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SPECIAL ISSUE

The Effect of Head and Neck Position on Head Rotation, Cervical Muscle Tension, and Symptoms

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*Slouching posture may be observed when people interact with digital devices such as sitting at a computer screen or looking downwards at a smartphone while sitting or walking. The study investigated two procedures: the effect of head position on perceived head rotation and the effect of neck scrunching on symptom development. In the first study, 87 students sat in either a head-erect or head-forward position and rotated their heads from side to side. Ninety-two percent of the participants reported that they significantly increased their head rotation range during the head-erect position as comparted to the head-forward position, and that it was much easier to rotate their head in the erect position (*M = *8.5;* SD = *2.4) than in the slouched position (*M = *4.3;* SD = *1.9), F(1, 171) = 152, p < 0.001. In the second study, 125 students were asked to scrunch their neck for 30 seconds. After neck scrunching, 98.4% of participants reported experiencing an average pain rating of 5.3 on a scale from 0 (none) to 10 (severe), which consisted of pressure in the head (*M = *6.7), stiff neck (*M = *5.9), eye tension (*M = *4) and headaches (*M = *3.8). For a subset of 12 students, the effects of head-forward position and neck scrunching (compression) on cervical and trapezius muscles was monitored with electromyography. The average cervical surface electromyography (sEMG) was higher during head-forward position and neck scrunching than during pre- and post-baseline, and the average trapezius sEMG was higher during the neck scrunching than during pre- and post-baseline. For most participants, the effect of their head/neck position on rotation and neck scrunching on symptom development was a total surprise. Experiential practices can provide somatic feedback as an education tool to teach awareness and thus motivate participants to change their body posture so that they reduce slouching and neck scrunching.*

Introduction

Sit up straight! Don't slouch! These commands are based upon accepted beliefs that an upright posture is healthier and more empowering than a collapsed posture. Fewer and fewer of our daily interactions with digital devices such as smartphones, tablets, and computers are in an upright posture, resulting in an increased prevalence of musculoskeletal dysfunction (Nahar & Sayed, 2018). For example, a recent meta-analysis estimated that greater than 75% of the risk associated with digital device use is attributable to poor posture, and that up to 67% of those problems were associated with the neck region (Xie, Szeto, & Dai, 2017).

Even for blue-collar or non-office workers, digital devices of many sizes have become integrated into job performance because these devices may control the machinery, schedule new assignments, and display reports on almost any size device or screen. The more you use a screen for completing digital tasks, the more you tend to have head-forward posture, especially when the screens are small, such as using an app on a smartphone (Kang et al., 2012). For instance, Kang et al. (2012) found that workers who used a computer for over six hours a day exhibited increased forward head posture and had a more anterior center of gravity along with decreased ability to maintain balance. In office workers, reducing the severity of forward head posture and activity in the upper trapezius muscles can also be done by applying tape to the cervical extensor muscles on both sides of the neck (Yoo, 2013).

Many factors modify the relationship between device use and posture. For example, device size moderates slouching posture when increased thumb, finger flexor, and wrist extensor muscle activity occurs while texting or typing on a smartphone or tablet device (Kietrys, Gerg, Dropkin, & Gold, 2015). From a biomechanical perspective, Granata and Wilson (2001) reported that a forward and collapsed head position during small-device use contributes to the onset of headaches, as well as neck, shoulder and upper back discomfort. Forward head

postures with rounded shoulders (e.g., head is extended anterior to the center of gravity) for long periods of time using small devices is correlated with self-reported chronic neck pain (Lee, Lee, & Yong, 2015; Tehereh, Farzaneh, Shima, & Zahra, 2013). Forward head posture characterized by an extension and simultaneous flexion of the upper and lower cervical muscles, respectively, is associated with inefficient muscle activity patterns (Sim, 2015). For example, participants with extended or flexed cervical muscles recruited additional sternocleidomastoid muscles while rotating their necks. Forward head position was also associated with reduced range of axial neck rotation. Forward head position has also been found to be associated with reduced proprioceptive awareness, the awareness of the position of one's joints and tendons (Lee et al., 2015; Portelli & Reid, 2018). For instance, based on head repositioning accuracy (HRA) scores, researchers observed a positive correlation between the angle of a participant's forward head posture and errors in perceived cervical spine position while performing neck extension, flexion, and rotation movement (Lee et al., 2015).

