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Evaluation of the Correlation Between Vertical Facial Discrepancies and Cervical Vertebral Fusion

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ABSTRACT

Background and aim: To date, the possibility of any correlation between pathological problems associated with cervical vertebral fusion and long facial pattern has been limitedly assessed. The aim of the present study was to find the correlation between the risk of fusion in cervical vertebrae and long facial pattern in adults.

Materials and methods: In the present cross-sectional study, 80 lateral cephalograms with proper density and contrast were selected. The vertical facial dimension was analyzed to determine normal and long face patterns and to divide the samples into control and case groups, respectively. Cervical vertebrae were observed to detect the continuance of radiopacity between cervical vertebrae, which is considered as a risk of fusion. Data were transferred to SPSS software, and Pearson's chi-squared test was used to detect the correlation between cervical vertebral fusion and the vertical facial pattern.

Results: The analysis of the data showed that the number of samples with fusion was higher in long face samples than in samples with normal vertical facial dimensions. Pearson's chi-squared test revealed a correlation between the vertical facial pattern and the risk of fusion in cervical vertebrae ($P<0.001$).

Conclusion: According to the results, there is a correlation between an increase in the vertical facial dimension and the prevalence of cervical vertebral fusion.

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Introduction:

A variety of factors such as gender, age, ethnicity, and dysfunction and diseases of the airways and the temporomandibular joint (TMJ) can affect the morphology of the craniofacial structures.[1] While the lower third of the face, including the jaws and condyles, originates from the neural crest, cervical vertebrae and posterior part of the cranium are developed from the notochord.[2] However, according to previous studies, the facial morphology affects the morphology of cervical vertebrae.[1,3-5] Of other factors that can affect both facial and cervical postures is the res-piratory needs.[4,6-8] Solow et al,[6] Wenzel et al,[7] and Chen et al[8] reported a correlation between the respiratory needs and the head position. The position of the head and its effects on the cervical vertebral condition have been evaluated in studies by Arntsen and Sonnesen[9] and Kim et al; [10] they found more abnormalities in cervical vertebrae with abnormal head postures. The relationship between vertical facial discrepancies and the cervicovertebral morphology has been evaluated by Trajković et al.[1] They found that subjects with an anterior facial growth rotation have greater cervical spine inclination and angulation, greater cervical vertebrae and intervertebral spaces, longer upper cervical spines, and shorter Gonion to C2 (GoC2) and Pterygomaxillare to C2 (PmC2) distances.[1] Furthermore, they found that males show smaller cer-vical column curvature but greater cervical vertebrae and greater length of the upper cervical spine.[1] Anterior and posterior facial growth patterns can lead to vertical orthognathic discrep-ancies between the upper and lower jaws.[1] Previous studies have confirmed the impact of vertical and sagittal parameters of the craniofacial system on the morphology of cervical vertebrae.[1,3,5,9,10] Unfortunately, although some studies have been conducted to evaluate the relation-ship between the facial morphology and the cervical vertebral morphology, the possibility of any correlation between pathological problems associated with cervical vertebral fusion and long facial pattern has been limitedly assessed. The aim of the present study was to determine the correlation between cervical vertebral fusion and long facial pattern in adults.

Materials and Methods:

The samples of the present cross-sectional study were selected from the archived standard lateral cephalograms of patients who referred for orthodontic treatment to the Department of Orthodontics of the Dental Faculty of Islamic Azad University of Medical Sciences, Tehran, Iran, between September 2012 and December 2017. The files and the records of the patients were reviewed in order to extract the necessary information.

The lateral cephalograms had appropriate density and contrast and had been taken by the same unit (Rotograph EVO D, Villa Sistemi Medicali S.p.A, Bologna, Italy) in the natural head position and according to the recommended settings for taking lateral cephalograms to prevent any magnification and to ensure the standard position of cervical vertebrae.[11] Only lateral cephalograms of 18-30-year-old patients without any previous history of orthognathic surgery, orthodontic treatment, temporomandibular problems, respiratory diseases, muscular diseases, syndromes, or scar tissue on the face or neck were included in the study. Moreover, to eliminate the effects of sagittal skeletal discrepancies on the variables, overjet, SNA, and SNB were measured, and cases out of the range of ANB=2±2 were excluded. Samples with abnormal function of the tongue were also excluded. Finally, 80 samples were selected from among 183 lateral cephalograms.

To determine the vertical facial pattern of the samples, lateral cephalograms were manually traced using acetate papers and an H3 pencil. In cases with double mandibular borders, the mean constructed line was considered. SNA, SNB, ANB, Upper Anterior Facial Height/Lower Anteri-or Facial Height (UAFH/LAFH), and SN-MP were measured by a single observer, and data were transferred to data sheets. Patients with a normal UAFH/LAFH=65-75% and MM=32 degrees were assigned to the control group, and patients with an abnormal UAFH/LAFH=0.68±0.06

and MM>28 degrees (more than the normal value) were assigned to the case group.

To evaluate the possibility of fusion in cervical vertebrae, the lateral cephalograms were examined by two researchers. Vertebral fusion (continuous fusion) was recognized as an osseous continuity between cervical vertebrae without complete separation at the articular facets or at the intervertebral disc space.[5] It was important to observe a complete radiopacity between the ver-tebrae on the lateral cephalograms.

