Editor-in-Chief : Atul Goel (INDIA)
Open Access HTML Format
Journal of Craniovertebral Junction and Spine

Original Article

The distribution of cervical vertebrae anomalies among dental malocclusions

Hasan Kamak, Eren Yildırım[1]

Departments of Orthodontics and [1]Oral and Maxillofacial Radiology, Faculty of Dentistry, Kirikkale University, Kirikkale, Turkey

Corresponding author: Dr. Hasan Kamak, Department of Orthodontics, Faculty of Dentistry, Kirikkale University 71100, Kirikkale, Turkey. E-mail: hkamak@gmail.com

Journal of Craniovertebral Junction and Spine 2015, 6:40

Abstract

Aims: The aims of our study were to investigate the distribution of cervical vertebrae anomalies (CVAs) among dental Angle Class I, II, and III malocclusions in Turkish population and whether a correlation between CVA and dental malocclusion. **Materials and Methods:** The study was performed on lateral cephalometric radiographs which were taken at the Department of Orthodontics, Faculty of Dentistry, Kirikkale University. The final sample of 318 orthodontic patients was included in the study. Dental malocclusions were performed according to Angle classification. CVAs were categorized: (1) fusion and (2) posterior arch deficiency (PAD). The Chi-square test was used to the analysis of the potential differences among dental malocclusions. **Results:** The final sample of 318 patients was examined. CVA was observed in 42 individuals (of 26 [8.17%] had fusion and 16 [5.03%] had PAD), with a frequency of 13.2%. Of the 26 fusion defect, 8 (30.7%) had Angle Class I, 8 (30.7%) had Angle Class II, and 10 (38.4%) had Angle Class III malocclusion. Of the 16 PAD, 8 (50%) had Angle Class I, 8 (50%) had Angle Class II but no patients with Angle Class III malocclusion was observed. The distribution of dental malocclusions regarding CVA was not statistically significant ($P = 0.076$). Of these 42 individuals with CVA, 52.3% (15 fusions and 7 PAD) were females and 47.7% (11 fusions and 9 PAD) were males. **Conclusion:** In our study, the prevalence of fusion and PAD were found 8.1% and 5.0% in Turkish population, respectively. Besides, no statistically significant correlation between CVA and Angle Class I, II, and III malocclusions were found. Our findings support the studies showing no gender dimorphism.

Key words: Anomaly, cervical vertebrae, dental malocclusion

INTRODUCTION

The first and second vertebrae (atlas and axis, respectively) are different from others with their function and anatomy.[1] Normally, the intervertebral disc is located between two vertebrae, but not located between atlas and axis.[2] The most common cervical vertebrae anomalies (CVAs) are fusion and posterior arch deficiency (PAD).[3,4] The second (C2) and third (C3) cervical vertebrae are most commonly influenced by fusion.[5] Posterior arch anomalies occur probably the result of a locally decreased blood supply during fetal development. CVA is often asymptomatic, but aging and injury may expose symptoms.[5]

Access this article online

Quick Response Code:

Website: www.jcvjs.com

DOI: 10.4103/0974-8237.167857

How to cite this article: Kamak H, Yildirim E. The distribution of cervical vertebrae anomalies among dental malocclusions. J Craniovert Jun Spine 2015;6:158-61.

Skeletal deviations in maxillofacial region, head and neck posture deformities, cervical inclination, and orthopedic findings can be associated with malocclusion.[6-9] Several studies declared the relation between the cervical vertebrae morphology and position of the mandible.[10,11]

CVA is often asymptomatic, for this reason, patients may notice anomalies with decrease age or an injury. Orthodontists may play an essential role to early diagnose of CVA. Lateral cephalogram is the most commonly used radiographs in orthodontia clinics. The pathologic condition may reveal with the radiographic examination. Although orthodontists do not have to be experts in CVA, they should be careful about the cervical vertebrae anatomy. Hence, the orthodontist may be the first person detects the patients with CVA. These patients should be directed to the experts early as possible and prevents progressively degenerative neurologic defects.[12]

CVAs are associated with skeletal malocclusions and have been documented extensively in published studies. The present study is the first report to determine the frequency of CVAs in orthodontic patients with dental malocclusions.