Almost all digital display users adopt a collapsed head forward position that unintentionally increases subjective experience of low energy and may trigger a defeated, helpless, hopeless experience (Bader, 2015; Peper & Lin, 2012). More people appear to be slouching without awareness, such as when they look down at their cell phones or collapse in a chair or couch while watching digital media. Previous research by Peper and Lin (2012) has shown that an upright posture increased subjective levels of energy, and decreased hopeless, helpless, powerless thoughts and memories as compared to the collapsed or slumped posture (Figure 1).

The study explored the effect of head-forward positions on the range and experience of head rotation, and the effect of neck scrunching/compression on symptom development. The classroom activities related to raising awareness about head position and body posture. This activity incorporates a therapeutic/teaching technique known as symptom prescription, designed to promote greater awareness of muscle use and misuse. Symptom prescription is an approach where participants are instructed to actively engage in behaviors that may evoke problematic symptoms to increase awareness and thereby learn control over processes leading to those same symptoms (Katz, 1984). Through this learning process the person becomes aware of what they are doing that induces the symptom and the person now has awareness and a choice to initiate health-promoting activities to mitigate symptoms getting worse.

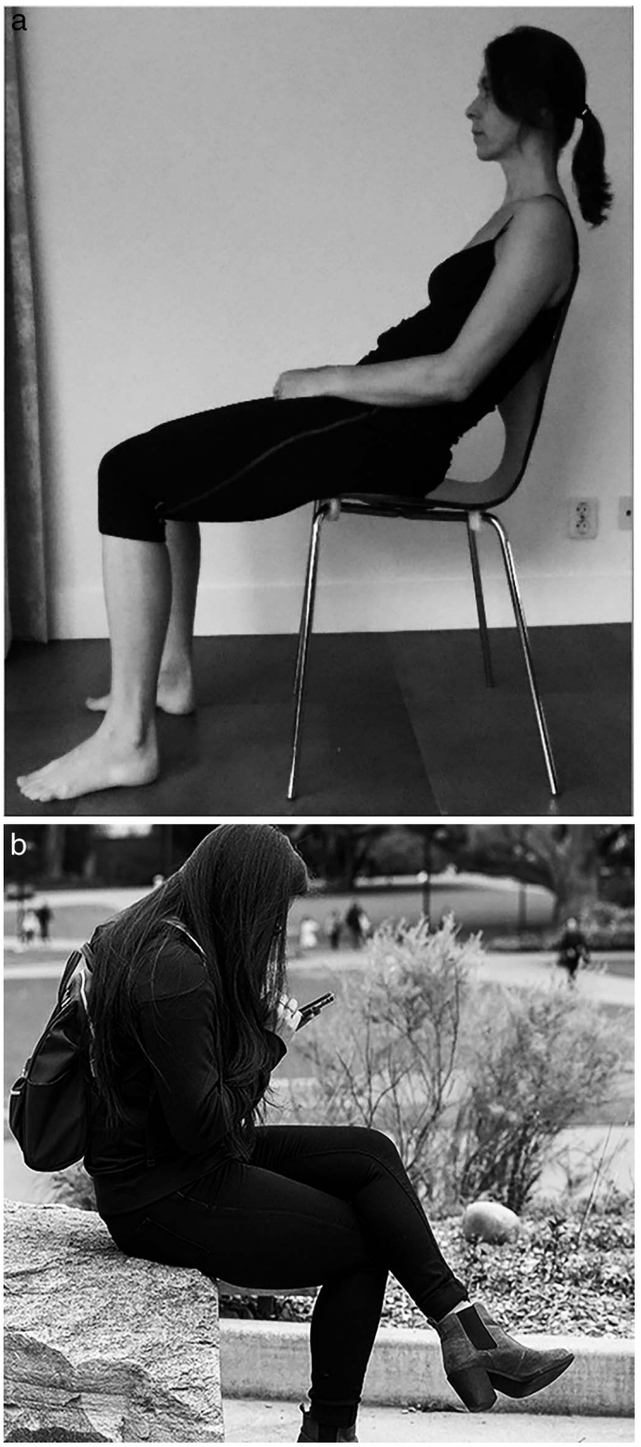

Figure 1. (a) Slouching while sitting (photo © Annette Booiman, model Marcella Sjollema). (b) Slouching while texting (from http://news.sfsu.edu/news-story/digital-addiction-increases-loneliness-anxiety-and-depression).

