Effectiveness of Cervico-Thoracic Manual Therapy Combined with Deep Neck Flexor Training in Patients with Shoulder Pain Due to Cervical Radiculopathy(A RCT)

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Abstract—**Objective: Neurological dysfunction brought on by constriction and irritation of the spinal nerves or nerve roots of the cervical spine is known as cervical radiculopathy. This study looked at how deep neck flexor (DNF) exercises combined with cervico-thoracic mobilization exercises improved shoulder discomfort and functional impairment.**
Patients and methods: This randomized controlled trial was conducted at ANS Hospital between September 25, 2025, and December 24, 2025, with fifty participants who had persistent neck discomfort. They were divided into two groups at random. Group-A received cervico-thoracic mobilization (10 minutes) and deep neck flexor training (10 minutes), while Group-B, the control group, received conventional physical therapy (i.e., physical therapy agents, stretching, and isometric exercises) for the same amount of time as Gp-A. Every participant experienced a 20-day intervention. They were evaluated for functional impairment and shoulder pain intensity using a visual analog scale (VAS) and DASH before and after 20 days of therapy.
Results: Compared to baseline, both the groups showed a significant decrease in shoulder pain and disability ($p < 0.05$), And there was a significant increase in Neck ROMs. The improvement of the mobilization with DNF training group was significantly Higher than the control group. Moreover, the improvement of the DNF group was significantly higher than the control group ($p<0.05$).
Conclusions: The cervico-thoracic mobilization exercises with DNF were better than traditional physiotherapy to treat shoulder pain and functional disability due to cervical radiculopathy.

Index Terms—**cervical radiculopathy, shoulder pain, mobilization, deep neck flexor, VAS, DASH**

I. Introduction

Shoulder discomfort resulting from inflammation or entrapment of a cervical nerve root in the neck, as opposed to a main shoulder problem, is referred to as cervical radiculopathy. Neurological dysfunction brought on by compression and inflammation of the spinal nerves or nerve roots of the cervical spine is known as cervical radiculopathy. There is a lack of epidemiological data and uncertainty on the prevalence and incidence rate of cervical radiculopathy. In a large-scale retroactive population-based investigation, the incidence rate peaked in the fifth decade at 83.2 per 100,000 individuals (107.3 males and 63.5 women)(1). Cervical radiculopathy can cause a wide range of clinical symptoms, such as discomfort, reduced reflexes, sensory impairments, motor impairments, or any combination of these. Cervical nerve root dysfunction can also be caused by a number of distinct pathophysiologic mechanisms. Defining the natural course of cervical

radiculopathy and elucidating surgical indications and post-operative outcomes have been major areas of research in recent years(1). A pathological condition affecting the cervical nerve root is called cervical radiculopathy. The nerve root or roots at or close to the cervical neural foramen are compressed and inflamed. People who engage in activities with poor ergonomics experience it(2). Cervical radiculopathy is a frequent clinical diagnostic that is categorized as a nerve root condition. It is often caused by an inflammatory or compressive pathology from a space-consuming lesion, such as a cervical osteophyte, spondylitic spur, or disc herniation(3). Depending on whether nerve root level is impacted, the location and pattern of symptoms will change. If the dorsal or ventral nerve root is injured, these symptoms may include changes in sensation and/or motor function. Arm discomfort is the most common cause for seeking medical attention, even though patients with radiculopathy may complain of neck pain(4). The pathological condition linked to compression and inflammation of the cervical spinal nerve or nerve roots is called cervical radiculopathy. Cervical spondylosis and cervical disc herniation are the most frequent causes of cervical radiculopathy. Lumbar radiculopathy is more frequently linked to disc herniation than cervical radiculopathy. Just 21.9% of instances of cervical radiculopathy are caused by disc herniation(5). In most adult populations, degenerative changes brought on by aging are referred to as cervical spondylosis. Age-related disc degeneration causes foraminal constriction and reduced disc height. Increased stresses on the vertebral body and intervertebral joints are caused by decreased disc height. Bony hypertrophy and osteophyte development result from this. Cervical radiculopathy and foraminal stenosis can result from uncovertebral and aspect joint hypertrophy(6). Small injuries to the neck brought on by long-term posture and abrupt muscle contractions can also cause muscles that are rarely used to shrink, which can result in mechanical dysfunction and persistent discomfort(7). According to a prior study, the sternocleido-mastoid and the deep cervical flexor (DCF) muscles lose strength and endurance in around 70% of individuals with persistent neck discomfort(8). The longus colli and longus capitis muscles, which make up the DCF muscles, are crucial for preserving neck stability and postural control. The peripheral sternocleido-mastoid and longus capitis muscles were more active than the deep longus colli and longus capitis muscles. Thus, preserving the DCF muscles' strength is essential for regulating the stability and posture of the neck(9). The head moves farther forward from the body as a result of a persistent imbalance between the deep and superficial neck muscles. One of the most frequent postural abnormalities seen in individuals with persistent neck and shoulder discomfort is the forward head position. In this position, the head's central line shifts toward the front to allow for the loading of additional weights on the neck, aggravating cervical lordosis or acromion projection and causing significant alterations to the joints connecting the head and neck(10). Retraining the DNF muscles enhances their activation level, which increases their capacity to maintain cervical vertical alignment and lessens the symptoms of neck discomfort(11). The DNF musculature, a region rich in muscle spindles, is specifically targeted by the DNF workouts. Additionally, DNF exercises increase neck stability by improving the cervical spine's awareness of position and motion (12). The diagnosis of cervical radiculopathy lacks widely recognized standards. Patients