The aims of this study were to investigate the distribution of CVAs among Angle Class I, II, and III malocclusions in a Turkish patient population and whether a correlation between CVA and dental malocclusion; thus, being the first series of CVAs in our population described in the English literature.

MATERIALS AND METHODS

A power analysis conducted using the G*power version 3.1.7. Software (Franz Faul, Universität Kiel, Germany) indicated that a total sample size of 150 patients would give more than 80% power (actual power = 0.8229) to detect significant differences with an effect size of 0.30 at an $\alpha = 0.05$ level of significance (critical $\chi^2 = 11.0705$; noncentrality parameter $\lambda = 13.5000$).

The study was performed on 318 patients' clinical records (case histories, lateral cephalometric radiographs, and study models) which were taken in archive at the Department of Orthodontics, Faculty of Dentistry, Kirikkale University. These records were used to determine CVAs. If an accurate diagnosis of the CVA could not be made from these records, the subject was excluded from the study. Exclusion criteria included the patients, who were less than 18 years of age, had records with poor quality radiographs, had craniofacial anomaly and systemic muscle or joint disorder and, wound, burns, or scarring in the head and neck. Subjects were selected according to the following criteria: Turkish with Turkish grandparents, no history of trauma, and previous orthodontic treatment, study models including the first molars and standardized lateral cephalometric radiographs with the first five cervical vertebrae visible. A total of 341 subjects were included in the study, but 23 subjects with developmental anomalies were excluded. All patients were in cervical stage 6 of cervical vertebral maturation.[13,14]

The radiographs of the patients were obtained with the teeth in occlusion, the lips in a relaxed position in a standardized head posture (the Frankfort plane parallel to the horizontal). The radiographs were taken by an experienced X-ray technician using an orthopantograph (Planmeca Proline CC 2002, Helsinki, Finland) with a film-to-focus distance of 165 cm and a film-to-median plane distance of 15 cm. Dental malocclusion groups observed through molar relationship in plaster models were divided into Angle Class I, II, and III according to Angle's classification.[15] Angle Class I: Normal relationship of the molars (mesiobuccal cusp of the upper molar occludes in buccal groove of the lower molar), but a line of occlusion incorrect because of malposed teeth, rotation, or other causes. Angle Class II: Lower molar distally positioned relative to upper molar, a line of occlusion not specified. Angle Class III: Lower molar mesially positioned relative to upper molar, a line of occlusion not specified.

The first five cervical vertebrae were examined in radiographs. CVAs were categorized and recorded for all patients:

1. Fusion and
2. PAD.

Fusion was defined as no intradiscal radiolucency or osseous continuities without complete separation between two cervical vertebrae.[4,10] PAD was defined as a uniform radio-opacity without an internal cortical outline at the posterior arch of the cervical vertebra.[4,10]

All orthodontic examinations were performed by an orthodontist (H.K.). The lateral cephalograms were examined by an orthodontist (H.K.) and a dentomaxillofacial radiologist (E.Y.) simultaneously. To determine errors in the methods, 20% of the subjects with or without CVA were selected randomly. First, each radiograph was separately evaluated by authors, but a final examination was done together, so a sentence was made to decide. In addition, the same examiners twice reevaluated all of the radiographs after 4 weeks of the first evaluation.

A paired *t*-test was applied to both the first set and a second set of measurements, and no significant difference was found between the two sets. Intra-examiner reproducibility was found to be 90 and 92%, respectively, and the agreement between both investigators was 95%.

The Chi-square and Fisher's exact test were used to determine the potential differences in the distribution of dental malocclusions, and genders when stratified by CVAs. Pearson's correlation test was used to determine the correlation between CVAs and different parameters (dental malocclusions and genders). All of the statistical analyzes were performed with the SPSS software package (SPSS version 16.0, SPSS Inc., 233 South Wacker Drive, 11th Floor, Chicago, IL, USA). A $P < 0.05$ was considered statistically significant.

