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Review Article

Effect of Exercise Intervention on Craniovertebral Angle and Neck Pain in Individuals With Forward Head Posture in South Korea: Literature Review

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Forward head posture (FHP) is a musculoskeletal disorder that causes neck pain. Several exercise interventions have been used in South Korea to improve craniovertebral angle (CVA) and relieve neck pain. There has been no domestic literature review study over the past 5 years that has investigated trends and effects of exercise intervention methods for CVA with neck pain. This domestic literature review aimed to evaluate the trends and effects of exercise interventions on CVA and neck pain in persons with FHP. A review of domestic literature published in Korean or English language between 2018 and 2022 was performed. Literature search was conducted on Google Scholar and Korea Citation Index by using the following keywords: "exercise," "exercise therapy," "exercise program," "forward head posture," and "neck pain." Ten studies were included in this review. All of the studies showed positive improvements after intervention programs that included exercises. Notably, four of these studies demonstrated significant differences in results between the experimental and control groups. Among the 10 studies, nine measured visual analogue scale or numerical rating scale scores and reported significant reductions in pain following interventions, including exercise programs. Five of these studies showed significant differences in results between the experimental and control groups. Furthermore, six studies that used neck disability index exhibited a significant decrease in symptoms after implementing intervention programs that included exercise, and significant differences in results were found between the experimental and control groups. This domestic literature review provides consistent evidence to support the application of various exercise intervention programs to improve CVA and relieve neck pain from FHP. Further studies are warranted to review the effects of various exercise interventions on FHP reported not only in domestic but also in international literature.

INTRODUCTION

Approximately 30%–50% of workers experience neck pain due to musculoskeletal disorders annually [1]. Forward head posture (FHP) is one of the most common musculoskeletal disorders owing to the social and environmental characteristics of modern society and long sedentary working posture [2,3]. Similar to many other countries, FHP is a major health issue, and its incidence continues to increase in South Korea [4,5].

FHP is an abnormal posture in which the head is forwarded excessively, causing damage, tissue imbalance around the neck, structural changes, and neck pain [6]. FHP evaluation is often based on the craniovertebral angle (CVA) between the horizontal line passing through the spinous process of C7 and the line connecting the tragus of the ear to the spinous process of C7 [7]. As CVA decreases, neck pain increases, leading to chronic pain that causes physical changes and dysfunction, such as increased muscle activity, fatigue of the superficial neck muscles, limited cervical range of motion, decreased proprioception, and impaired neuromuscular control [8-10]. In turn, FHP occurs due to complex problems, and the research for effective treatment methods for FHP is still ongoing [11].

Among the various intervention methods used to relieve alignment and neck pain in patients with FHP, exercise treatments, such as neck stabilization, stretching, sling, and McKenzie exercises, are widely used in clinical practice [12-14]. Additionally, various exercise treatments and programs have been implemented in South Korea and validated for their ef-

fectiveness [11,15].

Identifying exercise intervention methods for FHP accompanied by neck pain may improve our understanding of FHP and help with its treatment. However, to my knowledge, there has been no review study in the domestic literature over the past 5 years that has confirmed trends and effects of exercise intervention methods for FHP with neck pain. Therefore, the objective of this domestic literature review was to determine trends of exercise intervention methods and their effects on CVA and neck pain in persons with FHP over the past 5 years to help understand and address related issues.

MATERIALS AND METHODS

Literature published in South Korea between 2018 and 2022 was searched using Google Scholar and Korea Citation Index. The following keywords were used for the search: "exercise," "exercise therapy," "exercise program," "intervention," and "forward head posture." The inclusion criteria were as follows: (1) experimental studies on exercise intervention in persons with FHP and neck pain; (2) studies that used the CVA as a variable; (3) studies reporting data on neck pain (e.g., scores of visual analogue scale [VAS], numerical rating scale [NRS], and neck disability index [NDI]); (4) randomized controlled trials (RCTs) presenting comparison groups; and (5) full-text studies published in Korean or English language.

RESULTS

Of the 68 studies searched in electronic databases, 10 RCTs were selected and analyzed. The 10 studies included in this review are summarized in Table 1. A total of 271 persons were included in the review, with an average of 31.1 persons per study. The highest number of persons in the analyzed studies was 40 [16], whereas the lowest number was 17 [17]. All interventions were conducted three times per week, and the duration of the interventions ranged from 2 to 8 weeks. All studies measured the CVA using photogrammetry, goniometry, or radiography. Nine studies measured neck pain intensity using the VAS or NRS, and six studies measured neck disability with pain using the NDI.