with cervical radiculopathy typically experience a range of symptoms, including unilateral arm and neck discomfort accompanied by numbness, weakness, or abnormal reflexes (13). Patients' primary symptoms include arm pain (97%–99%), sensory deficit (85%–91%), reflex deficit (71%–84%), neck pain (56%–80%), motor deficit (64%–70%), scapular pain (37%–52%), anterior chest discomfort (18%), and headaches (10%)(14). Pathology at the C4–C5 level causes radiopathy of the fifth cervical nerve root. Numbness and localized shoulder pain are common presentations for patients, which might be mistaken for a pathological shoulder issue(15). Shoulder illness may manifest as abduction and external rotation weakness when it is caused by a rotator cuff injury. However, mobility of the shoulder has no effect on radicular pain, in contrast to discomfort from primary shoulder illness. The numbness continues laterally to the midsection of the arm and follows the C5 sensory distribution, which is situated across the top of the shoulder along its midportion. Supraspinatus and deltoid muscle weakness with decreased shoulder abduction is the main motor deficit. There may also be weakness in the biceps, infraspinatus, and clavicular head of the pectoralis major muscles. The fifth and sixth cervical nerve roots innervate the pectoralis reflex and the biceps reflex, which may be weakened(16). Only a few provocative tests have consistently shown statistically relevant variations among patients and controls in a study context, despite the fact that there are many tests available to assess cervical radiculopathy. By reducing the size of the foramen, the Spurling test is intended to worsen encroachment of nerve roots that are leaving. While the clinician applies an axial force, the patient is instructed to extend and rotate their neck laterally to the suspected side. Radiating agony is replicated by a positive test. Only pain makes equivocal tests noteworthy. According to recent research, this test is very specific (94%) and sensitive (95%). Cervical radiculopathy symptoms should be lessened by the shoulder abduction sign, which involves raising the arm over the head. Similar results should be obtained via cervical traction(17). A possible site for stiffness is the cervicothoracic (CT) junction, which acts as a transition between the less mobile, kyphotic thoracic spine and the more mobile, lordotic cervical spine. Headaches, shoulder discomfort, neck pain, and general midback stiffness can result from a reduction in cervicothoracic joint motion. Although the evidence for this relationship mostly comes from older cross-sectional studies in occupational populations, a modified mobility pattern known as the "Inverse C7-T1 relationship" has been connected to neck pain, highlighting the significance of restoring proper CT junction mobility in people experiencing neck discomfort. Enhancing CT junction mobility lessens the mid and lower cervical segments' need for movement, which lessens the load on the cervical spine(18,19). Therefore, cervicothoracic mobilization and manipulation are employed as therapies for shoulder, neck, and thoracic discomfort and dysfunction. Because of the neurophysiological advantages of manual treatments and the concepts of regional interdependence, neck discomfort is often treated with manual therapy for the thoracic spine (20). Patients with neck discomfort have shown relief when using the Mulligan Concept approach for a Sustained Natural Apophyseal Glide (SNAG) to the cervicothoracic spine (21). The impact of conventional physical therapy versus a wide range of treatment procedures has been examined by several writers. These include infrared therapy, ultrasound, nerve stimulation, and sporadic

