FORWARD HEAD POSTURE AND ITS EFFECT ON MUSCLE ACTIVATION

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ABSTRACT

Forward head posture (FHP), which is defined as a forward displacement of the head on the cervical spine, is a common postural disorder. It is suggested that this malalignment alters the loads on the spine, affects the length-tension relationship in muscles, and changes muscle activation. Therefore, the aim of this review is to investigate the results of studies on the examination of the changes exerted by FHP on muscle activation. Although there are many methods used to assess FHP, there is no standard clinical method for accurate measurement of this angle. Photographic measurement is the most widely used, valid, and reliable assessment method. Craniovertebral angle (CVA) is the most widely used value to assess FHP in photographic measurements. A CVA of less than 48-50° is defined as FHP, although there are differences regarding the norm value of the CVA. There are many studies on the assessment of differences in the activation of the neck and shoulder muscles by making FHP and non-FHP classifications according to the CVA to show the changes in muscle activation in individuals with FHP. Although many studies have shown increased sternocleidomastoideus and upper trapezius activation, there are also others indicating no difference. Similar conflicting results exist for the lower trapezius and serratus anterior muscles. Although there are conflicting results regarding muscle activation in studies, it seems likely that muscle activation is altered in individuals with FHP. It may be recommended that physiotherapists conduct interventions by considering these differences in muscle activation in individuals with FHP.

Key words: Forward head posture, Photogrammetry, Craniovertebral angle, Muscle activation, Electromyography

BAŞ ÖNDE POSTÜRÜ VE KAS AKTİVASYONUNA ETKİSİ

ÖZ

Başın servikal omurga üzerinde öne doğru yer değiştirmesi olarak tanımlanan baş önde postürü, sık görülen bir postür bozukluğudur. Bu dizilim bozukluğunun omurga üzerindeki yükleri değiştirdiği, kaslardaki uzunluk-gerilim ilişkisini etkilediği ve kas aktivasyonunu değiştirdiği ileri sürülmektedir. Bu nedenle bu derlemenin amacı, baş önde postürünün kas aktivasyonu üzerinde yaptığı değişikliklerin incelenmesine yönelik çalışmaların sonuçlarını incelemektir. Baş önde postürünü değerlendirmek için kullanılan birçok yöntem olmasına rağmen, bu açının doğru ölçümü için standart bir klinik yöntem yoktur. Fotoğrafik ölçüm en yaygın kullanılan geçerli ve güvenilir değerlendirme yöntemidir. Kraniovertebral açı (KVA), fotografik ölçümlerde baş önde postürü değerlendirmek için en yaygın kullanılan değerdir. KVA'nın norm değerinde farklılıklar olmakla birlikte, 48-50°'nin altındaki bir KVA, baş önde postürü olarak tanımlanır. Baş önde postürlü bireylerde kas aktivasyonundaki değişiklikleri göstermek için KVA'ya göre baş önde postürü olan ve olmayan olarak sınıflandırma yaparak boyun ve omuz kaslarının aktivasyonundaki farklılıkları değerlendiren birçok çalışma bulunmaktadır. Birçok çalışma sternocleidomastoideus ve üst trapezius kaslarının aktivasyonunun arttığını göstermiş olsa da, fark olmadığını gösteren çalışmalar da vardır. Alt trapezius ve serratus anterior kasları için benzer çelişkili sonuçlar mevcuttur. Çalışmalarda kas aktivasyonu ile ilgili çelişkili sonuçlar olmasına rağmen, baş önde postürü olan bireylerde kas aktivasyonunun değişmiş olması muhtemel görünmektedir. Fizyoterapistlere baş önde postürü olan bireylerde kas aktivasyonundaki bu farklılıkları göz önünde bulundurarak müdahaleler yapmaları önerilebilir.

Anahtar kelimeler: Baş önde postürü, Fotogrametri, Kraniovertebral açı, Kas aktivasyonu, Elektromiyografi

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GİRİŞ

Forward head posture (FHP) is a frequently encountered postural deviation reported in the literature (1) and has many definitions. It is the protrusion of the head in the sagittal plane to position the head in front of the body (2). It is defined as the extension of the top cervical vertebrae (C1 to C3) and the flexion of the bottom (C4 to C7) (3). In the definition by Peterson-Kendall et al., FHP was described as an alignment in which the external auditory canal is situated anterior to the plumb line along the shoulder joint (4, 5). FHP can be associated with computer use, carrying a backpack, smartphone use, headaches, mouth breathing or overuse of the shoulder (6). Neck and shoulder pain of FHP is considered a potential risk factor for abnormal scapular movement, tension, cervicogenic or migraine headaches, myofascial pain syndrome, temporomandibular dysfunction, decrease in forced vital capacity, forced expiratory volume in one second and activation of accessory respiratory muscles, proprioceptive deficits, dizziness, problems in balance and coordination and visual disturbances (7).

