

## ■ Research Article

# The effects of physical workload on cervical sagittal balance in surgeons

## *Cerrahlarda fiziksel iş yükünün servikal sagittal dengeye etkisi*

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### ABSTRACT

**Aim:** Surgeons are exposed to a variety of occupational risks, including work-related musculoskeletal disorders. Occupational necessities such as repetitive movements and long-term inappropriate posture in surgeons may be the cause of neck pain. This study evaluated the cervical sagittal balance parameters of the surgeons.

**Material and Methods:** This cross-sectional study included 57 patients with work-related neck pain between 2016 and 2019. T1S and Cobb angle were measured using magnetic resonance imaging. Personal characteristics of the participants, such as age, body mass index, height, and weight were obtained by a questionnaire filled in at the time of application.

**Results:** Fifty-seven participants were included in the study. Of these, 13 were neurosurgeons, 13 were otolaryngology surgeons, 12 were general surgeons, 11 were plastic surgeons, and 8 were cardiovascular surgeons. The mean age of the surgeons were  $38.7 \pm 6.44$  years and the mean VAS of the surgeons were  $5.12 \pm 0.73$ . The mean T1S was  $23.2 \pm 7.95$  ° and the mean Cobb angle was  $12.3 \pm 7.99$ °. In the neurosurgeons, the mean T1S was  $22.2 \pm 11.18$  ° and the mean Cobb angle was  $8.4 \pm 5.91$  °. Among all surgical branches, neurosurgeons had the lowest mean values in both T1s and Cobb angle measurements.

**Conclusion:** The physical workload of surgeons in their daily routines causes the cervical sagittal balance to deteriorate, suggesting that surgeons are in the high-risk group for occupational musculoskeletal diseases.

**Key words:** Neck pain, Cervical spine, T1 slope, cervical lordosis, surgeon

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## ÖZ

**Amaç:** Cerrahlar, işle ilgili kas-iskelet sistemi bozuklukları da dahil olmak üzere çeşitli mesleki risklere maruz kalmaktadır. Cerrahlarda tekrarlayan hareketler ve uzun süreli uygunsuz duruş gibi mesleki gereklilikler sonucu boyun ağrıları görülebilmektedir. Boyun ağrıları nedenleri arasında servikal sagittal denge parametrelerinin önemli bir yeri vardır. Bu çalışmada cerrahların servikal sagittal denge parametrelerinin değerlendirilmesi amaçlanmıştır.

**Gereç ve Yöntemler:** Bu kesitsel çalışmaya 2016-2019 yılları arasında işle ilgili boyun ağrısı olan 57 hasta dahil edildi. Manyetik rezonans görüntüleme kullanılarak T1S ve Cobb açısı ölçüldü. Katılımcıların yaş, vücut kitle indeksi, boy, kilo gibi kişisel özellikleri başvuru sırasında doldurulan anket ile elde edildi.

**Bulgular:** Çalışmaya elli yedi katılımcı dahil edildi. Bunların 13'ü beyin cerrahı, 13'ü kulak burun boğaz cerrahı, 12'si genel cerrah, 11'i plastik cerrah ve 8'i kalp ve damar cerrahıydı. Cerrahların ortalama yaşı  $38,7 \pm 6,44$  yıl ve ortalama VAS'ı  $5,12 \pm 0,73$  idi. Ortalama T1S  $23,2^\circ \pm 7,95^\circ$  ve ortalama Cobb açısı  $12,3^\circ \pm 7,99^\circ$  idi. Beyin cerrahlarında ortalama T1S  $22,2^\circ \pm 11,18^\circ$  ve ortalama Cobb açısı  $8,4^\circ \pm 5,91^\circ$  idi. Tüm cerrahi branşlar içinde hem T1 hem de Cobb açısı ölçümlerinde beyin ve sinir cerrahları en düşük ortalamaya sahipti.

**Sonuç:** Cerrahların günlük rutin iş yükü, servikal sagittal dengenin bozulmasına neden olmakta, bu da cerrahların mesleki kas-iskelet sistemi hastalıkları açısından yüksek risk grubunda olduğunu düşündürmektedir.