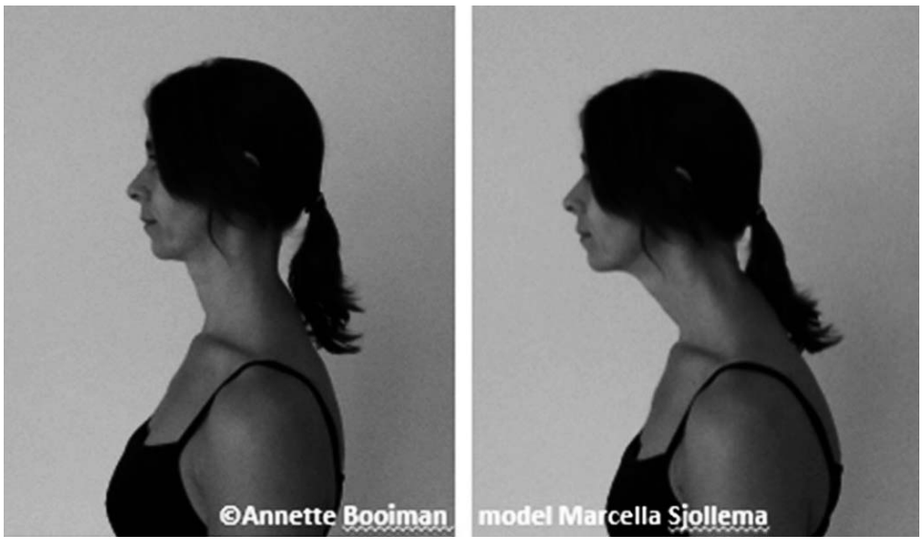

Figure 2. Head-erect versus head-forward position.

Study 1: Effect of Head Forward on Neck Rotation

Method

Participants. Eighty-seven students (mean age = 23.6 years) participated in a classroom activity designed to bring awareness of the effect of head and neck position on symptoms of muscle tension. This report of findings of the quality improvement and evaluation of classroom activity was exempted from Institutional Review Board oversight.

Procedure. Students sat in either an erect-head or head-forward position, then rotated their heads from side to side, followed by a subjective rating of their perceived range of rotation as shown in Figure 2. Afterward, they repeated the same task in the opposite position.

Results

Of the participants, 92% reported they significantly increased their head rotation range during the head-erect position as compared to the head-forward position (see Figure 3). Only a few reported no difference, and about 4% mentioned an increased head rotation range during the head-forward position.

Participants reported that it was much easier to rotate their head in the erect position ($M = 8.5$; $SD = 2.4$) than in the slouched position ($M = 4.3$; $SD = 1.9$), $F(1, 171) = 152$, $p < 0.001$, as shown in Figure 4.

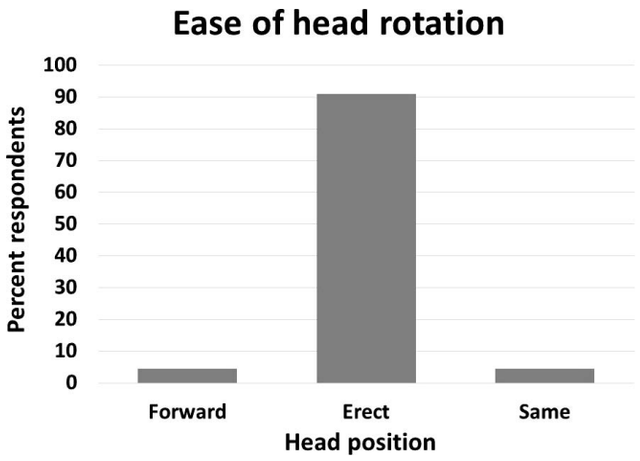

Figure 3. Percent of participants who reported in which position it was easier to rotate the head.