The criteria used to classify persons with FHP varied among the eligible studies. One study used a CVA between 31° and 59° [16], and other two studies used a CVA < 53° [18,19]. Kang and Kim [20] included participants with the centerline of external auditory meatus deviated from the centerline of acromion > 2.5 cm and CVA < 53°. Two studies used a CVA ≤ 52° [21,22], and other two studies used a CVA < 50° [17] and a CVA ≤ 50° [23], respectively. One study used Cobb's angle ≤ 35° [24], and other one study showed no clear inclusion criteria to examine FHP [25]. In addition, the criteria used for participants with neck pain varied among the studies. Two studies used a VAS score ≥ 4 [19,20]; other one study, an NDI score ≥ 15 [24]; other two studies, a VAS score ≥ 3 [18,22]; and other one study, a VAS score between 2 and 5 [23]. Four studies showed no clear inclusion criteria to examine the intensity of neck pain [16,17,21,25].

With regard to the treatment of FHP and neck pain, Kang and Kim [20] evaluated the effects of an exercise program that included scapular stabilization and thoracic extension exercises in comparison with an exercise program that included cervical self-myofascial release and stretching exercises. After the intervention, significant differences were found in CVA, VAS, and NDI scores in the experimental group, and a significant difference was observed in NDI scores between the experimental and control groups. Park et al. [24] investigated the effects of an intervention program that combined a corrective exercise program with transfer electrode capacitive and resistive therapy in comparison with the outcomes of a corrective exercise program alone. Significant differences were observed in CVA, VAS, and NDI scores in the experimental group after the intervention, and when compared with the control group, significant improvements were observed only in VAS and NDI scores.

Hyun and Choi [17] assessed the effects of an exercise program that combined cervical stabilization and stretching exercises. Significant differences were observed in CVA, NDI, and NRS scores in the experimental group after the intervention, and when compared with the control group, significant differences were also observed in all scores. Kim and Kang [19] investigated the effects of a combined exercise program that included cervical stabilization and stretching exercises in comparison with the effects of a program that included cervical self-myofascial release and stretching exercises. The results showed significant differences in CVA and VAS scores in the experimental group after the intervention and also showed significant differences in CVA and VAS scores between the experimental and control groups. Nam et al. [21] investigated

Table 1. Characteristics of studies selected

Study (y)	Study design	Subjects characteristic	Intervention description	Outcome variable	Main outcome
Kim and Kang [19]	Two-group pretest-posttest design, RCT	32 office workers between 20s and 60s with FHP (CVA < 53°) and neck pain (VAS ≥ 4) Study group (n = 16) Control group (n = 16)	Study group: Cervical stabilization exercise and stretching exercise. Control group: Cervical self-myofascial release exercise and stretching exercise. Both groups performed exercises for 40 min/d, 3 times/wk for 6 weeks.	CVA, VAS, NDI, CROM, respiratory pressure and function	The intra-group comparison showed significant differences in VAS and NDI of both groups post-intervention. CVA was significantly improved post-intervention in the study group only. The inter-group comparison showed significant differences in NDI.
Kang and Kim [20]	Prospective, RCT, two-group pretest-posttest design	32 school teachers with FHP and neck pain (CVA < 53°, VAS ≥ 4) Study group (n = 16) Control group (n = 16)	Study group: Scapular stabilization exercise and thoracic extension exercise. Control group: Cervical self-myofascial release exercise and stretching exercise. Both groups performed exercises for 40 min/d, 3 times/wk for 6 weeks.	VAS, NDI, CVA, CROM, respiratory pressure, pulmonary functions	The intra-group comparisons showed that VAS in both groups were significantly different after the intervention. The change in CVA was significant only in the study group. The inter-group comparisons showed a significant difference in VAS, and CVA.
Park et al. [24]	Two-group pretest-posttest design, RCT	30 patients in 20s and 30s with FHP and neck pain (Cobb's angle ≤ 35°, NDI ≥ 15) Study group (n = 15) Control group (n = 15)	Study group: Corrective exercises and TECAR therapy. Control group: Only corrective exercise. Both groups performed intervention for 40 min/d, 3 times/wk for 2 weeks.	CVA, NDI, VAS, pressure pain threshold	Both groups showed significant differences in CVA, NDI, and VAS. The study group significantly improved compared to the control group in NDI, and VAS, except CVA.
Hyun and Choi [17]	Pretest-posttest control group design, RCT	17 female adults under 45 with neck pain and FHP (CVA < 50°) Exercise group (n = 9) Control group (n = 8)	Exercise group: Cervical stabilization exercise and active stretching exercise were conducted 10 min/d, 3 times/wk for 4 weeks. The control group did not participate in the exercise program.	CVA, CROM, NDI, NRS	There were significant differences between groups after the intervention in CVA, NDI, and NRS. The intra-group comparison showed significant differences in CVA, NDI, and NRS in the exercise group only.
Nam et al. [21]	Three-group pretest-posttest design, RCT	30 college students in 20s with neck pain and FHP (CVA ≤ 52°) Group I (n = 10) Group II (n = 10) Group III (n = 10)	Group I: General physical therapy. Group II: General physical therapy and self-stretching. Group III: General physical therapy and joint mobilization. All groups participated in intervention 3 times/wk for 4 weeks.	VAS, CVA, autonomic system function	In Group II, VAS and CVA showed significant changes. In comparison between Group I and II was a difference in VAS and CVA. In comparison between Group II and III was a difference in VAS.
Kim and Park [23]	Three-group pretest-posttest design, RCT	30 college students in 20s with FHP and neck pain (CVA ≤ 50°, 2 ≤ VAS ≤ 5) Group I (n = 10) Group II (n = 10) Group III (n = 10)	Group I: Horseback riding simulator exercise. Group II: Sling exercise. Group III: Kendall exercise. All groups performed 3 times/wk for 6 weeks.	CVA, VAS	Neck pain was reduced significantly after intervention in all three groups. CVA in all groups increased significantly after intervention.
Song et al. [16]	Two-group pretest-posttest design, RCT	40 adults in 30s and 40s with FHP (31°≤ CVA ≤ 59°) and neck pain Group I (n = 20) Group II (n = 20)	Group I: Neck stabilization exercise. Group II: PNF neck flexion and extension pattern exercise. Each group conducted 30 min/d, 3 times/wk for 4 weeks.	CVA, KNDI, anterior limit of stability, posterior limit of stability	There were significant effects in CVA and KNDI of both groups post-intervention. There was a significant difference in KNDI in Group I compared to Group II.