cervical traction (22). The patient's overall functional state (aerobic training if aerobic fitness is poor) and strength training of the neck and chest are additional factors to take into account when creating a physical therapy program for radiculopathy. As patients' pain improves, a well-designed physical therapy program should move them through these phases. It should start with mild range-of-motion exercises and include strengthening and conditioning exercises once the acute symptoms go away (23). Physical therapy may provide a moderate short-term effect in terms of neck discomfort and grip strength, but these advantages fade after six months to a year, according to studies comparing it to other conservative therapies (24). Although cervical traction is frequently seen as a physical therapy method, it is treated separately here because its effectiveness has been the subject of several research. Physical therapists can apply cervical traction manually or mechanically using a sequence of escalating weights. The range of traction weights is 5 to 12 kg. The effectiveness of cervical traction alone or in conjunction with exercise has been investigated in a number of studies (25). The pain level was measured using a visual analog scale (VAS), which is a smooth, 100-mm-long line with word descriptions at either end. The participant's perception was positioned where he thought it best described his current state. The VAS score was calculated by measuring the distance in millimeters between the left end of the line and the participant's designated point. This method was widely considered to be a legitimate and reliable way to estimate pain(26). The disabilities of the arm, shoulder, and hand (DASH) checklist is a self-contained, region-specific outcome measure designed to assess symptoms and self-rated upper-extremity impairment. The 30-item disability/symptom scale, which ranges from 0 (no disability) to 100, is the primary component of the DASH. This study's primary goal was to evaluate the DASH's longitudinal construct validity in surgical patients. Quantifying self-rated treatment efficacy following surgery was the second goal (27).

II. MATERIAL AND METHOD

In this study, 70 patients who visited the ANS Hospital, dept of physical therapy, located in Jaipur City, between oct 2025 and jan 2026 with a complaint of shoulder pain radiating from neck were enrolled. This study was approved by the hospital, and all the participants provided written informed consent. Among of these 20participants were dropped due to some private issue. Then after 50 subjects were selected for the study: 1) subjects with shoulder pain radiating from neck having age between 30-50; 2) subjects with a VAS score of > 5 points; 3) subjects who had been experiencing neck pain for more than 2 months; 4) subjects who had never approach surgical interventions; 5) subjects who were not receiving medications; and 6) subjects who could not have any cardio-pulmonary issue; 7) subjects who had not any h/o trauma on shoulder. Prior to the study, the participants were fully informed regarding the study procedures and provided written consent for participation. All the participants were divided in two groups with equal nos of participants (25 each). All the participants were introduced with moist hot pack for 10 mins followed by the group intervention methods. Group-A introduced with cervici-thoracic manual therapy(SNAG) for 10 min followed by deep neck flexor training for 10 mins. Similarly Group-B introduced with traditional physiotherapy for 20

mins (i.e exercises with modalities). All the participants were intervened for 20 day regularly. A pre and post intervened data was collected at day 0 and day 20 through pain and functional score. For pain calculation VAS was used and for functional score DASH was used. The study result were analyzed by using JASP 16.0 V, the repeated measure study were done through pair t-test. The pre and post data of between the group and within the group study were done. The significance of $p< 0.05$ was considered.

Interventions:

DNF: activities to Strengthen the Deep Neck Flexors and Scapulothoracic Muscles Regardless of their strength levels, patients were encouraged to conduct activities aimed at strengthening the deep neck flexors after the thoracic spine manipulation. Without using a biofeedback equipment, the patients engaged in deep neck flexor strengthening activities. The patient was told to nod their head in order to flatten the curve of their neck while lying supine with their cervical spine in neutral. Ten repetitions of this position were performed, each lasting ten seconds. Exercises for the scapulothoracic region included strengthening the middle and lower trapezius muscles as well as the serratus anterior.