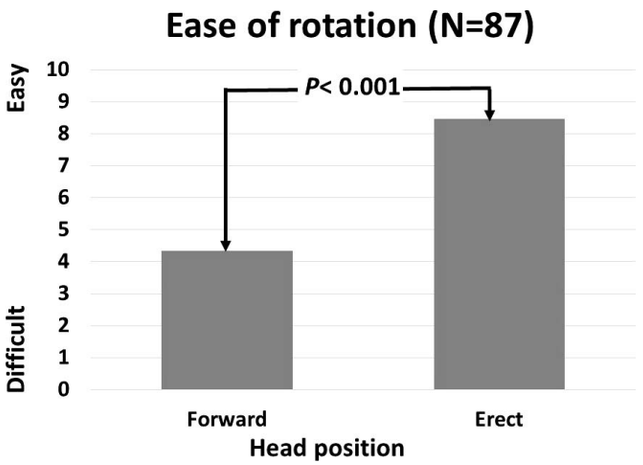

Figure 4. Self-report of ease of head rotation.

Discussion

Neck and head position significantly affects head rotation and most participants were surprised that the head-forward position restricted head rotation. It is more difficult to rotate the head in the head forward position, which also reduces peripheral awareness (Fernandez-de-Las-Penas, Alonso-Blanco, Cuadrado, & Pareja, 2006). This may directly affect personal safety since reduced peripheral awareness is an important issue while walking, biking or driving a car. In the United States, the pedestrian death rate has significantly increased as people are walking while looking at their cell phones. The faster the speed, the more important the peripheral sight becomes.

The head-forward position also increases the risk of intervertebral disc damage. In the head-forward position, the center of gravity of the head is about 3 in. forward and the cervical vertebrae are in a more curved position compared to the stretched neck with the normal cervical curve (Kang et al., 2012). This means that in the head-forward position, the pressure on the vertebrae and the intervertebral disc is elevated compared to the preferred positon with a stretched neck. This increases the risk of damage to the vertebrae and intervertebral disc and balance impairment (Kang et al, 2012). The following analogous awareness exercise demonstrates the effects of a head-forward posture.

Awareness Exercise

Take a 5-kg hand weight with the arm bent 90 degrees at the elbow. Feel the tension in the upper arm muscles. Now bring the arm about 3 in. forward and feel the difference in the upper arm muscles. Most people are astonished how much more tension this position demands from the muscles, and this is an experiential analogy of what happens in a person's neck in the head-forward position.

There are numerous covert factors that contribute to a head-forward position, such as:

1. Sitting in a car seat in which the headrest pushes the head forward so that the person automatically slouches.
2. Feeling pressure on the back of the head for people with their hair in a bun or ponytail, especially when resting their head against a headrest. For example, it may not feel comfortable when the back of the head is resting against a headrest. This causes a change of the head to a more forward position, and it becomes a habit without the person even knowing it.
3. Difficulty reading the text on the digital screen. The person automatically cranes their head forward to read the text. Pragmatic solutions could include an eye exam and computer reading glasses or increasing the font size on the screen.
4. Working on a laptop and looking down on the screen as shown in Figure 5. A pragmatic option is to have a detachable keyboard and place the laptop on a stand so that it is at eye level.
5. Being tired or exhausted encourages the body to collapse and slouch and increases the muscle tension in the upper cervical region. You can explore the effect of tiredness that causes slouching and head-forward position during the day by observing the following if you drive a car.

Figure 5. Trying to read the laptop screen, which causes the head to go forward.

Awareness While Driving

In the morning, adjust your rear-view mirror and side mirrors. Then, at the end of the day when you sit in the car, you may note that you may need to readjust your inside rear-view mirror. And no, the mirror didn't change of position during the day by itself—you slouched unknowingly.

Surface electromyography (sEMG) from the cervical area can also demonstrate the same effect. When collapsed and slouched, the sEMG is significantly higher than when elongating the neck and feeling tall as is shown in Figure 6. The sEMG feedback can help the client identify the elongated neck position and point out the muscle tension cost of the collapsed position. Biofeedback makes the invisible visible and facilitates the change in belief—seeing is believing.