FHP is one of the most common musculoskeletal disorders of the upper body. The upper body includes the neck and shoulder girdle, which are closely interconnected, making up anatomical and functional structures (8). The anterior displacement increases the load on the posterior neck by placing the center of gravity of the head anteriorly to the vertical axis. This posture affects scapular mechanics and muscle activity around the shoulder complex, resulting in altered force couples and scapular movements that lead to tissue overuse, injury and pain. Therefore, the neck, scapula and thoracic spine regions are affected resulting in a general imbalance in the musculoskeletal system (9). FHP increases pathological myofascial adaptations and muscle imbalances by raising weight pressure on the cervical spine. It weakens the deep neck flexors, scapular stabilizers and retractor muscles. The deep upper cervical extensors, shoulder protractorsand elevators shorten and become overactive. The imbalance between these muscles may lead to cervical and thoracic instability, resulting in a decrease in respiratory function, deficits in proprioception, increase in muscle tone. and pain in the cervical region (10). As a result of postural deviations in the scapula due to FHP, a protracted scapula with increased forward tilt occurs in downward rotation. This increases the compressive forces in the subacromial space during elevation of the arm. Therefore, FHP is considered to be an etiological factor in the pathogenesis of subacromial impingement syndrome (11, 12).

Assessment of Forward Head Posture

A reliable assessment of FHP is important for therapists to evaluate the impact of their therapeutic interventions (13). Despite its high prevalence, there is no standard clinical method for its accurate measurement (5, 13, 14). Clinical evaluation of FHP is based on visual observation of the position of the head relative to reference anatomical points defined by Kendall et al. (5, 13, 15). The subjective definition of FHP is interpreted differently by clinicians, and therefore it is classified as mild, moderate and severe (5, 13, 16). In a different approach, FHP is divided into three groups: non-FHP, slight FHP and with FHP, and this method is used to measure it in clinical assessments (13, 17).

The current gold standard for the quantitative determination of cervical angle is the X-Ray, but it presents significant limitations due to the high cost of examination and exposure of patients to high doses of potentially harmful radiation. Photogrammetry can be recommended as a reliable and valid method that can be used without the disadvantages of radiography (10). Examination of FHP with lateral photography is a method that is frequently used in clinical practice and research (18). This method has many advantages; it is quicker, provides a permanent photographic record, and is more accurate and reliable than visual assessment alone. For this reason, photogrammetry is considered the "gold standard" for assessing the head position (19). As the gold standard, photographic measurement is reliable and valid compared to radiological measurements (10, 20, 21). However, accuracy can vary significantly depending on where the adhesive markers are attached to the patient's body (22, 23). Angles used to analyze FHP when using the photographic method are craniovertebral angle (CVA), cervical inclination angle and head tilt angle (5, 19). CVA is the most widely used angle to evaluate FHP (15, 22) and to examine the position of the head relative to C7 (24). CVA is defined as the angle between a horizontal line passing through the C7 spinous process and the line extending from the ear tragus to the C7 vertebra (9, 13, 25). The CVA can be evaluated in both standing and sitting positions. However, Shaghayeghfard et al. found that CVA increased in the sitting position compared to the standing position and that the standing posture was more sensitive to evaluate FHP. A smaller CVA indicates a greater FHP, and a CVA less than 48°-50° is defined as FHP (5). Many researchers have reported an angle between 50° and 57° as a normal CVA (2, 26, 27). According to the study by Salahzadeh et al., the normal CVA range is 53.2°-56.8°. They reported that CVA values in individuals with moderate-severe FHP and mild FHP were 40.7°-43.2° and 46.9°-49.1°, respectively (13). In a systematic review conducted in 2020, it was stated that there was no definite CVA value that could show FHP (28). However, the most commonly used cut-off values of the CVA angle to identify individuals with FHP in studies are 48° (5, 29, 30) - 50° (3, 31, 32) and 53° (7, 33, 34). There are also studies using the distance measurement from the line passing through the acromion to the line passing through the external acoustic meatus to identify individuals with/without FHP. In this assessment, a distance of 2.5-5 cm is classified as slight FHP and a distance value of >5 cm is classified as moderate-severe FHP (22). However, the literature focuses more on the measurement of the CVA angle.

