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Effect of deep cervical flexor exercises on pain, range of motion and neck strength in patients with chronic neck pain

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ABSTRACT
Background
Neck pain is an unpleasant sensory experience in the neck which may be manifested as fatigue, tension or pain that radiates to the shoulders, upper extremities or head.It is becoming increasingly common throughout the world with two-thirds of the population having neck pain at some point in their lives. Hence, we examined the effect of deep cervical flexor exercises (DCF) on pain, range of motion and neck strength in patients with chronic neck pain.
Methodology
30 subjects with non specific chronic neck pain were recruited in this study. 15 subjects were given conventional treatment whereas 15 subjects received DCF exercises along with conventional treatment. Treatment was given for a period of 4 week (3 times per week). Subjects were evaluated for pain with Numerical Rating Scale (NRS), cervical ranges using a measuring tape method and deep cervical muscle strength using blood pressure cuff with dial (for biofeedback) at the beginning and end of 4 weeks of treatment.
Results
On intra-group comparison in the conventional group and DCF group, all the outcome measures namely; Numerical pain rating scale (NRS) (at rest and on activity) , range of motion and deep cervical muscle strength showed significant improvement post treatment ($p \leq 0.05$). However, the mean values of DCF were more significant than conventional. Whereas inter group comparison revealed statistical significance only in neck strength.
Conclusion
Both conventional and DCF exercises improved pain, range of motion and neck strength post treatment.
Keywords: Deep cervical flexor exercises, Neck pain, Neck strength.

INTRODUCTION

Neck pain is an unpleasant sensory experience in the neck which may be manifested as fatigue, tension or pain that radiates to the shoulders, upper extremities or head [1]. It may be attributed to numerous structures in the neck and surrounding regions, such as the muscles, joint structures, ligaments, intervertebral disks, and neural structures [2].

Neck pain is a common condition that affects many individuals at some time in their lives. Prevalence of neck pain is generally higher in women and in urban areas compared with rural areas. There is an increased risk of developing neck pain until the 35–49-year age group, after which the risk begins to decline. International epidemiological data show a 12-month prevalence of neck pain ranging between 17% and 75%, with a mean of 40% and a point prevalence ranging between 10% and 20% [3].

Numerous studies have reported that approximately 70% of patients with chronic neck pain exhibit decline in muscular strength and endurance. It has been proven that specific muscles in the cervical spine when weakened tend to cause neck pain; the most common of these being the deep and anterior cervical flexors [4,5,6]

Exercise regimes for managing neck pain differ with respect to duration, training frequency, intensity, and mode of exercise. Previous studies have shown that isometric exercises and strength training can have positive effects on neck pain [7,8,9]. This study was aimed to find out how two different strength training protocols affect neck pain; one being conventional therapy which included cervical isometrics and other consisting of specifically targeting DCF strengthening plus conventional therapy.

MATERIALS AND METHODS

The study was conducted after the approval of Institutional Research Review Committee. It was an experimental study performed in 2017-2018. Subjects with neck pain for more than 3 months, without any specific cause and in the age group of 20-50 years were included in the study. Subjects with any history of neck trauma, cervical radiculopathy, spinal deformity, vertigo and neck surgery were excluded from the study. A convenient sample size of 30 subjects were chosen based on the inclusion and exclusion criteria. A written informed consent was taken from every participant. The participants were then randomly divided into 2 groups: GROUP A - participants receiving conventional treatment including neck isometrics & GROUP B - participants receiving deep cervical flexor exercises along with conventional treatment.

Participants were assessed for intensity of pain using Numerical Rating Scale [NRS], cervical ROM using measuring tape and neck strength using pressure biofeedback at the beginning and end of 4 weeks of treatment.

For assessing cervical ROM, the subjects were made to sit in a straight back chair with arms relaxed and resting on their thighs and with their shoulders, ears, and sternal notch exposed. The following anatomical landmarks were taken: Flexion - Distance from sternal notch to chin. 2. Extension - Distance from sternal notch to chin. 3. Rotation - Distance from acromion process to tip of the nose. 4. Lateral Flexion - Distance from acromion process to the ear lobe.

Deep cervical muscle strength was assessed using a Blood Pressure Cuff with dial [For biofeedback]. The superficial sternocleidomastoid and anterior scalene muscles were kept relaxed while performing the exercise. The pressure biofeedback device was positioned on the back of the head. First, the air bag under the neck was inflated to 20 mm Hg, and then the subject was asked to press the bag as hard as possible (Nodding movement) and maximum level that the patient could press was noted. This was repeated 3 times and average was taken as deep cervical muscle strength.