**Anahtar Kelimeler:** Boyun ağrısı, Servikal omurga, T1 eğimi, servikal lordoz, Cerrah

## Introduction

Neck pain has become a major health problem in modern society, and this is likely to be associated with adverse working conditions. The National Institute of Occupational Health (NIOSH) in the United States reported a relationship between the static load on the neck-shoulder muscle system; recurrent arm and hand movements; recurrent movements involving the same muscle groups with neck pain(1). In addition to physical risk factors in the work environment, it has been shown that working in negative psychosocial environments also may cause occupational neck pain(2, 3).

Heavy physical work with lifting, static muscular loading and inappropriate work positions are important risk factors for the development of occupational musculoskeletal diseases (4, 5). Surgeons are exposed to various physical and emotional risks during the day, although they are included in the white-collar employee group. It is stated that activities due to occupational necessity such as repetitive movements and long-term inappropriate posture in surgeons may be the cause of neck pain (6, 7).

In most of the studies that evaluated risk factors related to occupation, self-administered questionnaire was used. However, the evaluation of the effects of working conditions of occupational groups on the musculoskeletal system with radiological parameters allows us to obtain more objective data. Previous studies have reported that spinal sagittal

irregularity and spinal degeneration are closely related to clinical symptoms (8). The cervical sagittal balance is related to the T1 slope and T1 slope which is highly correlated with other cervical parameters and plays an important role in the cervical sagittal alignment (9, 10). In patients with higher T1 slope, the risk of end plate damage and disc degeneration increases, and more cervical lordosis and energy expenditure is needed to maintain the horizontal balance (11). In addition, decreased segmental or global cervical lordosis is associated with degenerative changes of the cervical spine and is a cause of neck pain (12). Therefore, we think that these radiological parameters are appropriate to evaluate the effects of long-term biomechanical imbalance.

The aim of this study is to evaluate the cervical sagittal balance and spinal degeneration parameters of the among surgeons.

## Material and Methods

### Study Design and Population

Before starting this study, approval was obtained from the Ethics Committee of Ahi Evran University Faculty of Medicine and informed consent was acquired from all patients who were willing to participate in the study before the data was received. This cross-sectional study includes the surgeons with neck pain between 2016 and 2019. Neck pain and disability scales were filled, and cervical MRI was performed to all patients at the time of application. Inclusion criteria; Surgeons between ages 20-50 with neck pain, with or without neurological

symptoms and, a weekly operation time of  $\geq 30$  hours / week for at least two years, were included. Exclusion criteria: trauma, rheumatoid arthritis, spine tumors, patients with a history of cervical spine surgery. The study group includes neurosurgeons, ear nose throat surgeons, cardiovascular surgeons, general surgeons and plastic surgeons. The patient's informed consent was obtained from every participant.

### Data Collection

Personal characteristics of the participants such as age, body mass index, height, smoking habits and marital status were obtained by a questionnaire filled in at the time of application. As a part of their clinical evaluation, the patients' clinical profiles were assessed using standardized questionnaires. Neck pain was evaluated using the visual analog scale. Neck pain was evaluated using the visual analog scale.

MRIs were performed in the radiology department of our hospital independent of the study, using the patient in the supine position. All images were obtained using the same imaging system. The standard hospital protocol for the cervical spine was used for each patient in the MRI unit. Cobb angle and T1S measurements were measured simultaneously by two spinal surgeons using the hospital imaging software system. Measurements made from mid-sagittal line. T1S is defined as the angle between the line drawn parallel to the upper end plate of T1 and the line drawn in the horizontal plane. The Cobb angle (sagittal lordosis) was measured as the angle between the parallel line to the lower end plate of C2 and the parallel line drawn to the lower end plate of the C7. Disc degeneration assessment between C2 and C7 was performed using Miyazaki's grading system<sup>22</sup>) and sagittal MRI images.

