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Assessment of value of protraction angle and functional disorders of motion segments of cervical spine in bus drivers

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Abstract:

Introduction: Cervical segment is a part of the spine which is the most exposed to stress and dysfunction.

Aim: The aim of the study is to analyze the body posture of bus drivers and, especially, functional assessment of cervical spine mobility segments.

Material and methods: The study included a group of 40 people, consisting of professionally active drivers working in public transport, 20 of whom were the men under 40, and the remaining 20 were the men over 40. The study used the original study card.

Results: There was dependence between the subjects' length of service and the appearance of hand numbness. There was dependence between protraction angle and length of service. Most of the study subjects (67.5%) report the presence of back pain syndromes. Among the study subjects, 45.0% declare that they do sports / physical activity improving their condition. In the case of rectus abdominis muscle strength, the majority of the surveyed (60.0%) cannot sit unassisted.

Conclusions: The bus driver is exposed to a lot of stress every day, resulting, i.a. from the responsibility he bears for passengers in the vehicle, as well as from heavy traffic, which leads to changes in myofascial tensioning, resulting in the incidence of pain.

Keywords: pain; disfunction; protraction

Introduction

Cervical segment is a part of the spine which is the most exposed to stress and dysfunction. Each spine segment is curved properly so that a person can keep vertical body posture. Apart from keeping the body in a straight line, a properly curved spine also acts as amortisation against various shocks. Nowadays, improper sitting posture and little physical activity have the biggest influence on the misshape of the curves. Continuous sitting in front of the TV, computer, mobile phone, as well as long and frequent driving have led to an increase in the number of cases [1,2,3].

While sitting, compressive, shear and tensile forces constantly act on the spine and the structures surrounding it. Sitting for a long time is also not beneficial for our body, so it is worth changing this position often, even if it is correct. Assuming improper posture for a long time contributes to overloads, which are usually located in the cervicothoracic spine, which leads to pain in the neck and the entire shoulder girdle. Appearing muscle pains caused by improper posture come from the incorrectly positioned body, as a result of which some structures are subject to too much pressure and, consequently, increased tension and their overload. On the other hand, other muscle groups are stretched for too long time, which leads to decrease in muscle tone [2,4].

Neck pain is one of more common medical conditions which makes people seek help from a physical therapist. Females are more susceptible to various types of changes and dysfunctions in neck area due to less developed musculature in cervical spine and also weaker corset muscles of the neck in women. Unchanged nature of work, assuming a sitting position for a long time, with bent or forward head posture, as well as stress and other injuries, such as "whiplash" injury are among the most common factors leading to the incidence of disorders [5,6,7,8].

In most cases, joint dysfunction is manifested through increased muscle tension in the neck area and reduced range of mobility. It is often possible to observe excessive tension in the sternocleidomastoid muscle by moving its vector before the center of rotation which is on the posterior wall of the fifth and sixth cervical vertebrae. This tension combined with the shortening of scalene muscles leads to the development of dyslordosis in cervical spine. Consequently, joint overload may lead to functional blockages, and these, in turn, to degenerative changes, mobility disorders in the entire cervical spine, or complaints outside the spine, such as headaches and dizziness, finger paresthesia, impaired vision and sense of hearing with incidence of tinnitus and squeal. Type of condition depends on the location of the disorder, e.g. dysfunction of lower cervical segment may radiate to upper limbs, while disturbed upper cervical segment may provoke headaches. Joint dysfunction between occiput and the first cervical vertebra is manifested by excessive tension in suboccipital muscles and disruption of the sliding movement, which in turn hampers flexion movement. This occurs as a result of getting used to poor working conditions or after an injury, and may result in symptoms such as headaches, fatigue or concentration disorder. The disorder between the first and second cervical vertebrae relates to the constraint of rotation movements. Incidence of pain in this segment may be caused by uncontrolled trauma, e.g. a "whiplash" type, sudden,

rapid move, stress, and various types of overload, such as sports activities. Joint dysfunction between the second and third cervical vertebrae can be caused by various kinds of injuries, overload, degeneration of these areas, and by remaining in an improper position for a long time. In this case, we can observe dysfunctional symptoms such as headache along with dizziness. Considering dysfunction of muscles located in the area of the craniocervical junction, we can observe the occurrence of migraine headaches, jaw pain, and they can even lead to tinnitus. The last segment of the cervical spine, i.e. the passage of the seventh cervical and the first thoracic vertebrae, can transmit pain to other structures. With dysfunction of this segment, we may notice pain radiating to the palm, but it can also be the cause of headaches [1, 9, 10, 11].