Table 1. Continued

Study (y)	Study design	Subjects characteristic	Intervention description	Outcome variable	Main outcome
Kim and Kang [22]	Two-group pretest-posttest design, RCT	26 patients in 40s with FHP and neck pain (CVA ≤ 52°, VAS ≥ 3) Study group (n = 13) Control group (n = 13)	Study group: PNF cervical stabilization exercise. Control group: Traditional physical therapy. Each group participated in the intervention 3 times/wk for 6 weeks.	VAS, CVA, KNDI	Both groups showed significant differences in VAS, KNDI, and CVA. The study group showed more significant improvements in pain, CVA, and KNDI than those of the control group.
Seo et al. [25]	Pretest-posttest control group design, RCT	28 adults in 20s with FHP and neck pain Exercise group (n = 14) Control group (n = 14)	Only the exercise group participated in the exercise program including 8 types of self-stretching and performed 3 times/wk for 8 weeks.	CVA, CRA, VAS, neck tilt angle, neck load	After 8 weeks of intervention, there was a significant improvement in CVA and VAS in the exercise group.
Park and Jung [18]	Two-group pretest-posttest design, RCT	34 subjects in 30s with neck pain and FHP (VAS ≥ 3, CVA < 53°) Study group (n = 17) Control group (n = 17)	Study group: Exercise program (Thoracic extension and Lower trapezius strengthening exercises) and Dynamic taping. Control group: Exercise program only. The program was conducted for 55 min/d, 3 times/wk for 4 weeks.	CVA, CRA, VAS, NDI, SF-12, HIT-6, upper trapezius muscle tone	Both groups showed significant differences before and after the intervention in VAS, NDI, and CVA. Moreover, a significant difference in NDI was observed between the two groups.

RCT, randomized controlled trial; FHP, forward head posture; CVA, craniovertebral angle; VAS, visual analogue scale; NDI, neck disability index; CROM, cervical range of motion; NRS, numerical rating scale; KNDI, Korean version of neck disability index; CRA, cranial rotation angle; PNF, proprioceptive neuromuscular facilitation; SF-12, short form-12 health survey questionnaire; HIT-6, headache impact test-6; TECAR, transfer electrode capacitative and resistive.

the effects of an intervention approach that combined self-stretching and general physical therapy in comparison with the effects of general physical therapy alone and joint mobilization combined with general physical therapy. Significant changes were found in CVA and VAS scores in the combined general physical therapy and self-stretching group after the intervention.

