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Effects of Active and Passive Intervention Programs Applied to Patients' Necks on Their Muscular Strength, Muscular Endurance, and Joint Range of Motion

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Abstract. [Purpose] The purpose of this study was to conduct a passive intervention program and an active intervention program for healthy subjects for six weeks, and analyze and compare their effects on the neck's muscular strength and endurance and the joint range of motion (ROM). [Subjects] This study selected 28 undergraduates as subjects and allocated them randomly and equally to either the passive intervention program group (PIPG) or the active intervention program group (AIPG). [Methods] The cranio-cervical flexion test (CCFT) was modified to measure the deep neck flexor (DNF)'s strength and endurance, and the cervical range of motion (CROM) was measured to compare and analyze flexion, extension, right lateral flexion (RLF), left lateral flexion (LLF), right rotation (RR), and left rotation (LR) of the neck. [Results] Both the PIPG and the AIPG showed significant improvements in the measured items post-intervention. In a comparison of the two groups, strength, endurance, flexion, and extension in the AIPG were significantly better than their respective values in PIPG. [Conclusion] In treating deep neck flexors, an active intervention program is more effective than a passive intervention program at improving muscular strength, muscular endurance, and joint ROM.
Key words: Passive intervention, Active intervention, Deep neck flexor

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INTRODUCTION

For strengthening weakened deep cervical muscles, isometric exercise, an active intervention, improved mobility by increasing joint ROM as well as muscular functions[1)], and an active intervention program that combined different interventions applied to the neck enhanced muscular strength and endurance[2)]. Joint mobilization techniques, a passive intervention, have been reported to result in improvd of muscular strength and endurance and joint ROM[3)], and there was a report that a passive intervention program that combined several methods was effective at the neck's muscular strength and joint ROM[4)]. In addition, a combined program that mixed joint mobilization techniques, a passive intervention, with exercise, an active intervention, was also effective at enhancing the neck's muscular strength and joint ROM[5)].

This study searched for find an appropriate program that patients can effectively perform by themselves at home by comparing and analyzing a passive intervention program, which needs professional assistance, together with massage and joint mobilization, and an active intervention program, which patients can perform by themselves, together with isometric stabilization and self-stretching exercises. To accomplish this, we compared and analyzed the effects of a passive intervention program and an active intervention program, performed for 6 weeks by healty subjects, on their muscular strength and endurance and joint ROM.

SUBJECTS AND METHODS

This study selected 28 undergraduates attending G College in Gyeong Sang Buk-do and allocated them randomly and equally to a passive intervention program group (PIPG, male:7 and female:7) and an active intervention program group (AIPG, male:7 and female:7). Those who had problems with muscles or the skeletal and nervous systems, or felt pain during neck mobilization, or whose ROM was restricted due to burns or postoperative scars were excluded. This study's purpose and its experimental procedure as a whole were sufficiently explained to the subjects and their voluntary consent was obtained. The mean age, height, and weight of AIPG were 24.71 ± 3.60 years, 169.00 ± 8.52 cm, and 67.14 ± 12.59 kg, respectively, and the mean age, height, and weight of AIPG were 24.00 ± 4.18 years old, 167.07 ± 7.47 cm, and 64.50 ± 12.91 kg, respectively. Analysis of

gender was made with the chi-square test, and age, height, and weight were analyzed using the independent t-test. There were no statistically significant differences between the two groups in the above items ($p>0.05$); and therefore, the two groups were considered homogeneous.