Occupational factors significantly increasing the risk of pain and disorders in the musculoskeletal system are often the factors related to the way the work is performed and the length of work time. The position in which a person has to remain during work, performing repetitive motions and activities, and frequent occurrence of mechanical vibrations which also affect the human system is an important element. When driving the vehicle, the driver assumes a quite characteristic posture. The driver's seat is not always positioned in such a way that the spine is correctly laid, but in such a way that the driver feels comfortable. The driver's hands rest on the steering wheel, which leads to positioning the shoulders in protraction. With this positioning, the head very often changes its position, too. Considering these facts, it could be concluded that people working in a continuous sitting position, e.g. professional drivers are an occupational group most vulnerable to cervical spine dysfunctions. Their unchanged and badly assumed sitting position is also manifested by the head moved forward, which in turn may lead to the loss of cervical lordosis. Prolonged, enforced static positions related to the performance of duties lead to significant overload of the entire spine, which results in functional disorders and changes in tissue structures located nearby [12, 13, 14].

Materials and Methods

The study included a group of 40 people, consisting of professionally active drivers working in public transport, 20 of whom were the men under 40, and the remaining 20 were the men over 40. The study used the original study card. The subjects answered the questions about their general health condition, length of service and traffic incidents encountered during that time. The study card consisted of two parts. The first concerned age and length of service, general health, accidents and blood pressure measurement of the subject. The second part concerned measurements and tests. In the first part, there were questions about the presence of tinnitus, hand numbness, balance disorders, a history of illnesses, smoking, past injuries or physical activity. In the part concerning the tests, the measure of the protraction angle was taken based on a digital photograph, the Spurling’s test was performed, and muscle strength of anterior oblique and rectus abdominis was tested.

All participants gave their written consent to participate in the study. The research was conducted in accordance with WMA Declaration of Helsinki - Ethical Principles for Medical Research Involving Human Subjects.

Testing the protraction angle

This test consisted in setting the subject in a chair in a relaxed position. Then a side photo of the shoulders and head was taken. Two lines are marked in the photo. One of them went through the spinous process of the seventh cervical vertebra, while the other went through the same spinous process and antilobium. Marked lines made an angle which allowed for the

measurement of the protraction angle of cervical spine. A measure of not less than 45° is considered the norm of protraction.

Figure. 1 Presentation of measurement points of the protraction angle

The Spurling's test

Start position: sitting down. Motion: head flexion (to one side) with rotation. The test giver stands behind the subject and places his hands on the head of the sitting person and presses. The aim of the test is to show the occurrence of pain syndromes in intervertebral joints of the cervical segment by increasing pain during the test.

Strength of the anterior oblique muscles

Start position: lying on the back. The test giver places two fingers at the level of the subject's eyes and slowly moves them downwards. The subject raises his head and follows the test giver's fingers until they are out of sight. The time during which the subject managed to endure in this position should be measured (the time is measured when the subject reaches the limit of the visibility of the test giver's fingers). A short time span and head and neck trembling may indicate poor strength of the tested muscles.

Strength of the rectus abdominis muscle

Start position: lying on the back, legs bent at the knee and hip joints, heels driven into the ground to switch off the iliopsoas muscle. The subject's task is to move to sit down. Being unable to do this may prove a weakened rectus abdominis muscle.

Figure. 2 Performing a rectus abdominis muscle strength test

Statistical analysis

The analysis of the scores was performed using basic computational statistics (the mean and percentage differences) to present the distribution of the responses given by the subjects and using the Chi2 test with Yates' correction to verify the dependence between length of service and declared ailments. The Yates' continuity correction was applied because the chi-square distribution is a continuous distribution, and in the chi-square test we deal with natural numbers. With a small number of the subjects, it could disturb obtained scores, and thus there would be a chance of making a mistake while making inferences.