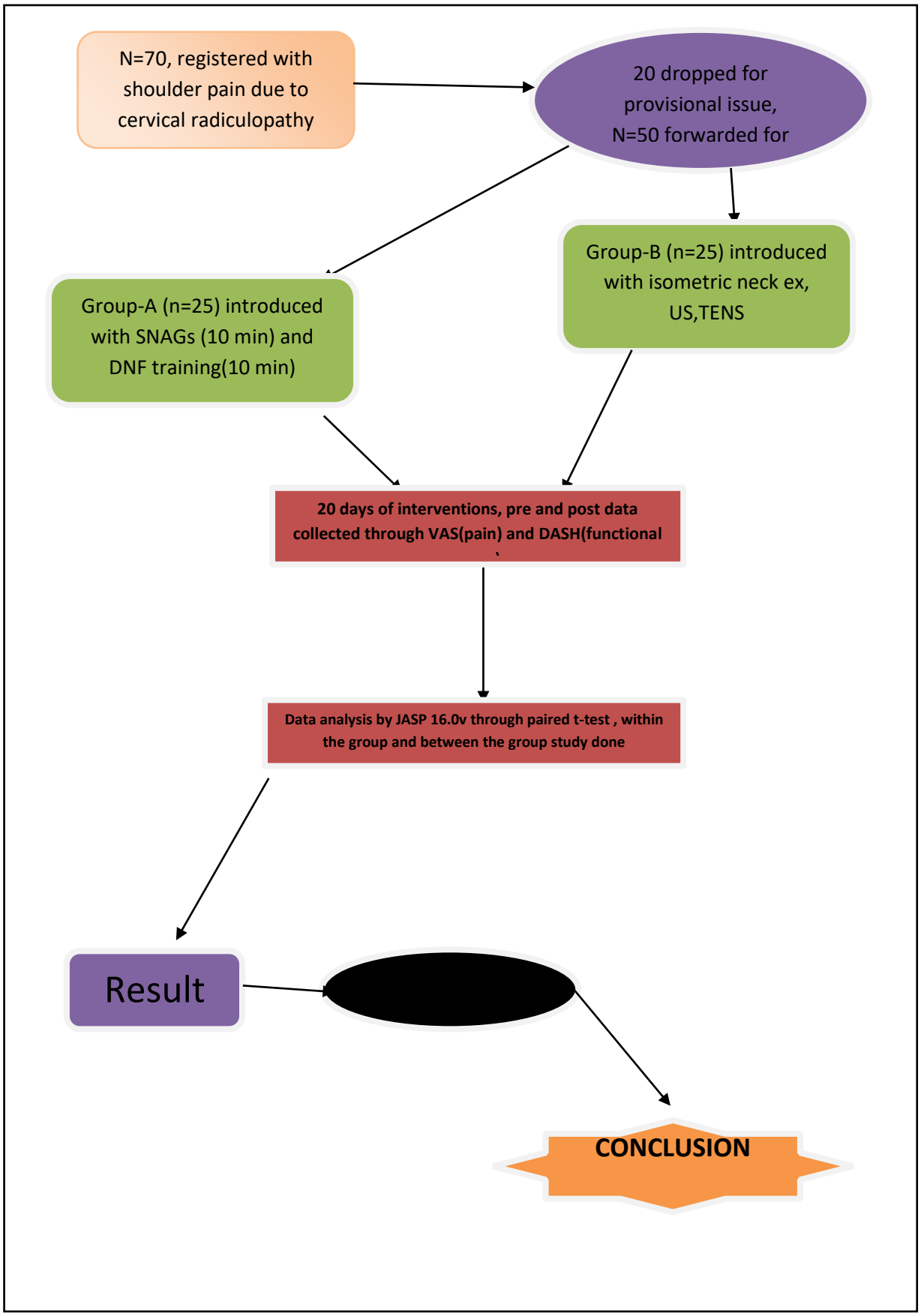
SNAG: Brian Mulligan created the manual treatment method known as Sustained Natural Apophyseal Glides (SNAGs) as a component of the Mulligan Concept. They entail the patient performing the previously uncomfortable or limited movement while a prolonged glide is applied to a spinal facet joint. The patient sits up straight. The therapist administers an anterior-superior glide to the cervico-thoracic junction and the targeted cervical vertebra. The patient twists their neck while maintaining the glide. After that, the exercise was repeated five times. Pain and movement were immediately improved by the method.

Moist heat: a heating pad dipped with hot water box at 50 degree temperature then drawn the pad from the hot box, did wrapping it with a dry towel, placed it under the neck and upper back while pt was in supine lying. The pad was placed for 10 mins for all participants.

Traditional physiotherapy: the conventional method of physical therapy was introduced to group-B participants. There after the intervention conducted as neck isometric exercise for 10 mins and electro-modalities for 10 min(US used as pulsed with $0.7W/cm^2$, TENS as brust frequency of 150mA).