Significant differences were also noted in CVA and VAS scores between the combined general physical therapy and self-stretching group and the general physical therapy group. A significant difference was only observed in VAS scores between the combined general physical therapy and self-stretching group and the combined general physical therapy and joint mobilization group. Kim and Park [23] evaluated the effects of horseback riding simulator, sling, and Kendall exercises. Neck pain was significantly reduced, and CVA scores were significantly increased after the intervention in all exercise groups. Song et al. [16] examined and compared the effects of neck stabilization and proprioceptive neuromuscular facilitation (PNF) neck pattern exercises. Both exercise groups showed significant differences in CVA and NDI scores after the intervention, and the neck stabilization exercise group showed a significant difference in NDI scores compared with the PNF neck pattern exercise group. Kim and Kang [22] investigated the effects of PNF cervical stabilization exercise. Significant differences were observed in CVA, VAS, and NDI scores in the experimental group after the intervention, and significant improvements in all scores were observed between the experimental and control groups. Seo et al. [25] investigated the effects of a self-stretching exercise program. Significant improvements were found in CVA and VAS scores after the intervention in the experimental group. Park and Jung [18] compared the effects of a complex exercise program that included thoracic extension and lower trapezius muscle strengthening exercises with dynamic taping (experimental group) with those of an exercise program alone (control group). Significant differences were observed in CVA, VAS, and NDI scores after the intervention in the experimental group, and a significant difference was found in NDI scores between the experimental and control groups.

DISCUSSION

This review presents research trends in various effective ex-

ercise intervention programs for FHP over the past 5 years. In the selected studies, CVA, VAS, and NDI, were the main evaluation tools for measuring FHP, pain intensity, and disability, respectively. In addition, cranial rotation angle, cervical range of motion, pulmonary function, pressure pain threshold, pain by using NRS, autonomic nervous system, cervical spine stability, neck tilt angle, neck load, and upper trapezius muscle tone were assessed. In the 10 selected studies, exercise interventions to improve FHP and neck pain included cervical stabilization, stretching, shoulder stabilization, thoracic extension, corrective, horseback riding simulator, sling, Kendall, PNF, and lower trapezius muscle strengthening exercises. All studies measuring CVA showed positive improvements following intervention programs that included exercises [16-25]. Four of the 10 studies showed significant differences between the experimental and control groups [17,20-22]. Nine studies that measured VAS or NRS scores showed significant reductions after the interventions, including exercise programs [17-25]. Among them, five studies showed significant differences between the experimental and control groups [17,20-22,24]. Six studies that measured NDI scores demonstrated a significant decrease after an intervention program, including exercises, and significant results were also found between the experimental and control groups [16-19,22,24]. The effective FHP exercise treatment reviewed in the international literature by Sheikhhoseini et al. [26] included stretching and strengthening exercises for the spine and hamstrings; a home exercise program including stretching and strengthening exercises for the neck; stretching and strengthening exercises for the neck and upper back based on Pilates; Rocabado 6 × 6 exercises including neck and jaw stretching; strengthening and stabilization exercises; and corrective exercises, which included general stretching and strengthening exercises. In the domestic literature by Na et al. [15], effective FHP exercise treatments included neck and shoulder stabilization; neck, shoulder, and chest stretching and strengthening; sling; McKenzie; biofeedback; and PNF exercises. Therefore, over the past 5 years, the FHP exercise intervention methods in Korea were not significantly different from those used in previous literature reviews.

This study had some limitations. First, only 10 domestic studies, which included adults aged 20–60 years, met the inclusion criteria. Therefore, the applicability of the results to all age groups is difficult. Second, the review included domestic studies only, making it difficult to understand the overall trend of FHP both domestically and internationally. Third, we did not examine the homogeneity of the literature and the effect size of the intervention, it is impossible to know which exercise intervention program is objectively more effective. Finally, the review focused on FHP using mostly CVA as a variable. Therefore, future literature reviews addressing these limitations and using other variables such as cranial rotation angle, head tilt angle, and Cobb angle are recommended.

CONCLUSIONS

This domestic literature review collectively suggests that various exercise-based intervention programs are effective and helpful in improving CVA and reducing the associated symptoms, as supported by multiple studies.

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CONFLICTS OF INTEREST

No potential conflicts of interest relevant to this article are reported.

AUTHOR CONTRIBUTION

Conceptualization: GH, CY, Seo-hyun Kim, Su-bin Kim. Data curation: GH. Formal analysis: GH, CY. Investigation: GH. Methodology: GH, CY, Seo-hyun Kim, Su-bin Kim. Project administration: CY. Resources: GH, Su-bin Kim. Software: GH, Seo-hyun Kim. Supervision: CY, Seo-hyun Kim. Validation: GH, CY, Seo-hyun Kim, Su-bin Kim. Visualization: GH. Writing - original draft: GH. Writing - review & editing: GH, Seo-hyun Kim.

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