Neck joint mobilization techniques and neck massage were performed on the 14 subjects of the PIPG and the 14 subjects of AIPG performed neck stabilization and self-stretching exercises. Massage, mobilization techniques, self-stretching exercises, and stabilization exercises were performed 20 minutes, 10 minutes, 15 minutes, and 30 minutes each time, respectively. They were conducted three times per week for a total of 4 weeks. Modified Kaltenborn's joint mobilization techniques were performed on PIPG for 10 minutes three times per week for 4 weeks[6]. This study applied grade III gliding in order to improve joint mobility. The glides were conducted for 7 seconds about 10 times after rest intervals of two to three seconds between each glides. Gliding exercise was always used simultaneously with traction grade I in order to eliminate normal muscular compression (Fig. 1). For the massage, Swedish and clinical massage techniques were performed for 20 minutes on the cervical and upper thoracic areas (Fig. 2)[7]. The mobilization was performed by one therapist whose clinical career was longer than ten years and the massage was performed by one therapist whose clinical career was longer than eight years. For the neck stabilization exercise performed by AIPG, deep neck muscle isometric exercise was performed with the subjects in a standing position and in a prone position and the exercise with the subjects in a standing position was based on the recommendation of Wright et al.[8] For this exercise, the subject leaned against the wall in a standing position and supported a 5-mm thin book with the head, drew the chin forward, and pressed the wall with the whole head so that the book did not fall off. At this time, the subject did not use the surface muscles of the neck. Avoiding use of the surface muscles of the neck, each subject exercised for 5 minutes three times using individually adjusted book thicknesses, and increasing the thickness of the book. For the exercise in the prone position, the subject lay on a bed in the prone position with the shoulders on thr bed, but with the head and head and neck not on the bed. The therapist raised the subject's head and neck in a passive way and gradually removed support. At this time, the subject used only deep neck muscles without using the surface muscles on the back of the neck so as to support the weight of the head and neck. This exercise was performed for five minutes three times. The self-stretching exercise was conducted for 15 minutes for the upper trapezius, suboccipitalis and back of the neck, levator scapulae, scalene, and sternocleidomastoid muscles[9]. Each exercise was repeated twice for 30 seconds and done slowly at normal breathing rhythm and with no compensations allowed.

Deep neck flexors (DNF)'s strength and endurance were measured by modifying the cranio-cervical flexion test (CCFT). Strength was defined as length time over which maximum voluntary contractile strength (MVCS) could be maintained, a maximum pressure that can be applied from a base pressure, and endurance was defined as the length of time for which a pressure halfway between base pressure and MVCS could be maintained. For the modified CCFT, a pressure biofeedback unit (PBU, Chattanooga Group, Australia) was used and the test was conducted by three examiners. The PBU was placed on the back of the neck of subjects who were in the supine position, 80 mmHg was set as the base pressure, and the subjects were instructed to draw the chin forward and push the head downward. Examiner 1, one of the three examiners, watched the pressure gauge and Examiner 2 observed the subject maintain static muscular contraction of the cervical spine region. At this time, the subject's chin was not held upward and the sternocleidomastoid muscles (SCMs) were stimulated with the index and middle fingers and the contraction of SCMs was checked. Examiner 3 measured the time with a stop watch. The measurements of strength and endurance were was made until the subject's chin was lifted, SCM became overly contracted, or the change reported by the pressure gauge was $\geq$2 mmHg.

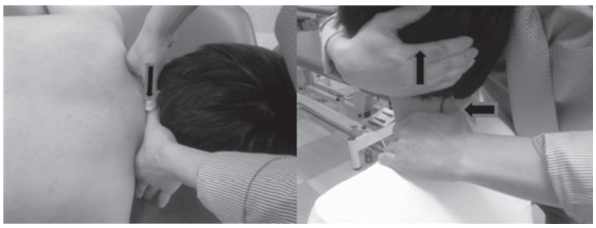

Fig. 1. Modified Kaltenborn's joint mobilization techniques

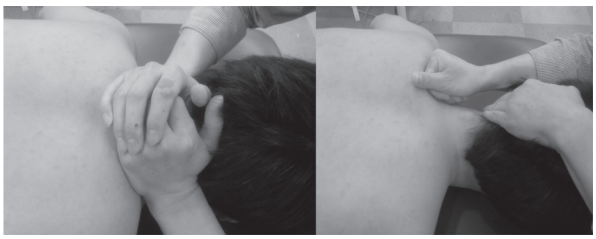

Fig. 2. Swedish and clinical massage techniques

In order to measure cervical ROM, the subject was seated on a chair in a neutral posture with the trunk and the shoulders fixed. Flexion, extension, right lateral flexion (RLF), left lateral flexion (LLF), right rotation (RR), and left rotation (LR) were measured[10, 11].