RESULTS

The final sample of 318 patients was examined (170 females and 148 males, mean age; 20 ± 0.9 years from 18 and 29 years). Of these 318 patients, 98 (30.81%) had Angle Class I, 124 (38.99%) had Angle Class II, and 96 (30.18%) had Angle

Class III malocclusion. CVA was observed in 42 individuals (of which 26 [8.1%] had fusion and 16 [5.0%] had PAD), with a frequency of 13.2%.

Of the 26 fusion defect, 8 (30.8%) had Angle Class I, 8 (30.8%) had Angle Class II, and 10 (38.4%) had Angle Class III malocclusion. Of the 16 PAD, 8 (50%) had Angle Class I, 8 (50%) had Angle Class II but no patients with Angle Class III malocclusion was observed. The distribution of dental malocclusions regarding CVAs was not statistically significant ($P = 0.076$) [Table 1].

Of these 42 individuals with CVA, 52.3% (15 fusions and 7 PAD) were females and 47.7% (11 fusions and 9 PAD) were males. The CVAs and the gender were also compared [Table 2] and no statistically significant differences were found ($P = 0.339$). As shown in Table 3, statistically significant negative correlation ($P = 0.025$) was found among CVAs and dental malocclusions, but no statistically significant correlation was found between CVAs and genders.

DISCUSSION

According to the sample size calculation for a power of 0.80 at $\alpha = 0.05$ significant level, 150 subjects would be sufficient. At baseline, there were 341 subjects for this study group; Twenty-three subjects in the study group have been excluded from the study. At the end of the study, there were 318 patients for the study group. Thus, the power of the study has been increased.

Correlation between CVA and vertebrae morphology, craniofacial malformations, and skeletal malocclusions were reported in the previous studies.[16-18] The aims of our study were to identify the prevalence of CVA in Turkish population and also whether there is a correlation between CVA and dental malocclusion. In our study, the prevalence of fusion and PAD were found 8.1% and 5.0%, respectively [Table 1]. Besides, a statistically significant correlation ($P = 0.025$) was found among CVA and dental malocclusions [Table 3]. The prevalence of CVA was reported with a wide range of 0-61.4% in the literature.[16,17] Sonnesen and Kjaer[17] reported that the incidence of fusion (61.4%) more common in skeletal Class III patients and skeletal horizontal overjet when compared with control group (14.3%). However, they found that no statistically significant relation between PAD and controls. They revealed that if a skeletal horizontal overjet was caused by maxillary retrognathia, the decreased prevalence of fusion more likely seen. Faruqui *et al.*[18] reported that the descending distribution of CVA were determined in skeletal Class I, II, and III malocclusion, respectively (17). In addition, a higher prevalence of C1 level partial cleft and occipitalization was reported in their study. The differences between the studies were explained with the study methods. Our study was designed to investigate dental malocclusion, but the previous studies were planned to examine skeletal anomalies. To the best of our knowledge, this is the first study evaluate the frequency and distribution of CVAs in orthodontic patients with dental malocclusions.

Sonnesen *et al.*[19] had stated that the angle of the cranial base and the head posture deviations were sexually dimorphic, females showing larger cervicohorizontal, and cranial base angles than males. In addition, they reported that the relation between the cervical column fusion and cranial base angle, the inclination of the upper cervical spine and cervical lordosis were determined in females. However, this relation was not determined in males. Hence, it could be hypothesized that cervical column fusion has a dimorphic pattern in their occurrence. In contrast, some researchers[18,20,21] affirmed that there was no significant relation between gender and the occurrence of CVA in their studies. No statistically significant correlation was found between CVAs and genders [Table 3]. So that, our findings supports the studies showing no gender dimorphism [Table 2].