III. RESULT

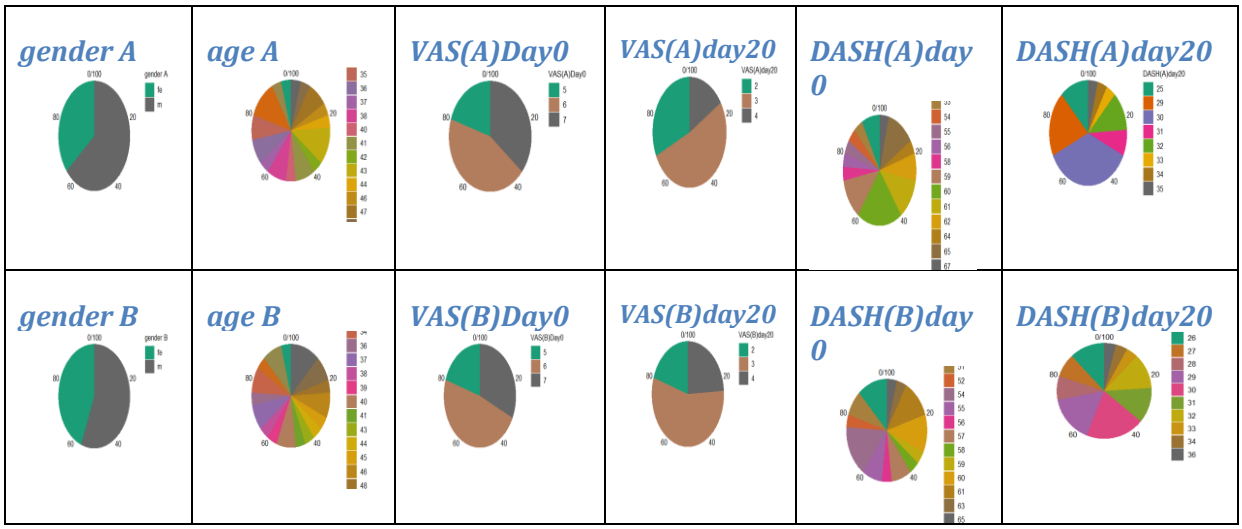
Consort chart


N=70, registered with shoulder pain due to cervical radiculopathy
20 dropped for provisional issue, N=50 forwarded for
Group-A (n=25) introduced with SNAGs (10 min) and DNF training(10 min)
Group-B (n=25) introduced with isometric neck ex, US,TENS
20 days of interventions, pre and post data collected through VAS(pain) and DASH(functional
Data analysis by JASP 16.0v through paired t-test , within the group and between the group study done
Result
CONCLUSION

Descriptive Statistics

	gender A	age A	gender B	age B	VAS(A)Day0	VAS(A)day20	VAS(B)Day0	VAS(B)day20	DASH(A)day0	DASH(A)day20	DASH(B)day0	DASH(B)day20
Valid	25	25	25	25	25	25	25	25	25	25	25	25
Missing	0	0	0	0	0	0	0	0	0	0	0	0
Mean		39.720		40.960	6.160	2.840	6.120	3.040	59.440	30.000	56.320	29.840
Std. Error of Mean		1.120		1.288	0.149	0.138	0.145	0.135	0.891	0.490	0.873	0.506
Std. Deviation		5.601		6.439	0.746	0.688	0.726	0.676	4.454	2.449	4.366	2.528
Variance		31.377		41.457	0.557	0.473	0.527	0.457	19.840	6.000	19.060	6.390
Range		19.000		19.000	2.000	2.000	2.000	2.000	17.000	10.000	15.000	10.000
Minimum		31.000		31.000	5.000	2.000	5.000	2.000	50.000	25.000	50.000	26.000
Maximum		50.000		50.000	7.000	4.000	7.000	4.000	67.000	35.000	65.000	36.000