Statistical analysis was performed using the MedCalc Statistical

Software version 12.7.7 (MedCalc Software bvba, Ostend, Belgium; <http://www.medcalc.org>; 2013). Descriptive statistics were presented using mean and Standard deviation for normally distributed variables and median (and minimum-maximum) for the non-normally distributed variables. Non-parametric statistical methods were used for values with skewed distribution. For comparison of two non-normally distributed groups Mann Whitney U test was used. Statistical significance was accepted when two-sided p value was lower than 0.05.

### Results

Fifty-seven participants were included in the study. Of these, 13 were neurosurgeons, 13 were otolaryngology surgeons, 12 were general surgeons, 11 were plastic surgeons, and 8 were cardiovascular surgeons. The mean age of the surgeons were  $38.7 \pm 6.44$  years and the mean VAS of the surgeons were  $5.12 \pm 0.73$ . The demographic data of the subgroups are presented in Table 1.

When the surgeons' weekly surgical operation times were evaluated, the average weekly operation time of neurosurgeons was  $> 40$  hours, while the average weekly operation times of cardiovascular surgeon, otolaryngology surgeons, general surgeons and plastic surgeons were found to be  $< 40$  hours. There was no statistically significant difference between the surgical branches in terms of personal characteristics such as body mass index, height, weight.

The mean T1S was  $23.2^\circ \pm 7.95^\circ$  (range,  $9^\circ - 40^\circ$ ) and the mean Cobb angle was  $12.3^\circ \pm 7.99^\circ$  (range,  $2^\circ - 29^\circ$ ). Radiological measurements of all surgical branches are summarized in Table 2.

In the neurosurgeons, the mean T1S was  $22.2^\circ \pm 11.18^\circ$  (range,  $9^\circ - 40^\circ$ ) and the mean Cobb angle was  $8.4^\circ \pm 5.91^\circ$  (range,  $3^\circ - 21^\circ$ ). Among all surgical branches, neurosurgeons had the lowest mean values in both T1s and Cobb angle measurements (Table

**Table 1.** The demographic data of the according to surgical branches.

Variable	Neurosurgeons	Cardiovascular surgeon	General surgeon	ENT surgeon	Plastic surgeon	p value
Age (yr)	38.8 $\pm$ 5.97	39.1 $\pm$ 4.79	39.5 $\pm$ 5.36	34.4 $\pm$ 6.66	42.5 $\pm$ 6.93	0.797
VAS	5.2 $\pm$ 0.83	5.3 $\pm$ 0.71	5.1 $\pm$ 0.67	4.9 $\pm$ 0.76	5.2 $\pm$ 0.75	0.875
Weight (kg)	75.8 $\pm$ 8.08	74.9 $\pm$ 3.23	73.3 $\pm$ 6.42	75.5 $\pm$ 8.86	73.9 $\pm$ 10.15	0.919
Height (cm)	170.8 $\pm$ 5.81	173.7 $\pm$ 3.81	169.9 $\pm$ 7.39	168.2 $\pm$ 8.47	167.9 $\pm$ 6.31	0.177
BMI (kg/m <sup>2</sup> )	25.9 $\pm$ 1.71	24.8 $\pm$ 1.29	25.4 $\pm$ 1.29	26.7 $\pm$ 2.37	26.2 $\pm$ 3.07	0.916

Abbreviations: ENT: Ear, nose and throat

**Table 2.** T1s and Cobb angle measurements according to surgical branches

Variable	Total study population	neurosurgeons	Cardiovascular surgeon	General surgeon	ENT surgeon	Plastic Surgeon
T1 slope ( $^\circ$ )	23.1 $\pm$ 8.05	22.2 $\pm$ 11.18	23.5 $\pm$ 7.6	21.8 $\pm$ 6.17	23.8 $\pm$ 8.44	24.1 $\pm$ 6.34
Cervical lordosis ( $^\circ$ )	12.3 $\pm$ 7.99	8.4 $\pm$ 5.91	11.1 $\pm$ 9.34	12.3 $\pm$ 8.8	14.9 $\pm$ 6.46	14.6 $\pm$ 9.13

