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Original Research

Effectiveness of Deep Cervical Flexor (DCF) Exercise on Neck Functional Scores in Helicopter Crew with Mechanical Neck Pain

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ABSTRACT

Background: Mechanical neck pain is defined as neck pain due to biomechanical dysfunction in the neck or upper back. Exercise can reduce muscle tension and strengthen deep cervical flexor (DCF) muscles by helping to relieve pain. The prevalence of neck pain is considered high in helicopter crews compared to the general population.
Aim: To investigate the effectiveness of DCF exercise on neck functional scores (study of helicopter crews with mechanical neck pain).
Material and Methods: Experimental one pre and post-test group design. The samples were 14 squadron-31/serbu helicopter crew performing conventional DCF muscle exercise 12 times for 4 weeks with a frequency of 3 times each week. Neck function was assessed using the Neck Outcome Score (NOOS) which consists of domains of mobility, stiffness, symptoms, sleep disturbances, everyday activity and pain, participating in everyday life, and quality of life.
Results: This study showed that the mean NOOS score before intervention was 30.64 (SD: 9.44) and the mean NOOS score after intervention was 8.57 (SD: 5.33). There was a significant difference in the NOOS score before and after deep cervical flexor exercise ($p = 0.001$).
Conclusion: DCF exercises are effective for improving neck functionality in helicopter crew with mechanical neck pain.

Keywords: *deep cervical flexor exercise, mechanical neck pain.*

Introduction

Mechanical neck pain is defined as neck pain resulting from biomechanical dysfunction in the neck or upper back, or originating in joints, muscles, ligaments, discs, or other soft tissues in the neck or upper back.[1] Flight-related neck pain is common among military helicopter pilots and crew members. The 3-month prevalence of neck pain among helicopter pilots was 57% with approximately 30% of the cohort reporting recurrent pain episodes. With a lifetime prevalence of 81% for pilots and 84% for helicopter crew members, the prevalence of neck pain was considered high in this occupational group compared to the general population.[2] Neck pain can be assessed using a variety of different standard results, and the NOOS (Neck Outcome Score) is a widely used, researched and validated instrument for assessing disability in patients with neck pain causing neck functional impairment.[3,4]

Studies on cervical disorders show that weakness of the deep cervical flexor muscles (longus capitis, superior longus colli, and anterior rectus capitis) is the cause or plays a role in the pathogenesis of mechanical neck pain.[5] In theory, when muscle performance is impaired, the balance between stabilizers on the posterior neck and deep cervical flexor will be disrupted and causes poor posture and alignment and impact on cervical disorders.[6]

Patients with neck pain disorders have reduced neuromotor activity and endurance of the deep cervical flexor muscles (e.g. the longus capitis and colli muscles) as identified by the craniocervical flexion test, which is a clinically test the anatomical action of these muscles.[7] Deep cervical flexor exercise is recommended for increasing the endurance of these postural muscles, leading to improvement in neck pain.[8] Muscles in contracting and producing tension require an exertion or strength. Muscle strength, apart from being influenced by age and sex, is also influenced by several factors such as biomechanical, neuromuscular, metabolic and psychological factors.[9] Rio et al. reported that isometric contractions showed greater pain reduction in terms of immediate analgesic effect and without a decrease in muscle performance.[10]

There has been no previous study about the effect of conventional DCF training on helicopter crews with mechanical neck pain in Indonesia. Therefore, the purpose of this study is to determine the effect of conventional deep cervical flexor training on neck functional scores (study of helicopter crews with mechanical neck pain).

