotation and 14 % (n=9) showed medial border prominence. (Figure-1)

Among 64 subjects - 41 had unilateral affection and 23 had bilateral affection of neck pain. Out Of 41 subjects with unilateral affection, 38 had Right sided dominance and 3 had Left sided dominance. Of 23 subjects with bilateral affection, 19 had Right sided dominance and 4 had Left sided dominance.

Table 2, table 3 and table 5 show mean and standard deviation values of outcome measures of total sample (n=64), subjects with unilateral affection (n= 41) and subjects with bilateral affection (n= 23) respectively.

Table 4 and table 6 show correlation of NPRS and NDI with Lennie's Test (superior angle, root of spine and inferior angle) and Acromion to plinth distance on dominant and non-dominant side on subjects with unilateral affection. (n= 41) and bilateral affection (n= 23) respectively.

Table 1: Demographic data of total sample (n=64).

Variables		**Mean ± SD**
Age (Years)		50.39 ± 5.24
Height (m)		163.36 ± 5.59
Weight (kg)		65.62 ± 5.83
BMI (kg/m^2)		24.47± 1.80
Gender	Males	25
	Females	39

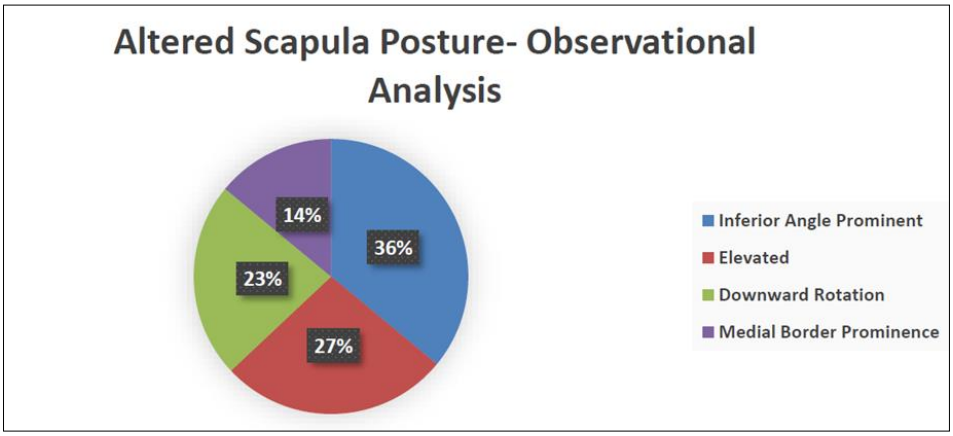

Fig 1: Altered scapula posture on observational analysis. (n=64)

Table 2: Mean values of Outcome Measures of Total Sample (n=64).

Sr. No.	Variables	Mean ± SD		
1	NPRS	5.48 ± 1.14		
2	NDI	53.73 ± 11.11		
3	Lennie's Test	Dominant Side	Non-Dominant Side	P Value
	Superior Angle	6.15 ± 0.92	5.97 ± 0.98	0.0019
	Root of spine	5.83 ± 1.02	5.59 ± 0.98	0.0004
	Inferior angle	7.03 ±1.13	6.71 ± 1.12	0.0006
4	Acromion-to-plinth distance	6.38 ± 1.12	6.1 ± 1.2	0.0002

Table 3: Mean values of subjects with unilateral affection (n= 41) of Outcome measures.

Variables		Mean ± SD		
1	NPRS	5.41 ± 1.18		
2	NDI	53.38 ± 10.8		
3	Lennie's Test	Dominant Side	Non-Dominant Side	p Value
	Superior Angle	6.19 ± 0.92	5.76 ± 0.97	< 0.0001
	Root of spine	5.82 ± 1.11	5.35 ± 0.94	< 0.0001
	Inferior angle	7.12 ±1.24	6.58 ± 1.24	< 0.0001
4	Acromion-to-plinth distance	6.39 ± 1.14	5.99 ± 1.29	0.0002

Table 4: Correlation of NPRS and NDI with Lennie's Test (superior angle, root of spine and inferior angle) and Acromion to plinth distance on dominant and non-dominant side on subjects with unilateral affection. (n= 41)

Variables	r- value	
	Dominant Side	Non- Dominant Side
NPRS with Superior Angle	0.9030	0.8524
NPRS with Root of spine	0.8309	0.7511
NPRS with Inferior angle	0.7242	0.6412
NPRS with Acromion to plinth distance	0.7305	0.5939
NDI with Superior Angle	0.8971	0.8708
NDI with Root of spine	0.8623	0.7466
NDI with Inferior angle	0.7281	0.6152
NDI with Acromion to plinth distance	0.7157	0.6484

Table 5: Mean values of subjects with bilateral affection (n= 23) of Outcome measures.