Results

Tinnitus	Yes	35%
	No	65%
Hand numbness	Yes	62.50%
	No	37.50%
Headaches	Often	35.00%
	Seldom	35.00%
	No	30%
Back pain	Yes	67.50%
	No	32.50%
Location of back pain	segm. C	42.50%
	segm. C-Th	7.50%
	segm. Th	2.50%
	segm. L	5.00%
	segm. L-S	55.00%
Physical activity	Yes	45.00%
	No	55.00%
Collisions	Yes	70.00%
	No	30.00%
Head protraction angle	Normal	40.00%
	Out of norm	60.00%

Table 1 Results of the interview and the assessment of head protraction.

More than half of the surveyed (65.0%) report they do not have tinnitus. It is present in 35.0% of the surveyed. Most of the study subjects (62.5%) report hand numbness. Negative answer was given by 37.5% of the surveyed. 35.0% of the surveyed declare that they often have headaches and 35% - rarely. 30.0% of the surveyed do not report headaches. Most of the study subjects (67.5%) report the presence of back pain syndromes. 32.5% of the subjects do not have them. 55.0% and 42.5% of the respondents respectively report suffering from pain in segm. L - S, or segm. C. The incidence of pain, segm. C - Th or segm. L, or segm. Th is reported by 7.5%, 5.0% and 2.5% of the study subjects respectively. Among the study subjects, 45.0% declare that they do sports /physical activity improving their condition. More than half of the surveyed (55.0%) do not do any physical activity. More than half of the respondents (70.0%) have experienced some collisions. Their absence is indicated by 30.0% of the surveyed. In 60.0% of the respondents the protraction angle is out of norm. It is normal in 40.0% of them.

Is there hand numbness?	Length of sevice				In total	The result of chi-square test with Yates' correction
	over 15 years		up to15 years			
	n	%	*n*	%	*n*	
yes	20	100.0	5	25.0	25	$\chi^2 = 20.907$
no	0	0.0	15	75.0	15	$df = 1$
In total	20	100.0	20	100.0	40	$p < 0.001$

Annotation. n – count; χ^2 – test statistic ; df – degrees of freedom; p – significance.

Table 2 Dependence between the subjects' length of service and the appearance of hand numbness

The test score was statistically significant ($p < 0.05$). This means that dependence between the variables was found. All of the study subjects (100.0%) with over 15 years length of service report hand numbness. This percentage in the group of subjects working up to 15 years was lower and amounted to 25.0%. Obtained scores prove that the hypothesis was confirmed.

Protraction angle	Length of service				In total	The result of chi-square test with Yates' correction
	over 15 years		up to 15 lat			
	n	%	*n*	%	*n*	
Out of norm	20	100.0	4	20.0	24	$\chi^2 = 23.438$ *df* = 1 *p*< 0.001
Normal	0	0.0	16	80.0	16	
In total	20	100.0	20	100.0	40	

Annotation. n – count; χ^2– test statistic; *df* – degrees of freedom; *p* – significance.

Table 3 Regularity of protraction angle in the subjects - dependence on length of service

The Spurling's test site of pain (N=40)	**Count**	**Percentage**
C3	1	2.5
C4	10	25.0
C5	13	32.5
C6	9	22.5
occiput area	2	5.0
Others	1	2.5
In total	36	0.0

Table 4 The Spurling's test - site of pain.

The Spurling's test caused the following sites of pain in the subjects: C5 (32.5%), C4 (25.0%), C6 (22.5%), C3 (2.5%), in occipital area (5.0%), others (2.5%).

The obtained test score was statistically significant ($p < 0.05$). This means that there was dependence between the variables. In 100.0% of study subjects with over 15 years of length of service the protraction angle was out of norm. This percentage in the surveyed working for up to 15 years was lower and was 20.0%. It was normal in 80.0% of people in this group.

There were statistically significant differences between the groups, so the hypothesis must be accepted.