Material and Methods

This study was a quasi-experimental design with a single-group pre and post-test, which is an experimental study carried out in one group only called the experimental group without any comparison or control group.[11]

This study was conducted at Squadron-31 / *Serbu* of the Semarang Army Aviation Center from December 2019 to January 2020. Sampling was carried out using a purposive sampling method. Inclusion criteria included being 30 to 40 years of age; males; working as pilots and helicopter crews with 2-4 hours of flight hours per day; subjects with mechanical neck pain; subjects with chronic pain with an onset of more than 3 months; VAS (Visual Analog Scales) scores 3-5; and willing to participate. Exclusion criteria for subjects were history of cervical vertebral fracture, muscle and ligament injury in the neck area for less than 4 weeks; subjects with cervical scoliosis; open wounds in the neck area; cervical tumors; cervical HNP; history of stroke; use of NVG (Night Vision Googles); history of pain on the shoulders, thoracic vertebrae and lower back in the last 6 months, the use of a collar neck, and a history of physical and mental fatigue when coming home from work. The drop-out criteria were subjects who did not attend the exercise for a maximum of three times, receiving medication or other conservative therapy while the study was ongoing, and not adhering to study procedures.

Helicopter crew on Squadron-31 with 2-4 hours of flight hours per day, and with flight-related neck pain, caused monotonous and uncomfortable sitting postures during flight, exposure to high amplitude low-frequency vibrations, and prolonged contractions of the muscles neck due to wearing a flight helmet. The total research subjects were 15 helicopter crews who met the research criteria and were willing to take part in the research by signing the informed consent after receiving complete explanation and information about the research and the process to be undertaken. Subjects were given conventional deep cervical flexor exercises 12 times for 4 weeks with a frequency of 3 times per week. The conventional DCF training protocol is that the subject is in a supine position with the cervical spine in a neutral position, and then the patient is instructed to flatten the neck curve with a nod of the head. This position is then held for 10 seconds and repeated 10 times. Researchers monitored the sternocleidomastoid muscles to ensure minimal or no activation of these muscles during DCF muscle contraction. Neck function was assessed using NOOS which consisted of the domains of mobility, stiffness, symptoms, sleep disturbance, every day activity and pain, participating in everyday life, and quality of life. Early before treatment and at the end of the 4th week of treatment, evaluation of the functional score of the neck was carried out by filling in the NOOS questionnaire.

The data normality test was evaluated using the Shapiro Wilk test. The pre and post NOOS domain data analysis used the Wilcoxon test, and the symptom domain data analysis used the paired t test. The pre and post total NOOS score hypothesis test used the Wilcoxon test. All of the data were computerized and processed using SPSS® software. The p value <0.05 is a significant value.

Results

The number of subjects analyzed at the end of this study were 14 people. There was 1 subject who dropped out because he did not participate in the exercise more than 3 times in a row. There were no recorded side effects during or after conventional DCF exercise either as reported by the study subjects or those discovered at the time of examination by the investigators.

The characteristics of the subjects in the study are described in Table 1. The age in this study ranged from 31-38 years with a mean age of 34 ± 2.15 years.

Variabel	n	%	Mean ± SD	Median (min – max)
Gender				
Male	14	100		
Age			34,00 ± 2,15	31 – 38
Qualification				
Mechanics	9	64,3		
Avionics	1	7,1		
Pilots	4	28,6		
Weight (kg)			66,75 ± 4,30	65,5 (61 - 75)
Height (cm)			175,92 ± 3,82	175 (172 – 184)
BMI (kg/m^2)			21,55 ± 0,73 *(normoweight)*	21,5 (20,57 – 22,72)
Flight hours (hour)			13,21 ± 2,33	13 (10 – 18)

Working periode (year)	9,75 + 1,86	9,5 (7-13)

Table 1. Characteristics of the participants

BMI : Body Mass Index

The research subjects' neck functional score were assessed using the NOOS, which was carried out at the beginning and at the end of the study. The results of the NOOS score research before and after the intervention are presented in table 2. The Shapiro Wilk test was used to test the normality before and after the intervention

Table 2. Comparasion of NOOS domains between pre and post intervention

Variabel	Pre	Post	P
Mobility	4,14 ± 3,21	0,57 ± 0,94	0,002‡*
Stiffness	2,07 ± 0,92	0,57 ± 0,65	0,001‡*
Symptoms	7,21 ± 2,16	3,36 ± 1,34	<0,001§*
Sleep disturbance	4,29 ± 1,20	1,00 ± 1,24	0,001‡*
Everyday activity and pain	7,07 ± 2,20	2,07 ± 2,20	0,001‡*
Participating in everyday life	4,14 ± 2,85	0,71 ± 1,33	0,001‡*
Quality of Life	2,00 ± 2,11	0,29 ± 0,61	0,007‡*
NOOS total score	30,64 ± 9,44	8,57 ± 5,33	0,001‡*