Variables		Mean ± SD		
1	NPRS	5.6 ± 1.07		
2	NDI	54.35 ± 11.79		
3	Lennie's Test	Dominant Side	Non-Dominant Side	p Value
	Superior Angle	6.09 ± 0.93	6.35 ± 0.93	0.05
	Root of spine	5.9 ± 0.84	6.02 ± 0.93	0.05
	Inferior angle	6.87 ± 0.91	6.96 ± 0.86	0.11
4	Acromion-to-plinth distance	6.32 ± 1.06	6.26 ± 1.09	0.06

Table 6: Correlation of NPRS and NDI with Lennie's Test (superior angle, root of spine and inferior angle) and Acromion to plinth distance on dominant and non-dominant side on subjects with

Variables	r- value	
	Dominant Side	**Non- Dominant Side**
NPRS with Superior Angle	0.8625	0.8022
NPRS with Root of spine	0.8313	0.7688
NPRS with Inferior angle	0.7256	0.6226
NPRS with Acromion to plinth distance	0.9090	0.8705
NDI with Superior Angle	0.8112	0.7451
NDI with Root of spine	0.8144	0.7394
NDI with Inferior angle	0.6741	0.5900
NDI with Acromion to plinth distance	0.8117	0.8161

Discussion

The results of the present study indicates that as neck pain severity and perceived disability increases scapula posture is also altered in both subjects with unilateral and bilateral affection of neck pain. These results are in accordance with a study done by Kim *et al* who showed that moderate positive correlation is present between VAS with scapular posture assessed by Lateral scapular slide test at 90 degrees of abduction. Their study population included only young females with slight neck pain (VAS= 2.0 ± 2.2). They concluded that the reason behind this altered scapular posture is due to imbalance of surrounding muscles and it is related to neck pain. [16]

Literature reports that normal individuals as well as subjects with neck pain might have altered scapular position at rest. [12] This could be because both neck and scapula share common muscle attachments. It can, therefore, be hypothesized that faulty posture and movement patterns in activities of daily living, during work and leisure time in these patients can give rise to neck pain. [29] Normal alignment and movement of scapula is therefore important in normal neck and upper limb function during day-to-day activities. Scapula provides a stable base for muscle attachments and its appropriate orientation optimizes length- tension relationship for efficient contraction of rotator cuff muscles. Therefore, faulty movement of scapula can result in decreased neuromuscular performance of these muscles and may predispose the individual to injury of the glenohumeral joint and also neck. [30-32] The function of stability and mobility of the scapula is provided by surrounding scapular muscles which help in transferring loads between the upper limbs and the vertebral column, including the cervical spine. Disturbances in the function of the scapular muscles can result in an increase of load on the cervical spine. These disturbances can be in the form of altered muscle length, muscle activation or strength and endurance. [33]

Muscles such as levator scapula, rhomboids and upper trapezius have shown to have increased activity in patients with neck pain. [12] Subjects participating in our study showed elevation and downward rotation of scapula on observational analysis 45 % (n= 29) which could indicate increased activity in levator scapulae and rhomboids. Along with elevation and downward rotation, they also cause adduction of scapula. [33-35] In neck patients with unilateral affection (n=41) the mean values for distance between superior angle, medial most point and inferior angle on affected side were 6.19 ± 0.92 cm, 5.82 ± 1.11 cm and 7.12 ±1.24 cm. In patients with bilateral affection (n= 23) the mean distance on dominant side from superior angle, root of spine and inferior angle of scapula to the corresponding spinous process was 6.09 ± 0.93 cm, 5.9 ± 0.84 cm and 6.87 ± 0.91 cm respectively and non- dominant side from superior angle, root of spine and inferior angle of scapula to the corresponding spinous process was 6.35 ± 0.93cms, 6.02 ± 0.93cms and 6.96 ± 0.86cms respectively. Sobush *et al* have showed that on Lennie's Test the average distance from spinous process and medial border of scapula were around 8.7 cm (3.42 inches) [25]. Sahrmann has stated that vertebral border less than 3 inches (7.5 cm) from spine indicates that the scapula is adducted [36]. As compared to these normative values, scapula posture of subjects in this study was adducted for affected side in unilateral neck patients and on dominant and non-dominant side in patients with bilateral neck pain patients. However, normative values for Indian population are not available.

In normal static postures, low activity is seen in levator scapulae and upper trapezius even with an unloaded arm so as to suspend the scapula against gravity. However, prolonged poor static postures can cause chronic loading of these muscles as they transfer the weight of upper extremity to the cervical spine giving rise to fatigue and pain eventually. These muscles are also active during normal arm elevation. Levator scapulae contracts concentrically during first half of abduction and eccentrically during second half of abduction. This indicates that the force exerted by levator scapulae is greatest during the second half of abduction range where increase in compressive loading on the cervical joints must occur. This will increase the intradiscal pressure and the pressure on zygapophyseal joint surface. If abnormal stress already exists in the joint due to cervical pathology, it may cause tissue distortion, thereby, producing pain. Along with compressive loading levator scapulae also have a tendency to laterally flex and rotate the spine ipsilaterally, thereby increasing chances of nerve compression. To prevent this, overactivity is observed in upper trapezius muscle as it acts on cervical spine to cause contralateral rotation [33, 34].