Muscle strength - anterior scalene (N=40) **mięśni - pochyłe szyi przednie (N=40)** Muscle strength - the anterior scalenes	**Count**	**Percentage**
Head and neck trembling, endured 10s the head and nNeck trembling	2	5.0
Head and neck trembling, endured 11s	1	2.5
Head and neck trembling, endured 12s	4	10.0
Head and neck trembling, endured 14s	2	5.0
Head and neck trembling, endured 15s	2	5.0
Head and neck trembling, endured 16s	3	7.5
Head and neck trembling, endured 17s	5	12.5
Head and neck trembling, endured 20s	2	5.0
Head and neck trembling, endured 21s	2	5.0
Head and neck trembling, endured 25s	1	2.5
Head and neck trembling, endured 27s	1	2.5
Head and neck trembling, endured 29s	1	2.5
Head and neck trembling, endured 30s	2	5.0
Head and neck trembling, endured 32s	2	5.0
Head and neck trembling, endured 33s	2	5.0
Head and neck trembling, endured 35s	3	7.5
Head and neck trembling, endured 37s	2	5.0
Head and neck trembling, endured 40s	3	7.5
In total	40	100.0

Table 5 Muscle strength - anterior scalene

Among the subjects of the study, the following were found with regard to the strength of anterior scalene muscles: head and neck trembling, endured 10s (5.0%), head and neck trembling, endured 11s (2.5%), head and neck trembling, endured 12s (10, 0%), head and neck trembling, endured 14s (5.0%), head and neck trembling, endured 15s (5.0%), head and

neck trembling, endured 16s (7.5%), head and neck trembling, endured 17s (12.5%), head and neck trembling, endured 20s (5.0%), head and neck trembling, endured 21s (5.0%), head and neck trembling, endured 25s (2.5%)), head and neck trembling, endured 27s (2.5%), head and neck trembling, endured 29s (2.5%), head and neck trembling, endured 30s (5.0%), head and neck trembling, endured 32s (5.0%), head and neck trembling, endured 33s (5.0%), head and neck trembling, endured 35s (7.5%), head and neck trembling, endured 37s (5.0%) and head and neck trembling, endured 40s (7.5%).

Muscle strength - rectus abdominis muscle **(N=40)**	**Count**	**Percentage**
will not sit down unassisted	24	60.0
unassisted sitting position	9	22.5
unassisted sitting with great effort	7	17.5
In total	40	100.0

Table 6 Muscle strength - rectus abdominis muscle

In the case of rectus abdominis muscle strength, the majority of the surveyed (60.0%) cannot sit unassisted. 22.5% and 17.5% of the subjects performed unassisted sitting or sitting with great effort.

Discussion

A significant part of the society complains about health problems related to cervical spine. Our own study showed that back pain syndromes occur in as many as 67.5% of the studied drivers. Most often, this problem concerns lumbosacral segment, in 55% of the subjects, while problems with the cervical segment come second, in 42.5% of the subjects (Table 1).

Acc. to Joanna Bugajska and co-authors, back pain in most cases occurs through static loads, which are most often associated with keeping enforced body posture for an extended period of time. Most often it concerns lumbar and cervical spine. Intervertebral discs play an essential role in the amortization of movement, whereas during prolonged sitting posture, the curves of the spine change their position, whereby cervical lordosis is reduced by positioning the head forward [15]. Such dependence is confirmed by our own study, which showed significant reduction of cervical lordosis with the extension of the drivers' length of service (Table 3).

After examining the professional bus drivers' general health, it can be concluded that the biggest problem is headaches, which occur in 70% of the subjects. The second highest score was obtained by assessing hand numbness, where 62.5% of the examined drivers complained about this ailment, and 35% of the subjects complained about the incidence of tinnitus. The percentage of the subjects with hand numbness increases significantly with the extension of length of service (Table 2).

Looking at our own study, we can see that in the Spurling's test as many as 55% of the surveyed reported cervical pain. Most often, this pain was localized in C5 (32.5%), C4 (25%) and C6 vertebrae (22.5%) (Table 4). An interesting score was obtained by examining anterior scalene muscles. The biggest number of the subjects endured 17 seconds (12.5%), the longest endurance time was 40 seconds (7.5%), and the shortest 10 seconds (5%) (Table 5). These scores show that most of the subjects have problems with keeping their head up, which suggests a decrease in muscle endurance, even in the people who did not complain of cervical spine pain. An interesting result in our own study was obtained in the rectus abdominis muscle test, which showed that as many as 60% of the tested drivers were unable to adopt sitting position unassisted, 22.5% sat down unassisted, and 17.5% sat down with great effort (Table 6). The weakening of abdominal muscles may indicate instability of the torso which may result from sedentary lifestyle. During continuous sitting and wrong positioning of the body abdominal muscles which should work for our posture to be correct are switched off.