Group A subjects were given conventional treatment (CT) with hot pack (for neck) for 15 mins, stretching of muscles (trapezius, levator scapula and pectoralis major), active cervical range of motion exercises, neck isometrics - 10 repetitions with each repetition held for 10 seconds (cervical flexors, extensors, rotators and lateral flexors by resisting the forehead), chin tucks and shoulder shrugs for 10 repetitions. This treatment was given for 4 weeks (3 days per week). For home exercises subjects were asked to take hot packs for 15 min, self stretching of trapezius, levator scapulae and pectoralis major, and chin tucks for postural correction thrice a day.

GROUP B – Patients were given deep cervical flexor (DCF) exercises along with conventional treatment.

Figure 1.Placement of blood pressure cuff (Biofeedback unit)

DCF exercise protocol

Patient was in hook lying position with neck and head in a straight line. Blood pressure cuff was placed under the patient's neck and inflated upto 20 mmHg. Patient was then asked to gently nod the head as if saying 'yes' so that the blood pressure dial measured 2 mmHg above baseline. The patient was asked to hold this position upto 10 sec and then relax. The exercise was progressed by maintaining the blood pressure at 4 mmHg above baseline. Gradually the baseline was increased by 2 mmHg above the previous baseline and the procedure was repeated till the highest level was achieved with correct form.

Statistical analysis

All statistical analysis was done using SPSS Statistics v20.0. Descriptive statistics was used to calculate mean and standard deviation. Data was checked for normality using Shapiro-Wilk test. Comparison of mean values within CT group and DCF group was done using Wilcoxon Signed Rank test. Comparison of mean values in between CT group and DCF group was done using Mann-Whitney U test. The level of significance was set at $p < 0.05$.

RESULTS

In this study, there were total 30 subjects, of which 87 % were women & 13% were men in CT group, whereas; 73% were women & 27% were men in DCF group. Mean age of subjects in CT group was 33.67 ± 12.28 and DCF group was 28.53 ± 7.29. The comparison of mean values of NRS, ROM and DCF strength before and after treatment in CT group evaluated using Wilcoxon Sign rank test was statistically significant ($p \leq 0.05$) (Table 1). Also, the comparison of mean differences of NRS and ROM between CT and DCF group was found to be statistically non significant ($p \geq 0.005$),whereas; DCF strength showed a statistical significance ($p \leq 0.05$)(Table 2).

Table 1: Intra-group comparison (Willcoxon Sign Rank test)

Conventional Group				**DCF Group**		
Outcomes	**Mean**		**P-Value**	**Mean**		**P-Value**
	Pre	**Post**		**Pre**	**Post**	
1) NRS at Rest	2.60 ±0.98	0.26 ±0.737	0.001*	2.60±0.828	0.4±0.594	0.001*
2) NRS on Activity	5.93± 0.799	2.93± 0.704	0.000*	6.53± 0.640	3.2± 0.862	0.000*
3) Neck Strength	28.66 ± 2.795	31.33 ± 3.086	0.001*	30.66 ±3.352	48.71 ± 3.278	0.001*

4) Flexion	1.8 ± 1.612	0.66 ± 1.113	0.002*	2.8 ± 1.521	1.06 ± 1.163	0.001*
5) Extension	16.53 ± 1.767	17.13 ± 1.807	0.041*	17.53 ±2.167	18.6 ± 2.098	0.007*
6) Lateral Rotation(RT)	17.13 ± 2.031	15.93 ± 1.981	0.002*	16.2 ± 2.624	14.53 ±2.232	0.001*
7) Lateral Rotation(LT)	16.93 ±1.944	16 ± 1.964	0.003*	16.06±2.658	14.46 ±2.386	0.001*
8) Side Flexion (RT)	10.4 ± 1.882	9.06 ± 1.710	0.001*	9.2 ± 0.961	7.86 ± 1.302	
9) Side Flexion (LT)	10.46 ± 1.885	9.2 ± 1.699	0.001*	9.2 ± 1.373	7.73 ± 1.033	0.002*

Table 2: Inter-group comparison (Mann Whitney U test)