Note. Not all values are available for *Nominal Text* variables



Paired Samples T-Test

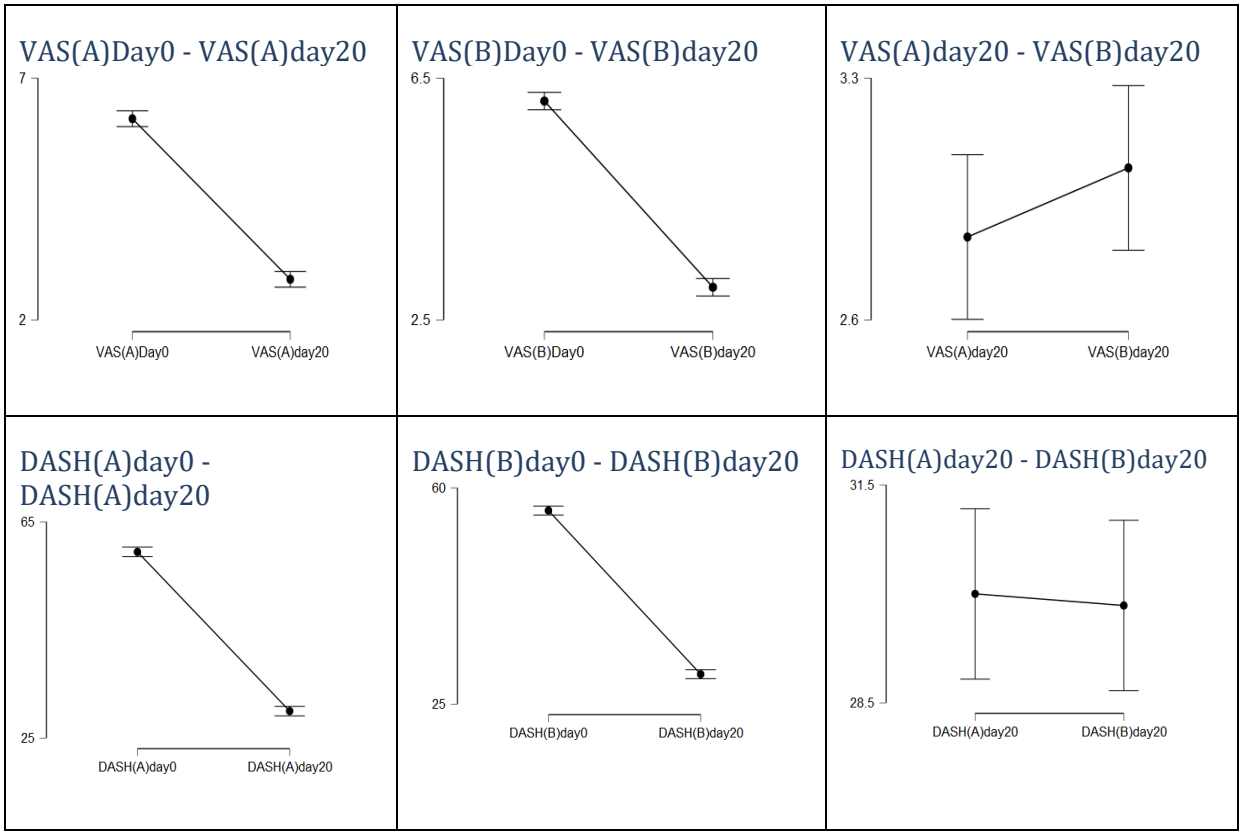
Measure 1		Measure 2	t	df	p	Mean Difference	SE Difference	95% CI for Mean Difference Lower	95% CI for Mean Difference Upper	Cohen's d	95% CI for Cohen's d Lower	95% CI for Cohen's d Upper
age A	-	age B	-0.744	24	0.464	-1.240	1.668	-4.682	2.202	-0.149	-0.541	0.247
VAS(A)Day0	-	VAS(A)day20	29.814	24	0.0477	3.320	0.111	3.090	3.550	5.963	4.238	7.633
DASH(A)day0	-	DASH(A)day20	48.601	24	0.0273	29.440	0.606	28.190	30.690	9.720	6.957	12.397
VAS(B)Day0	-	VAS(B)day20	31.219	24	0.0451	3.080	0.099	2.876	3.284	6.244	4.442	7.988
DASH(B)day0	-	DASH(B)day20	53.637	24	0.0366	26.480	0.494	25.461	27.499	10.727	7.556	13.675
VAS(A)day20	-	VAS(B)day20	-1.225	24	0.0233	-0.200	0.163	-0.537	0.137	-0.245	-0.640	0.156

Paired Samples T-Test

Measure 1	Measure 2	t	df	p	Mean Difference	SE Difference	95% CI for Mean Difference		Cohen's d	95% CI for Cohen's d	
							Lower	Upper		Lower	Upper
DASH(A)day20	DASH(B)day20	0.199	24	0.0438	0.160	0.803	-1.498	1.818	0.040	-0.353	0.432

Note. Student's t-test.