The experimental results were statistically analyzed using SPSS 12.0 KO (SPSS, Chicago, IL, USA). After the general characteristics of the subjects were determined, the paired t-test was used to compare the changes in strength, endurance, flexion, extension, End, Fle, Exe, RLF, LLF, RR, and LR between pre- and post-intervenson in each group. The differences between the 2 groups were tested using the independent t-test. The statistical significance level, α, was set at 0.05.

Table 1. Comparison of strength, endurance, flexion, extension, RLF, LLF, RR, LR between Pre- and post-intervention in each group (mean ± SD)

(unit: St, End-mm Hg, ROM-degree)

Category		Pre-intervention	post-intervention
PIPG	St*	52.1 ± 1.9	85.8 ± 2.2
	End*	91.9 ± 2.9	129.5 ± 2.3
	Fle*	47.1 ± 7.5	55.7 ± 9.3
	Exe*	69.2 ± 10.8	74.7 ± 8.3
	RLF*	32.1 ± 7.5	45.5 ± 9.4
	LLF*	35.0 ± 6.2	46.4 ± 8.1
	RR*	56.4 ± 11.6	68.0 ± 8.3
	LR*	60.7 ± 11.2	70.0 ± 8.4
AIPG	St*	54.9 ± 5.4	120.2 ± 1.9
	End*	95.8 ± 2.2	179.8 ± 2.2
	Fle*	44.4 ± 9.3	61.4 ± 9.2
	Exe*	61.3 ± 13.3	76.5 ± 9.4
	RLF*	26.2 ± 10.7	39.2 ± 7.8
	LLF*	33.1 ± 12.0	44.4 ± 7.2
	RR*	53.7 ± 11.6	70.2 ± 11.5
	LR*	53.3 ± 9.1	70.6 ± 9.6

* p<0.05, PIPG: passive intervention program group, AIPG: active intervention program group. RLF, right lateral flexion; LLF, left lateral flexion; RR, right rotation; LR, left rotation.

Table 2. Comparison of shoulder abduction ROM between PIPG and AIPG group(mean ± SD) (unit: degree)

Category		PIPG	AIPG
Pre-intervention	St	52.1 ± 1.9	54.9 ± 5.4
	End*	91.9 ± 2.9	95.8 ± 2.2
	Fle	47.1 ± 7.5	44.4 ± 9.3
	Exe	69.2 ± 10.8	61.3 ± 13.3
	RLF	32.1 ± 7.5	26.2 ± 10.7
	LLF	35.0 ± 6.2	33.1 ± 12.0
	RR	56.4 ± 11.6	53.7 ± 11.6
	LR	60.7 ± 11.2	53.3 ± 9.1
post-intervention	St*	85.8 ± 2.2	120.2 ± 1.9
	End*	129.5 ± 2.3	179.8 ± 2.2
	Fle	55.7 ± 9.3	61.4 ± 9.2
	Exe	74.7 ± 8.3	76.5 ± 9.4
	RLF	45.5 ± 9.4	39.2 ± 7.8
	LLF	46.4 ± 8.1	44.4 ± 7.2
	RR	68.0 ± 8.3	70.2 ± 11.5
	LR	70.0 ± 8.4	70.6 ± 9.6
Change between pre- and post-intervention	St*	33.7 ± 2.5	65.3 ± 4.9
	End*	37.5 ± 2.6	84.0 ± 0.0
	Fle*	8.5 ± 5.3	17.0 ± 11.7
	Exe*	5.5 ± 6.7	15.1 ± 13.6
	RLF	13.4 ± 10.1	13.0 ± 10.1
	LLF	11.4 ± 7.1	12.2 ± 9.8
	RR	11.6 ± 11.8	16.5 ± 10.3
	LR	9.3 ± 10.5	11.2 ± 11.7