Outcomes	Conventional group	DCF group	p-value
1) NRS at Rest	2.33 ± 0.842	2.2 ± 0.862	0.640
2)NRS on Activity	3 ± 0.475	3.33 ± 0.617	0.114
3)Neck Strength	2.66± 1.633	18.53 ± 4.033	0.000*
4)Flexion	1.13± 0.834	1.73± 0.884	0.061
5) Extension	0.6±0.986	1.13±1.060	0.112
6) Lateral Rotation(RT)	1.2±0.862	1.66±0.900	0.166
7) Lateral Rotation(LT)	0.93±1.033	1.6±1.121	0.057
8) Side Flexion (RT)	1.33±1.175	1.4±0.828	0.376
9) Side Flexion (LT)	1.26±0.704	1.46±1.060	0.488

DISCUSSION

This study was conducted to determine the effects of conventional therapy (CT) and DCF exercise with CT in patients with chronic neck pain. The results of our study showed that both the groups showed significant improvement in outcomes; NRS, cervical range of motion and neck strength in within group comparison. However, between group comparison revealed significant improvement only in neck strength.

Pain intensity decreased in both the groups significantly. This could be because of mechanisms of pain reduction through exercise. Muscle contractions activates muscle stretch receptors in turn activating afferents from these muscles leading to release of endogenous opioids and beta-endorphins from the pituitary gland. These results in blocking of central and peripheral pain [10]. Neck exercises may allow the downgrading of musculotendinous stretch reflex responses using operant conditioning techniques and multiple practice sessions. This may cause the intrafusal fibers to reset, discontinuing the cycle of muscle tension, impaired circulation with metabolite accumulation and pain associated with myogenic (myofascial) pain [11]

Forward head posture generally seen in neck pain patients results in shortening of cervical extensors and in lengthening and weakening of the cervical flexors. Due to this there is imbalance between the stabilizers on posterior neck region and deep cervical flexors, resulting in mal-alignment and bad posture [15] Deep cervical flexor training as a treatment for neck pain is based on the rationale that DCF have a major postural function in supporting cervical lordosis, since in the functional mid-ranges of cervical spine the lose their endurance capacity in patients with neck pain [12]. Therefore, it is thought that pressure biofeedback specifically targets DCF muscles and decreases neck pain.

Our results are supporting the initial hypothesis, are in agreement with those obtained in a randomized controlled trial conducted by Jull et al [13], to determine the effect of 6 weeks of low-load cranio-cervical flexion exercise on cervicogenic headache patients. The results showed that the treatment significantly reduced the pain associated with neck movements and joint palpation.

Neck muscle strength, assessed using pressure biofeedback showed a significant improvement in both the groups on intra-group comparison.

However, the mean values of neck strength showed greater improvement in the DCF group compared to the conventional group. This is because DCF training with a pressure biofeedback unit improves muscular endurance by facilitating DCF contraction and in flattening of cervical curve [15]Similar results were seen in a study by Dong Yeon Kang et al, which showed DCF training with a pressure biofeedback unit improves muscular endurance by facilitating DCF contraction, and that stretching exercises increases mobility of shortened muscles in subjects with forward head posture. [14]

The experimental group may have shown better results because doing exercises with constant feedback encourages patients doing the exercise to perform it correctly and gets them more involved in the treatment. Pressure biofeedback is a type of knowledge of performance, which is given during and after performance of a task and is related to how the task is performed. Feedback helps in motor learning leading to permanent changes in the capability of responding. Biofeedback techniques are used to augment the patient's sensory feedback mechanisms through precise information about body processes that might otherwise be inaccessible [15]

Inter-group comparison showed statistically significant improvement only in neck strength with the mean values of DCF being greater than conventional. Reason for this could be that both the interventions proved to be equally effective in majority of the outcomes.

On assessing the cervical mobility using cervical ROM, it showed significant improvement in both the conventional and DCF group in all three planes with the DCF group showing more significance especially in sagittal and transverse plane. However, on inter-group comparison there was no significant improvement post-treatment. Similar results were seen by Amr Almaz Abdel-aziem, Amira Hussin Draz in their study which proved that the reduction of neck pain, and improvement of neck stability was associated with improvement in ROM in the three planes of movement especially for the DCF exercises combined with Physical therapy agents group. [16]

There are some limitations of this study. First, the small number of cases recruited. Second, because there was no group consisting of DCF exercise alone, we cannot conclude whether DCF exercise without CT has similar effects on improvement in neck pain and other outcomes. Moreover, future work will be needed to include electromyography studies to record the effect of additional DCF exercise training on muscular activities in those patients with neck pain. Third, the lack of a strictly recorded, dose-specific home-exercise program maintained during the course of treatment.

CONCLUSION

Both conventional and DCF exercises improved pain, cervical range of motion and neck strength post treatment. However, DCF exercises were more effective than conventional in improving DCF strength.

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