Descriptives Plots



****From above statistical analysis the p shows the significant with pre and post value, seems as the both the group have significant changes in pre intervention and post intervention. As per between group study findings of p< 0.05 indicates the significant difference in management of pain, similarly the value of functional status findings of p< 0.05 put the results of significance. Hence after the intervention for Group-A signified the better effect than interventions for Group-B.****

IV. DISCUSSION

"Cervical radiculopathy, which results in referred pain, decreased neuromuscular control, muscle weakness, and functional limits of the shoulder and upper limb, is caused by irritation or compression of the cervical nerve roots (usually C5–C7)."

Physiological Effect	SNAG + DNF Exercises	Traditional Physiotherapy
Pain Reduction	Activates spinal and supraspinal pain inhibitory mechanisms; decreases nerve root sensitivity	Primarily provides symptomatic pain relief through heat, TENS, or ultrasound
Nerve Root Function	Improves cervical segmental mobility and may reduce mechanical irritation of the affected nerve root	Limited direct effect on nerve root mechanics
Cervical Joint Mobility	Restores normal facet joint gliding and cervical movement	Improves mobility through general ROM exercises
Neural Tissue Mobility	Reduces adverse neural tension and improves neural dynamics	Minimal direct effect on neural mobility
Deep Cervical Muscle Activation	Strengthens deep neck flexors, improving cervical stability	General strengthening with less emphasis on deep stabilizers
Postural Correction	Corrects forward head posture and cervical alignment, reducing stress on cervical structures	General postural advice and exercises
Proprioception	Improves cervical joint position sense and sensorimotor control	Moderate improvement through active exercises
Shoulder Muscle Function	Enhances neuromuscular control of the scapular and shoulder muscles through improved cervical stability	Indirect improvement due to pain reduction
Circulation and Tissue Healing	Increased blood flow from mobilization and active exercise	Improved circulation mainly from heat and exercise
Functional Recovery	Better restoration of neck–shoulder biomechanics and upper-limb function	Functional improvement mainly through symptom relief

“Cervical radiculopathy-related shoulder discomfort is frequently linked to altered cervical biomechanics, nerve root irritation, decreased cervical mobility, and compromised cervico-scapular function. Because they have a direct impact on movement, loading patterns, and nerve root stress, the mechanical consequences of therapy are significant.”

Mechanical Effect	SNAG + DNF Exercises	Traditional Physiotherapy
Cervical Joint Mobility	Restores normal facet joint gliding and segmental motion	Improves mobility through general ROM exercises
Intervertebral Movement	Enhances physiological movement between vertebrae	Limited direct effect on segmental movement
Nerve Root Mechanical Stress	Reduces compression and irritation by improving cervical mechanics	Minimal direct effect on nerve root loading
Cervical Alignment	Improves cervical lordosis and head-neck alignment	General postural correction with variable effects
Segmental Stability	Increases stability through DNF activation	General strengthening with less segmental control
Load Distribution	Promotes more even distribution of forces across cervical segments	May not specifically address abnormal loading patterns

Mechanical Effect	SNAG + DNF Exercises	Traditional Physiotherapy
Scapular Mechanics	Improves cervico-scapular coordination and shoulder mechanics	Indirect improvement through pain reduction
Range of Motion	Restores pain-free cervical movement with improved mechanics	Improves ROM but may not correct underlying dysfunction
Movement Efficiency	Normalizes movement patterns and reduces compensatory motions	Some improvement but compensatory patterns may persist
Functional Biomechanics	Enhances neck–shoulder kinetic chain function	Mainly improves symptoms and general function

V. CONCLUSION

When SNAG is combined with Deep Neck Flexor exercises, it may be superior compared to conventional physiotherapy because it also enhances cervical joint mobility, sectional stability, proprioception, and neuromuscular regulation while lowering nerve root irritation, leading to greater alleviation in pain and disability and more favorable functional outcomes. According to the aforementioned study, participants in Group-A performed better than those in Group-B. In patients with cervical radiculopathy, it reduces shoulder pain and improves function by mechanically restoring normal cervical joint motion, improving segmental stability, optimizing cervical alignment, minimizing mechanical stress on affected nerve roots, and improving cervico-scapular biomechanics.

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