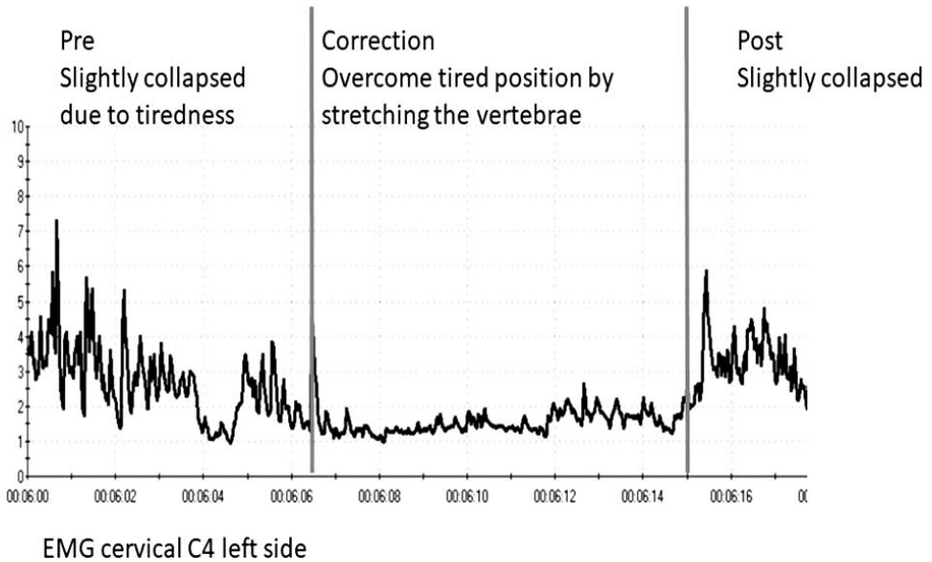

Figure 6. Example of sEMG recorded of the left side of C4 when a person slightly slouches or sits erect.

Study 2: Effect of Neck Scrunching (Neck Retraction/Compression) on Symptom Development

Method

Participants. One-hundred twenty-five college students ($M_{AGE} = 23.5$). This report of findings of the quality improvement, classroom activity evaluation was exempted from Institutional Review Board oversight.

Procedure. The students sat in their classroom chairs. They were asked to sit normally for 30–45 seconds, then bring their chin forward and scrunch their neck for approximately 30 seconds, and then relax and sit erect as shown in Figure 7. The students rated their discomfort on a scale from 0 (not at all) to 10 (severe).

Figure 7. Sitting erect and with neck crunched.

In addition, the cervical and trapezius sEMG activity during both head-forward and neck-scrunch positions was recorded for 12 volunteers. The surface EMG was recorded with Myoscan Pro sensors (100 Hz–200 Hz; Thought Technology Ltd., Montreal West, Quebec, Canada) from the midpoint of the right upper trapezius muscle, with narrow placed electrodes and cervical muscles recorded with wide electrodes placed 2 cm to the right and left side between C2 and C3, and the reference electrode placed on T1.

Results

After neck scrunching, 98.4% of participants reported experiencing an average symptom rating of 5.3 on a scale from 0 (none) to 10 (severe), which consisted of pressure in

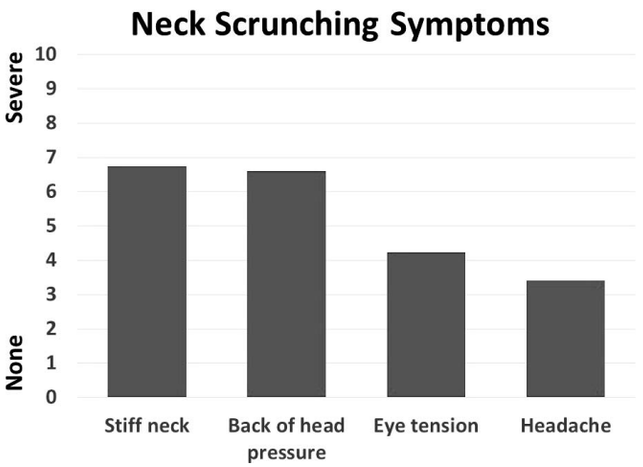

Figure 8. Symptoms induced by 30 seconds of neck scrunching.