Abbreviations: ENT: Ear, nose and throat

**Table 3.** Comparison between neurosurgeons and other surgical branches

Variable	Neurosurgeons	Others	p
Age (yr)	38.8±5.97	38.5±6.59	0.779
VAS	5.2±0.83	5.09±0.71	0.718
T1 slope (°)	22.2±11.18	23.3±7.02	0.818
Cervical lordosis (°)	8.4±5.91	13.5±8.20	0.046

## Discussion

In this study, cervical spine alignment measurements and segmental disc degeneration rates of surgeons with neck pain were compared. When evaluating occupational musculoskeletal diseases, most of the time questionnaire was used. This situation may affect the results of the study, depending on many factors (high quantitative demands, low social support, and low influence at work). However, musculoskeletal diseases are known to recur with intervals(13, 14). There may be some changes at intensity of complaints even in the same individual who is evaluated at two different times. Therefore, we think that the examination of radiological images is more valuable than questionnaire studies in order to evaluate the effects of physical workload and working in adverse psychosocially environments on musculoskeletal diseases.

The cervical sagittal balance defines how the cervical spine is positioned in the sagittal plane. In many studies conducted about this subject, the deterioration of cervical sagittal balance has been reported to cause headache, neck pain and poor quality of life(15, 16, 17, 18). Deterioration of the cervical spine balance changes the load distribution and momentum between the vertebrae and causes degeneration in the segment that is exposed to the maximum load(19). T1 slope is a useful parameter for evaluating sagittal balance(20, 21). Yang et al. reported that patients with low T1 slope less than 25 ° had a higher degree of degeneration independent from age and gender and T1 slope less than 25 ° is a potential risk factor for cervical spondylosis development(22). In addition, high T1 slope causes patients to spend more energy on the posterior neck muscles to maintain horizontal view and horizontal balance(20). This causes the muscles to become tired more easily and cause pain. Therefore, surgeons who need long-term flexion and rotation of the neck, have higher risk for neck pain. In the present study, the mean T1S values of all surgical branches included in the study were found to be <25 (Table 2). These results suggest that surgeons have risk of occupational neck pain.

Loss of the cervical lordosis causes an increase in the length and tension of the posterior spinal muscles(23). The tension in these muscles is thought to cause neck pain or cervicogenic headache(24). McAviney et al. evaluated 277 patients with or without neck pain and reported that hypo-lordosis (cervical angle  $\leq 20^\circ$ ) was associated with neck pain(15). Therefore, in our study, we used the Cobb angle to evaluate the occupational neck pain. The mean Cobb angle was  $12.3^\circ \pm 7.99^\circ$  in the surgeons. These results suggest that surgeons may have loss of cervical lordosis and related neck pain complaints. In addition, when surgeons are evaluated among themselves, neurosurgeons are shown to have worse Cobb angle measurements than other surgical groups, since neurosurgeons have both longer weekly operation times than others and use auxiliary equipment (microscope or loop) in all surgeries (Table 3).

It is known that neck is the most affected body region during surgical operations(25). Equipment widely used by surgeons such as microscopes, endoscopes and loupes cause a significant increase in the load on the cervical spine(26). In addition, inappropriate working conditions such as prolonged standing inappropriate posture and neck flexion, are known to increase the risk of developing neck pain(27, 28, 29, 30). The results of our study also showed that surgeons had almost the same risk for occupational neck pain.

## Study limitations

This study has several limitations. The first one is that there are small number of patients due to specificity of job groups and age categories. Second one is asymptomatic individuals from both groups were not taken into evaluation. Since the evaluation of asymptomatic individuals in our study was not performed, the relationship between the radiological parameters and clinical symptoms could not be clearly evaluated.

## Conclusion

The physical workload of surgeons in their daily routines causes the cervical sagittal balance to deteriorate, suggesting that surgeons are in the high-risk group for occupational musculoskeletal diseases.

## Conflict of Interest

No conflict of interest was declared by the authors. In addition, no financial support was received for this study.

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