Neck pain patients commonly show increase in activity in upper trapezius and altered pattern of muscle activation along with levator scapulae [37]. Levator scapulae muscle tends to get recruited first in movement

pattern resulting in overuse and chronic loading. This causes excessive and premature scapula elevation and alters scapulohumeral rhythm during arm elevation. [33,34] This in turn affects the participation of lower fibers of trapezius and serratus anterior due to altered length tension relationship. Evidence suggests that subjects with neck pain have reduced muscle activation and strength in middle and lower trapezius and serratus anterior as compared to healthy subjects [12]. Dysfunction of serratus anterior and trapezius can cause deficiency of upward rotation. [35] Serratus anterior weakness can also result in medial border prominence of scapula at rest and reduced posterior titling and external rotation of scapula during arm elevation [38]. Similar results were found in the present study where 23% subjects (n=15) showed prominent medial border at rest on observational analysis. On observational analysis 36% (n= 23) of subjects had prominent inferior angle. This can be due to reduced serratus anterior strength or pectoralis minor shortness. Shahidi *et al* has shown that significant reduction in length of pectoralis minor is seen in patients with neck pain Bilaterally [29]. A valid method to assess this length is Acromion-to-plinth distance.

According to Sahrmann, distance between posterior border of acromion and plinth if is greater than 1 inch it indicates that pectoralis minor muscle is short [36]. Mean values of Acromion-to-plinth distance in subjects with unilateral affection on affected side were 6.38 ± 1.12 cm. In subjects with bilateral affection, mean Acromion-to-plinth distance on dominant and non-dominant side was 6.32 ± 1.06 cm and 6.26 ± 1.09 respectively. This shows that scapula was anteriorly tipped in these patients. Between dominant and non-dominant side scapula posture was altered on both sides as statistically significant difference was not seen between Acromion-to- plinth distance ($p = 0.06$). This can be due to pectoralis minor tightness which through its attachment on coracoid process can result in anterior tipping of scapula that can prevent normal posterior tilting and upward rotation required for arm elevation. This can further alter length tension relation for global stabilizers such as serratus anterior and lower trapezius and can cause secondary pathology at glenohumeral joint. Therefore, during elevation of the arm, movement will be provided mainly by means of elevation of the scapula and the whole shoulder girdle by levator scapulae and upper trapezius which will become further become shortened and hyperactive and the vicious cycle will continue.

Also, it is well reported that in neck pain patients as the severity of neck pain increases their perceived disability also increases. Kim *et al* showed that strong correlation was also seen between VAS and NDI in patients with cervical spine disorders [16]. Similar, findings were seen in our study where strong positive correlation was seen between NPRS and NDI in both patients with unilateral ($r= 0.9381$) and bilateral neck pain ($r= 0.9563$). As pain intensity is one of the 10 areas addressed on the NDI, a relationship between these 2 variables, therefore, would be expected. Other items addressed on NDI include personal care, lifting, reading, headache, concentration, work, driving, sleeping and recreation. Of these, work, lifting and reading were the most affected components with mean values of 3.07 ± 0.78, 3.18 ± 0.95 and 2.7 ± 0.93. The coefficient of determination (R^2) for subjects with unilateral and bilateral neck pain reveals that about 86 % and 90 % of NDI score could be attributed to NPRS. There are number of other factors that can also contribute to level of perceived disability such as psychosocial components that were not explored in the present study.

Hence to conclude, present study shows that a positive correlation is present between NPRS and NDI with scapula posture assessed on Lennie's Test at superior angle, medial most point and inferior angle of scapula and by Acromion-to-plinth distance in subjects with unilateral and bilateral neck pain affection. This shows that as the neck pain severity and perceived disability is altered scapula posture is also altered. Therefore, assessment of scapula posture is fundamental and it should be incorporated in routine assessment and management of neck pain patients.

Conclusion

The present study concludes that positive correlation is present between NPRS and NDI with scapula posture assessed on Lennie's Test and by Acromion-to-plinth distance in subjects with unilateral and bilateral neck pain affection. This shows that as the neck pain severity and perceived disability in neck pain patients is altered, scapula posture is also altered.

Limitations

- In the present study, strength testing of muscles has not been done to support the hypothesized muscle weakness.
- Dynamic scapular movement assessment has not been carried out to observe how scapula moves along with static posture assessment done using Lennie's Test and Acromion-to-plinth distance and by observational analysis.
- In present study all patients with neck pain had altered scapula posture. In future studies maybe neck pain patients without change in scapula posture could be included to compare.

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