It is not clear why vertebral anomalies occur and why these anomalies occur in different craniofacial morphology groups and skeletal malocclusion traits. The genetic studies and insight of the early embryogenesis might be essential to understand the etiology of the CVA.[22-24] The recent studies affirmed that the notochord may be responsible to these anomalies. Because the vertebral bodies were formed around the notochord in the prenatal period. Besides, the jaws develop from the migration of the neural crest cells to the craniofacial area before the notochord is surrounded by bone tissue. However, the association between the precise signaling of notochord to the neural crest and the migration of the neural crest cells to the craniofacial area is still unknown.[25-27]

Lateral cephalograms are usually used in orthodontic clinics to planning pretreatment and examined the postorthodontic treatment results. The CVAs are often determined with lateral cephalograms. The orthodontic clinician may be the first person to detect these anomalies. Early diagnose of these pathologies on cephalograms can provide essential documentation to the patient due to symptoms, injury, aging, and progression

Table 1: The distribution of CVAs according to dental malocclusions

Dental malocclusions	CVAs			Total (%)	*P*
	Fusion (%)	Normal (%)	PAD (%)		
Angle Class I	8 (30.8)	82 (29.7)	8 (50.0)	98 (30.9)	0.076[NS]
Angle Class II	8 (30.8)	108 (39.1)	8 (50.0)	124 (38.9)	
Angle Class III	10 (38.4)	86 (31.2)	0 (0.0)	96 (30.1)	
Total	26 (8.1)	276 (86.9)	16 (5.0)	318 (100)	

CVAs: Cervical vertebrae anomalies, PAD: Posterior arch deficiency, NS: Not significant

Table 2: The distribution of CVA according to gender

Gender	Fusion (%)	PAD (%)	Total (%)	*P*
Female	15 (57.7)	7 (43.7)	22 (52.3)	0.339^{NS}
Male	11 (42.3)	9 (56.3)	20 (47.7)	
Total	26 (61.9)	16 (39.1)	42 (100.0)	

CVA: Cervical vertebrae anomalies, PAD: Posterior arch deficiency, NS: Not significant

Table 3: The correlation between CVAs and different parameters

Parameters	CVAs	
	r	*P*
Dental malocclusions	–0.113	0.025*
Gender	–0.346	0.475^{NS}

**P* < 0.05, NS: Not significant, *r*: Correlation coefficient, CVA: Cervical vertebrae anomalies

of the degenerative process. However, two-dimensional radiographs may not be valid in the diagnosis of CVA, because of the superimposition of the spine inclination and radiographic overlapping of the facets.[16] For this reason, the suspectable sign of CVA on cephalogram is reevaluated with three-dimensional imaging systems like cone beam computed tomography to prevent misdiagnose.[5]

CONCLUSIONS

In our study:

1. The prevalence of fusion and PAD were found 8.1% and 5.0% in Turkish population, respectively
2. Statistically significant differences were found among the dental malocclusions, and no statistically significant correlation between CVA and Angle Class I, II, and III malocclusion
3. No statistically significant differences were also found between the genders, and no statistically significant correlation between CVA and genders were found.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Bailey DK. The normal cervical spine in infants and children. Radiology 1952;59:712-9.
2. Gray SW, Romaine CB, Skandalakis JE. Congenital fusion of the cervical vertebrae. Surg Gynecol Obstet 1964;118:373-85.
3. Osborne GS, Pruzansky S, Koepp-Baker H. Upper cervical spine anomalies and osseous nasopharyngeal depth. J Speech Hear Res 1971;14:14-22.
4. Sandham A. Cervical vertebral anomalies in cleft lip and palate. Cleft Palate J 1986;23:206-14.
5. Bebnowski D, Hänggi MP, Markic G, Roos M, Peltomäki T. Cervical vertebrae anomalies in subjects with class II malocclusion assessed by lateral cephalogram and cone beam computed tomography. Eur J Orthod 2012;34:226-31.
6. Singh GD. Morphologic determinants in the etiology of class III malocclusions: A review. Clin Anat 1999;12:382-405.
7. Bui C, King T, Proffit W, Frazier-Bowers S. Phenotypic characterization of class III patients. Angle Orthod 2006;76:564-9.
8. Lippold C, Danesh G, Hoppe G, Drerup B, Hackenberg L. Sagittal spinal posture in relation to craniofacial morphology. Angle Orthod 2006;76:625-31.
9. Huggare JA, Cooke MS. Head posture and cervicovertebral anatomy as mandibular growth predictors. Eur J Orthod 1994;16:175-80.
10. Festa F, Tecco S, Dolci M, Ciufolo F, Di Meo S, Filippi MR, *et al.* Relationship between cervical lordosis and facial morphology in Caucasian women with a skeletal class II malocclusion: A cross-sectional study. Cranio 2003;21:121-9.
11. D'Attilio M, Epifania E, Ciuffolo F, Salini V, Filippi MR, Dolci M, *et al.* Cervical lordosis angle measured on lateral cephalograms; findings in skeletal class II female subjects with and without TMD: A cross sectional study. Cranio 2004;22:27-44.
12. Ugar DA, Semb G. The prevalence of anomalies of the upper cervical vertebrae in subjects with cleft lip, cleft palate, or both. Cleft Palate Craniofac J 2001;38:498-503.
13. Baccetti T, Franchi L, McNamara J Jr. The cervical vertebral maturation (CVM) method for the assessment of optimal treatment timing in dentofacial orthopedics. Semin Orthod 2005;11:119-29.
14. Meibodi SE, Parhiz H, Motamedi MH, Fetrati A, Meibodi EM, Meshkat A. Cervical vertebrae anomalies in patients with class III skeletal malocclusion. J Craniovertebr Junction Spine 2011;2:73-6.
15. Proffit WR. Contemporary Orthodontics. 3rd ed. St. Louis, MO: Mosby; 2000. p. 2-3.
16. Koletsis DD, Halazonetis DJ. Cervical vertebrae anomalies in orthodontic patients: A growth-based superimpositional approach. Eur J Orthod 2010;32:36-42.
17. Sonnesen L, Kjaer I. Cervical column morphology in patients with skeletal class III malocclusion and mandibular overjet. Am J Orthod Dentofacial Orthop 2007;132:427.e7-12.
18. Faruqui S, Fida M, Shaikh A. Cervical vertebral anomalies in skeletal malocclusions: A cross-sectional study on orthodontic patients at the Aga Khan University Hospital, Pakistan. Indian J Dent Res 2014;25:480-4.
19. Sonnesen L, Pedersen CE, Kjaer I. Cervical column morphology related to head posture, cranial base angle, and condylar malformation. Eur J Orthod 2007;29:398-403.
20. Sonnesen L, Kjaer I. Cervical vertebral body fusions in patients with skeletal deep bite. Eur J Orthod 2007;29:464-70.
21. Arntsen T, Sonnesen L. Cervical vertebral column morphology related to craniofacial morphology and head posture in preorthodontic children with class II malocclusion and horizontal maxillary overjet. Am J Orthod Dentofacial Orthop 2011;140:e1-7.
22. Sonnesen L, Kjaer I. Anomalies of the cervical vertebrae in patients with skeletal class II malocclusion and horizontal maxillary overjet. Am J Orthod Dentofacial Orthop 2008;133:188.e15-20.
23. Kjaer I, Keeling JW, Graem N. Midline maxillofacial skeleton in human anencephalic fetuses. Cleft Palate Craniofac J 1994;31:250-6.
24. Kjaer I. Neuro-osteology. Crit Rev Oral Biol Med 1998;9:224-44.
25. Müller F, O'Rahilly R. The early development of the nervous system in staged insectivore and primate embryos. J Comp Neurol 1980;193:741-51.
26. Kjaer I, Fischer-Hansen B. The adenohypophysis and the cranial base in early human development. J Craniofac Genet Dev Biol 1995;15:157-61.
27. Sadler TW. Embryology of neural tube development. Am J Med Genet C Semin Med Genet 2005;135C:2-8.