SPSS for iOS (version 23, IBM Corp., Armonk, NY, USA) was used to analyze the data. To assess the reproducibility of the measurements and the observer's error, the second researcher reviewed the records, and the data were analyzed by comparing the means. Pearson's chi-squared test was used to determine the relationship between cervical vertebral fusion and the vertical facial pattern.

Results:

The results of comparing the means of the measurements between the two observers by t-test showed no statistically significant error in the measurements (P=0.9).

Demographic information of the samples, including 26 men and 14 women, has been given in Table 1.

Table 1. Prevalence of vertical facial discrepancy according to the studied variables

Variable/ Vertical discrepancy		No	Yes
Age (year)	Mean±SD	23.15±5.23	20.87±3.84
Gender	Male(%)	35	42
	Female(%)	65	58
Overjet	Normal(%)	70	60
	Abnormal(%)	30	40
Overbite	Normal(%)	43	11
	Abnormal(%)	57	89
SNA	Normal(%)	57.5	52.5
	Abnormal(%)	42.5	47.5
SNB	Normal(%)	52.5	32.5
	Abnormal(%)	47.5	67.5
UAFH/LAFH	Normal(%)	80	75
	Abnormal(%)	20	25
MM	Normal(%)	85	55
	Abnormal(%)	15	45
SN-MP	Normal(%)	4	98
	Abnormal(%)	96	2
Growth pattern	Normal(%)	38	9
	Abnormal(%)	62	91

SD=Standard Deviation

Table 2 displays the results regarding the prevalence of fusion in long and normal facial patterns. The table shows that the number of samples with vertebral fusion is greater in the case group. In both groups, discontinuous fusion was observed; nevertheless, only continuous fusion was considered as vertebral fusion. There was a risk of fusion between C4-C5, C3-C4, C3-C2, and sometimes, between all cervical vertebrae in the case group. Factors related to fusion were long face pattern (SN-MP) and cervical curvature (CVT-OPT).

Table 2. Prevalence of cervical vertebral fusion in long and normal facial patterns

Vertical Discrepancy		No	Yes
Cervical Vertebral Fusion	No	30(75%)	15(37.5%)
	Yes	10(25%)	25(62.5%)
	Test result	P<0.001,25= (80N=2) 2X	

Pearson's chi-squared test showed the higher prevalence of fusion in the case group in comparison with the control group; the difference was statistically significant (P<0.001).

Discussion:

The results of the present study showed that the prevalence of fusion in cervical vertebrae was different between patients with normal (25%) and long (62.5%) facial patterns. The analysis of this difference by Pearson›s chi-squared test revealed that there was a correlation between long facial pattern and the prevalence of cervical vertebral fusion.

The cervical vertebral morphology has been extensively evaluated on lateral cephalograms. However, in particular, the evaluation of cervical vertebral fusion has not been reported in resources such as Scopus, PubMed, and ClinicalKey. Although it has been claimed by some researchers that twodimensional (2D) radiographs, such as lateral cephalograms, have limitations regarding the diagnosis of fusion,[12] some others have mentioned that lateral cephalograms can be used as a screening diagnostic record for the diagnosis of fusion in cervical vertebrae.[4,5] It is obvious that radiographs have some limitations when used as a research tool. On the other hand, it is necessary to obtain lateral cephalograms for orthodontic diagnosis and treatment planning. Therefore, it seems beneficial to use lateral cephalograms to study the relationship between different anomalies which can be observed in a single radiograph. The aim of the present research was to evaluate the relationship between long facial pattern and the possibility of fusion in cervical vertebrae. The risk factors that increase the risk of fusion are related to the morphology of cervical vertebrae. An inadequate intervertebral space can lead to a higher risk of fusion between two adjacent vertebrae.[8] The present study suggests the possibility of using lateral cephalograms as a screening tool to diagnose the risk of cervical vertebral fusion in patients and to determine the possible relationship between specific facial patterns, such as long facial pattern, and the risk of fusion.

In studying the morphology of cervical vertebrae, Trajković et al found that subjects with vertical facial growth pattern had greater cervical spine inclination and angulation, greater cervical vertebrae and intervertebral spaces, and longer upper cervical spines.[1] They attributed the variations to what they considered head position changes due to physiological alterations induced by respiratory needs.[1] While they found a change as a result of an alteration in the vertical facial pattern, in the present study, the presence of fusion was evaluated. The results of both studies showed a correlation between the vertical facial pattern and risk of pathologies in cervical vertebrae; the similar findings can be justified by considering the similar methodologies of the two studies. However, there were differences in the variables assessed in the two studies. Trajković et al mainly focused on the anatomical features of cervical vertebrae, which at first was necessary to find the possible changes in the morphology of cervical vertebrae.[1] The present study was designed to specifically evaluate pathological conditions, such as fusion, to gather novel information.

There are limitations with respect to the use of lateral cephalograms to evaluate fusion in cer-

vical vertebrae. How lateral cephalograms are taken can affect the field and the visibility of cervical vertebrae. It is not possible to observe all cervical vertebrae in most lateral cephalograms. In addition, for safety purposes, it is recommended to use a cervical shield to protect the thyroid gland; in such cases, the evaluation of cervical vertebrae is impossible.

To find more accurate results, it is suggested to conduct further studies to evaluate this relationship longitudinally. It is also recommended to use growthbased superimposition to decrease errors in the diagnosis of cervical vertebral fusion.

Conclusion:

It can be concluded that there is a correlation between an increase in the vertical facial dimension and the prevalence of cervical vertebral fusion.

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