The Effect of Forward Head Posture on Muscle Activation

FHP increases the compressive load on the tissues in the cervical spine, especially the facet joints, and the stress on the ligaments. In addition, it can cause neck pain and increase electromyographic activity in neck muscles (35). A change in the sagittal alignment of the head-neck complex is associated with the shortening or stretching of the cervical spine muscles. Muscles that are stretched or shortened may have decreased strength because the sarcomeres are no longer aligned in the most efficient orientation (36). As a result of the deterioration of sagittal alignment due to FHP, the strength of the deep neck flexors decreases and the neck extensors shorten

(28). Bokaee and Manshadi stated that individuals with FHP showed reduced thickness of the longus colli muscle during craniocervical flexion movement compared to the control group without FHP and that such a difference might indicate different muscle activity patterns or altered motor strategy (37). Cervical flexor torque is increased in individuals with FHP. Therefore, cervical extensor muscles show more activity to compensate for this imbalance (38). Alowe and Elsayed found that cervical erector spinae (CES) muscle activity increased significantly in the FHP group compared to the control group while performing a specific manual handling task on standing (32).

It is known that with a very small change in the forward head position, the load on the musculoskeletal system may increase and this may increase the activities of the upper extremity muscles (39). Since the shoulder girdle and neck regions share many muscles, changes in the head and neck alignment also result in changes in the muscles of the shoulder girdle (8). The majority of electromyography (EMG) studies have focused on the sternocleidomastoideus (SCM) and upper trapezius (UT) muscles. It has been stated that the primary problem in FHP is the shortening and hyperactivation of the SCM muscle (35). In addition, it has been stated that the UT muscle should be more active to overcome the increased levator scapula tension due to FHP (38). Khan et al. observed that the EMG activity of the SCM and UT muscles significantly increased in individuals with FHP compared to the group without FHP, both at rest and during shoulder abduction (7). Higher muscle activation was detected in the contralateral SCM muscles during neck rotation in both directions in individuals with FHP than in those without FHP (35). Investigating the differences in muscle activation during the overhead arm lift test, Kim et al. observed increased muscle activation in the UT, SCM and lower trapezius (LT) and decreased activation in the serratus anterior (SA) in the with FHP compared to the without FHP (9). It was found that the rate of UT muscle activation during arm abduction (with loading) in the dominant arm in individuals with FHP was higher than in individuals without FHP and that there was no difference in the non-dominant arm. In addition, no difference was found between the two groups in terms of LT and SA muscle activation (40). Evaluating the scapular muscle contribution during shoulder flexion in the non-dominant arm in women with and without FHP, Valizadeh et al. stated that the contribution of SA decreased, the contribution of UT increased and that there was no difference in terms of LT contribution in women with FHP (38). Kiatkulanusorn et al., who investigated the differences in muscle activation while resting in the side lying position in individuals with and without FHP. They found that FHP might cause excessive activation in the UT and LT muscles, and that the activations in the SCM and middle trapezius (MT) were similar in those with and without FHP (41).

In a study on the evaluation of the changes in UT muscle activation with high-intensity EMG in individuals with and without FHP, when the head was in neutral, backward and forward positions, Nishikawa et al. found that individuals with FHP had increased UT activation compared to the without FHP. They also stated that there was less UT activation in the neutral head posture than in the FHP (33). Jafarnezhadgero et al. stated that the activations of bilateral SA, CES, SCM, UT and LT muscles while running barefoot were similar in individuals with and without FHP. However, it was stated that the asymmetry index of the electrical activity of the SCM muscle of the control group was higher than the FHP group (42). Lee et al. compared individuals with and without FHP during neck protraction and retraction exercises. As a result of the study, they found that in the FHP group, the activation of the splenii and SCM muscles during protraction exercise and MT muscle activation during retraction exercise decreased. They stated that the decreased activation was due to changes in muscle length due to FHP and was associated with a decreased ability to generate force. They also found that UT activation was similar during both protraction and retraction exercises (34). In the study by Lee et al., it was suggested that the reason for the lack of difference in the UT muscle might be because the muscle does not play a major role in protraction and retraction movements (28, 34).