* Significant (p < 0,05); ‡ Wilcoxon; § Paired t test

The normality of the data on the domain scores of mobility, stiffness, symptoms, sleep disturbances, everyday activity and pain, participating in everyday life, quality of life, and the total NOOS score tested by the Shapiro Wilk test showed abnormal data distribution. Thus, the analysis was continued with the Wilcoxon test. The normality of the symptom domain score, tested using the Shapiro Wilk test, shows a normal distribution of data. Therefore, it was analyzed using paired t test. Table 2 shows that the domain scores of mobility, stiffness, symptoms, sleep disturbances, everyday activity and pain, participating in everyday life, and quality of life at the end of the study compared to the beginning of the study tested using the Wilcoxon test showed significant differences. Symptom domain scores at the beginning and at the end of the study which were tested using the paired t test showed significant differences. In this study, there was a significant difference in the total NOOS score before DCF training compared to after DCF training (p 0.001).

Discussion

The NOOS is a widely used, researched and validated instrument for assessing disability in patients with neck pain that causes neck function to be impaired. Based on the NOOS scoring protocol, Jull made a guideline for score interpretation that the lower the score, the less disability is acquired.[3,4]

In this study the change in the mean neck functional score of the beginning of the study was significantly different from the end of the study. Kim et al. reported that DCF exercise can reduce neck pain and improve neck function in chronic neck pain patients with various occupations.[12] Iqbal et al. reported that there was a significant change in neck functional scores in both the DCF exercise group with pressure biofeedback and the conventional exercise group. Iqbal et al. recommended that neck functional scores be used at baseline and every 2 weeks thereafter to measure treatment progress.[8]

Flight-related neck pain is common among pilots and crew members of military helicopters. Flight-related neck pain can be caused by a variety of reasons and no clear pathological mechanism has been identified. However, a number of factors have been hypothesized to be contributing factors, such as a monotonous and uncomfortable sitting posture during flight, exposure to high amplitude low-frequency vibrations, individual physiological and biological characteristics, and prolonged contraction of the neck muscles due to prolonged flight helmet wear. The weight of a flight helmet can increase the biomechanical stress on the cervical spine, especially during an uncomfortable head position. Murray et al. demonstrated pronounced weakness and fatigue in the inner neck muscles of helicopter pilots consistent with patients with chronic neck pain. Overloading of the cervical muscles may be potential to cause changes in neuromuscular function and subsequently cause neck pain.[2]

DCF exercises are exercise to strengthen the DCF muscles. DCF exercises can directly activate the DCF muscular system, which has a relatively high muscle coil density. Cervical kinesthetic improvement following DCF exercise may also account for the high improvement in neck stability in the study group. Furthermore, the forward head position in subjects with chronic headache has been associated with compression loads on the cervical tissue. Thus, the improvement in cervical posture created through DCF exercise may have long-term benefits in reducing recurrent episodes of neck pain.[13]

In this study, no side effects were recorded during or after the intervention either reported by the study subjects or found at the time of examination by the investigators, such as increased pain after exercise, headache, and stiffness in the neck. This is in accordance with the research of Kim et al who also showed that giving deep cervical flexor exercise did not cause any side effects and was proven to be safe to do. The increase in DCF endurance obtained from DCF exercise can be a basis for consideration in choosing this program as an exercise to improve neck function in helicopter crews which are assessed using the NOOS.

Limitations in this study include no control group, limited sample size, no complete data recording of the daily activities of each helicopter crew subject when not carrying out flight duties.

Conclusion

Deep cervical flexor exercise was effective in improving neck function in helicopter crews with mechanical neck pain as assessed by the Neck Outcome Score. In future research, it is necessary to make comparisons with the control group, a larger number of samples and long-term evaluation to determine the extent of the effectiveness of this DCF exercise on the subject.

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