There are professions, e.g. office worker or professional driver where the position to be taken in the performance of duties is predetermined, and this work cannot be performed in a different position. While driving the vehicle, the driver assumes a quite characteristic posture. The driver's seat is not always positioned in such a way that the spine fits properly, but so that the driver is comfortable. The driver's hands rest on the steering wheel, which leads to positioning the shoulders in protraction. Very often with this positioning, the head also changes its position.

Prolonged, enforced static positions related to the performance of official duties lead to significant overload of the entire spine, which results in functional disorders as well as changes in tissue structures located around it [15, 16, 17].

The figure below shows how the body of a professional driver is arranged while driving.

Figure 3 Relaxed position of a bus driver

Looking at the photo of the driver sitting in a relaxed position (Figure 3) while performing his duties, we can notice some bad habits. The first thing we can notice is deepened thoracic kyphosis. Looking at the driver's shoulders, we can see that they are slightly moved forward, which may have been caused by a long drive in an unchanged position. While doing his job,

the driver has to to hold a steering wheel in his hands, which causes the entire upper limbs to be pulled forward, which in turn may trigger shoulder protraction.

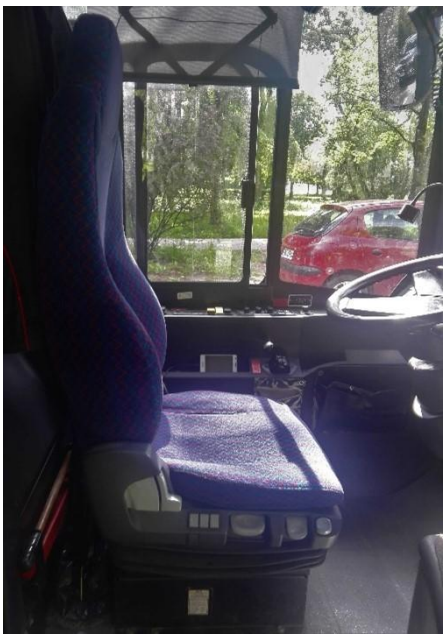

Figure 4 Professional driver's seat.

Figure 4 shows a professional driver's seat. The seat is equipped with delicate embossments that fill lordosis space at the level of lumbar segment. The seat is made of a soft material that should not only prevent discomfort during work but also prevent abrasions that could occur while sitting for a long time. On its side, we can see many buttons and levers which are used to adjust the seat so that the driver is well adjusted to driving the vehicle. A rubber harmonica-like part is also an interesting element of the bus driver's seat. As soon as the driver sits down and turns the key, the seat inflates automatically. The purpose of this function is to keep the air in the lower part of the seat so that a long ride is not so strenuous, and the driver's body is amortized while moving on the road. Looking at the attached figure, we can see how important it is that the workplace is properly adapted to the work we are supposed to do. Sometimes the slightest mistake could lead to wrong adjustment which will cause impediments and painful ailments in course of many hours, sometimes many years of driving.

Acc. to Jadwiga Siedlecka, the driver’s profession has an immense influence on the incidence of back pain. Both sedentary lifestyle and a poorly fitted chair contribute to the development of pain issues. The author also described the study conducted in California in 1998, which lasted 5 years and included a group of 1,449 professional drivers. In the course of the study, 320 people were found to have a spine disorder. Often, psychosocial aspects such as lack of job satisfaction or too high demands made by the employer, but also mechanical injuries to which a professional bus driver is exposed at any time are the reason for these disorder [16, 17].

Conclusions

1.Sedentary mode of work performed by drivers influences the appearance of backbone pain and change in the value of the cervical spine protraction angle.

2.Long sitting position leads to instability of the trunk, as well as increased thoracic kyphosis, which in turn leads to the development of cervical dyslordosis.

3.Unstable driver's sitting position during work leads to cervical hypotonia and hand numbness.

4.The bus driver is exposed to a lot of stress every day, resulting, i.a. from the responsibility he bears for passengers in the vehicle, as well as from heavy traffic, which leads to changes in myofascial tensioning, resulting in the incidence of pain.

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