In addition to studies in the literature comparing individuals with and without FHP, there are also studies examining the changes in muscle activation when the head position is changed (when the head is tilted forward, placed in a neutral position, or given a natural daily life position), regardless of head and neck posture, to show the effect of FHP. In two separate studies, it was found that increased UT and LT and decreased SA activation were observed when the shoulder isometric flexion exercise performed in the sitting position was done by individuals with FHP compared to the neutral head position (12, 43). They showed increased SCM, UT, CES and thoracic erector spinae (TES) activation in FHP during a typing task on a laptop compared to natural head posture. In addition, they indicated an increase in UT, CES and TES muscle activities in the FHP compared to the neutral head posture and a decrease in the activity of the lumbar erector spinae (LES) muscle (44).

The weakness and shortening of the neck muscles due to FHP not only affects pain and limitation of movement but also the diameter of the thorax and lung volumes, and accordingly, it may cause dysfunction of respiratory muscles such as the diaphragm and intercostal muscles (45). It is known that FHP has a significant effect on respiratory function by weakening the respiratory muscles (46, 47). SCM, scalene muscles, UT, pectoralis major and thoracolumbar erector spinae muscles are important accessory respiratory muscles involved in inspiration, and long-term FHP weakens these muscles and reduces respiratory functions (47). Kang et al. stated that severe FHP increased the respiratory activities of the SCM and anterior scalene muscles and decreased Forced Vital Capacity (FVC) (48). On the contrary, Han et al. reported that accessory respiratory muscle activity was lower in SCM and pectoralis major in the FHP group than in the normal group (47). In the review, Han et al. stated that the difference in the results of their study may be due to the measurement of muscle activity during deep breathing (28).

It is known that poor head and neck posture can adversely affect the chewing muscles and related structures. In addition, poor positioning of the head and neck may lead to temporomandibular disorder (49, 50). Gadotti et al. found that there was no difference between individuals with maximum and no FHP in terms of the masseter and temporalis muscles during chewing activity in the natural head posture. In addition, they found that the activity of the masseter muscle increased during chewing at maximum FHP and in the natural head position and that there was no change in temporalis muscle activation (51). Song et al. observed decreased suprahyoid and infrahyoid activation in FHP during mouth-opening activity compared to neutral head posture. This finding supports the finding that FHP may indirectly affect the temporomandibular joint through a change in the hyomandibular system (49).

CONCLUSION

FHP, one of the most common musculoskeletal disorders, is assessed objectively via photographic measurement, which is a clinically valid and reliable method. It is assessed through the measurement of CVA. Although the cut-off values of the CVA used to identify individuals with FHP vary in studies, the angles widely used include 48°, 50° and 53°.

It is suggested that FHP may cause changes in muscle activation by changing the loads on the musculoskeletal system. Studies on the investigation of the effect of FHP on muscle activation indicate that the primary problem in FHP is the shortening and hyperactivation of the SCM muscle. It is also stated that the UT muscle should be more active to overcome the increased levator scapula tension due to FHP. In the literature, there are inconsistencies in the results of studies examining changes in muscle activation by grouping individuals with/without FHP according to CVA. Although most studies have shown that SCM and UT activation is increased, there are also others indicating similar muscle activation in individuals with or without FHP. Studies showing that the activation of the LT muscle does not change are in majority; however, there are also those indicating that the activation is increased. There are many studies indicating a decrease in the activation of the SA muscle; yet, it was stated in one study that there was no change in the activation of the SA muscle in individuals with FHP. Although the results of the studies in the literature are contradictory, it seems likely that there will be a change in muscle activation in individuals with FHP. Differences in movement/exercise may change the contribution of the muscle to the movement, thus causing different results in muscle activation. In addition, there were differences in the identification of FHP in these studies. Although there are few studies on classification (below/above 5cm) by evaluating the distance between the tragus and acromion, most studies have used the CVA to identify individuals with FHP. There are also differences (48°, 50° and 53°) regarding the cut-off values of the CVA. The angle accepted for individuals in normal posture in some studies has been used for the group of individuals with FHP in others. This may have changed the standardization of studies and led to diversity in results. In addition, although photographic evaluation has been used in most studies to measure the CVA, there are many differences in these measurements due to the distance of the camera to the person and the ground, the diversity of the anatomical points determined, the extremity positions of the individual during the evaluation, the software used to analyze the angle, and the evaluation of the individual while standing or sitting. To eliminate these discrepancies, it is necessary to determine norm values for the normal head posture by using standardized methods and cut-off values to be used in identifying FHP. There is a need for studies on the examination of changes in muscle activation with standardized assessments in individuals with FHP.

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Critical Review: NAG

COI statements

The authors report no conflict of interest.

Declarations of interest

None

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