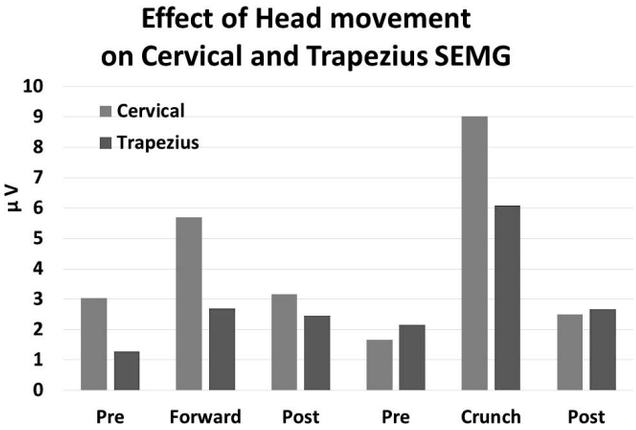

Figure 9. Change in cervical and trapezius sEMG during head forward and neck scrunching.

the head ($M = 6.7$), stiff neck ($M = 5.9$), eye tension ($M = 4.0$), and headaches ($M = 3.8$) as shown in Figure 8.

The average cervical sEMG was higher (5.7 μV) during head-forward and neck-scrunching positions (9.0 μV) than during pre- and post-baseline, and the average trapezius sEMG was higher (2.7 μV) during the neck scrunching (6.1 μV) than during pre- and post-baseline, as shown in Figure 9. A representative EMG recording is shown in Figure 10, although there was significant variation in how the participants performed the task.

Discussion

Most participants were totally surprised that 30 seconds of neck scrunching would rapidly increase symptoms and induce discomfort. It provided motivation to identify situations that evoked neck scrunching and avoid those situations or change the ergonomics. Some participants realized that they tended to scrunch their necks while looking at the screen and resolved the problem by either wearing computer glasses or increasing the font size.

Conclusion

The head rotation and neck scrunching exercises are useful experiential practice to demonstrate to the participant that head and neck posture matters. For those participants whose physiology was also monitored, they were surprised to observe the effects on their sEMG activity. For many subjects, the post-exercise sEMG did not return to the pre-baseline levels, which increases the risk of having chronic tension.

These practices are "symptom prescription practices" to help participants become aware of body patterns that may contribute to symptoms development. It allowed them to identify situations that are associated with these body patterns and quickly correct body patterns that could cause symptoms; namely, feeling is believing. These somatic feedback exercises demonstrated that common postural behaviors such as neck scrunching could contribute to symptom onset, and that head-forward inhibits head rotation, which reduces peripheral awareness. By inhibiting these head and neck patterns, it may be possible to reduce or avoid discomfort and increase peripheral awareness. Adding measurements such as sEMG muscle monitoring permits participants to "see" the extent to which their posture influences their muscle tension levels. Seeing is believing.

Feeling and seeing—self-experience—is much more powerful than telling participants to adjust their postures. Remember that we usually did not listen to our mothers when she told us to "sit up straight." Most participants had no idea that their head-neck position could limit rotation or induce significant discomfort. Experiential practices can provide somatic feedback and an education tool to teach awareness and thus motivate participants to change their body posture so that they reduce slouching and neck scrunching. Through feeling and seeing, these exercises demonstrated that common postural behaviors can contribute to symptom onset, and that inhibiting these behaviors

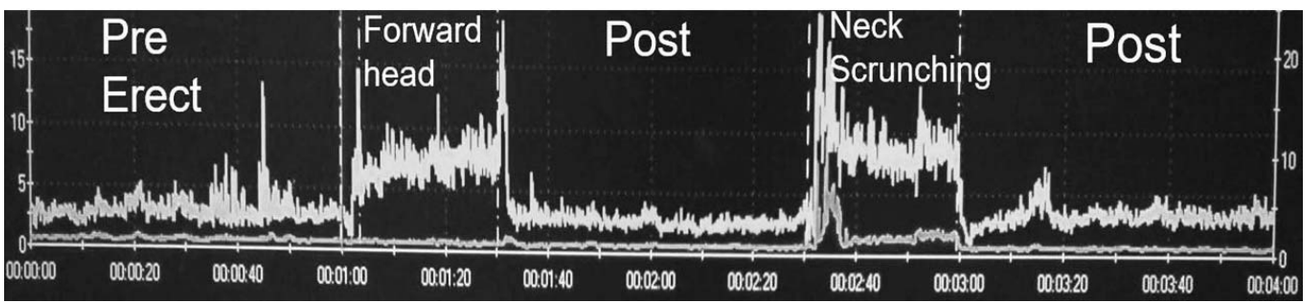

Figure 10. Representative sEMG recording during head-forward and neck-scrunching positions.

may possibly reduce or avoid such symptoms. In a simple way, paying attention assists with shifting intention about healthier body positions.

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