* p<0.05 St, Strength; End, Endurance; Fle, Flexion; Ext, Extension

RESULTS

Strength, endurance, flexion, extension, RLF, LLF, RR, and LR were compared between pre-and post-intervention and each item in both groups showed a statistically significant improvement (Table 1). Strength, endurance, flexion, extension, RLF, LLF, RR, and LR were compared between groups pre-and post-intervention as well as their post-inervention changes. None of items, except Endurance, were significantly different prior to the intervention, and none of the items, other than strength, endurance, were significantaly different post-intervention. Only the post-intervention changes changes of strength, endurance, flexion and extension showed statistically significant differentces (Table 2).

DISCUSSION

According to a head-neck flexion test, weakened deep neck flexors may lead to initial activation of sternocleidomastoid muscles, which are surface muscles, movement of the chin and the head, excessive extension of the upper neck area, and pressure on the cervical facet joints, causing headache and pain[12]. To find a method for treating weakened deep neck flexors, we performed joint mobilization techniques and massages(PIPG) and conducted deep neck isometric stabilization exercises and self-stretching exercises (AIPG).

Jari et al. divided 180 females into a muscle strengthening exercise group, a muscle endurance exercise group, and a control group and conducted the exercises for 12 months. The muscle strengthening exercise group's flexion, rotation, and extension increased by 110 percent, 76 percent, and 69 percent, respectively, and the muscle endurance exercise group's flexion, rotation, and extension rose by 28 percent, 29 percent, and 16 percent, respectively, while the flexion, rotation, extension of the control group which performed only aerobic exercise increased only by 10 percent, 10 percent, and 7 percent, respectively. The joint ROMs of the muscle strengthening exercise group and the muscle endurance exercise group were significantly different from that of the control group's. In particular, the muscle strengthening group showed significant changes in their lateral flexion, flexion, and extension[13]. Another study performed an experiment with 200 patients suffering from headache. The subjects were allocated to a joint mobilization technique group, a neck exercise group, a joint mobilization technique and neck exercise combined group, and a control group. The joint mobilization technique group showed no significant differences while the muscular strength and mobility of the neck exercise group and the joint mobilization technique and neck exercise combined group increased[14]. Another study divided 191 patients with neck pain into three groups, a neck exercise group, a joint mobilization technique group, and a neck exercise and joint mobilization technique combined group, and conducted exercise for 11 weeks. All the three groups showed improvements in muscular strength, muscu-

lar endurance, and joint ROM. In particular, the improvement of the active neck exercise group was significantly greater joint mobilization technique group and the improvement of the neck exercise and joint mobilization technique combined group's improvement in muscular strength, muscular endurance, and joint ROM was significantly the greatest.[3] In this study, we divided subjects into an active intervention program group and a passive intervention program group and both groups' muscular strength, muscular endurance, and joint ROM increased significantly. In particular, according to a comparison of differences between pre-and post-intervention, the active intervention method produced significantly greater increases in muscular strength, muscular endurance, and joint ROM than the passive intervention method. This is an outcome similar to that of prior studies and we consider that weak deep muscles of the longus colli and longus capitis muscles were strengthened by the deep stabilization exercise, enhancing their strength and endurance, resulting in improved neck functions and mobility. Our result suggests that an active intervention program alone may achieve the same level of increase in joint ROM as a passive intervention program, and that it is more effective than the passive intervention program at enhancing muscle strength and endurance. In particular, we except that implementing the active intervention program for patients who require neck mobility and stability will save time and costs. Further research is necessary in order to develop active intervention programs that patients can perform by themselves.

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