

DENTAL OCCLUSION AND BODY POSTURE IN GROWING SUBJECTS. A POPULATION-BASED STUDY IN 12-YEAR- OLD ITALIAN ADOLESCENTS

LETIZIA PERILLO¹, GIUSEPPE SIGNORIELLO², FABRIZIA FERRO³, TIZIANO BACCETTI⁴, CATERINA MASUCCI⁵, DAVIDE APICELLA⁶, ROBERTO SORRENTINO⁷, CIRO GALLO⁸

Abstract

Objectives: To assess the association between orthodontic and body posture findings in a large sample of Italian adolescents.

Methods and Materials: The study had a population-based cross-sectional design. Subjects were selected according to a cluster sampling design. Posture variables were assessed according to a photographic method. The following occlusal variables were evaluated: molar relationship according to Angle's classification, and posterior crossbite. Subjects were orthodontically untreated. Examiners had been calibrated previous to examination.

Results: The subjects eligible for the study were a total of 703 - 344 (49%) males and 359 (51%) females. Prevalence rates of Class II and III malocclusions were equal to 36.1% (95% CI, 32.6%-39.8%) and 2.7% (95% CI, 1.6%-4.2%), respectively. Prevalence rate for posterior crossbite was equal to 14.8% (95% CI, 12.3%-17.6%). Class III malocclusion was not correlated with backward posture, nor Class II malocclusion with forward body posture ($p=0.94$). Posterior crossbite did not correlate with modifications of the symmetry of the body ($p=0.24$).

Discussion: The present large-scale cross-sectional study did not find any significant association between specific postural attitudes and occlusal characteristics. Postural data were not related to different occlusions, when variables were assessed on the same view (lateral or frontal). The current large-scale population-based survey offered several epidemiologic indications for the prevalence of certain types of malocclusions and postural disorders in adolescents.

Conclusions: In this large-scale population-based survey, postural attitudes were not related to occlusal disorders.

Clinical significance: Claims of association between body posture and dental occlusion in growing subjects should be discarded on the basis of epidemiological observations.

Key words: posture, occlusal variables, association, crossbite

Short title: a rDental Occlusion and Body Posture in Growing Subjectseview of canal anatomy for fiber post fitting.

Introduction

Although relationships between dental occlusion and body posture have been investigated by many authors (for extensive reviews see^{1,2}), evidence of even a partial association between these two aspects is far from being reached. A number of experimental investigations attempted to evaluate the relationship between the presence (or correction) of occlusal

disorders and body posture characteristics by using photographic records, electromyography, or balance platforms.³⁻⁹ However, these studies are on small samples, usually very heterogeneous with regard to methods for postural recording, definition of postural attitude, age, and selection of subjects. As a consequence, contradictory results have arisen. In particular, it has been suggested that

1 Associate Professor of Orthodontics, Department of Orthodontics, Faculty of Medicine, Second University of Naples, Italy

2 Researcher of Medical Statistics, Department of Medicine and Public Health, Faculty of Medicine, Second University of Naples, Italy

3 Associate Professor of Orthodontics, Department of Orthodontics, Faculty of Medicine, Second University of Naples, Italy

4 Assistant Professor, Department of Orthodontics, University of Florence, Italy; "T.M: Graber Scholar", The University of Michigan, Ann Arbor, USA

5 Clinical Assistant, Department of Orthodontics, Faculty of Medicine, Second University of Naples, Italy

6 Undergraduate Student, Dental School, Faculty of Medicine, Second University of Naples, Italy

7 Research Fellow, Department of Prosthodontics, Faculty of Medicine,

University "Federico II" of Naples, Italy

8 Professor of Medical Statistics, Department of Medicine and Public Health, Faculty of Medicine and Dentistry, Second University of Naples, Italy

Corresponding Author:

Letizia Perillo

Dipartimento di Discipline Odontostomatologiche, Ortodontiche e Chirurgiche

Seconda Università degli Studi di Napoli

Via Bellini 44 - 80135 Napoli, Italy

Tel. 00390815493237

Fax: 00390815665477

E-mail: letizia.perillo@unina2.it

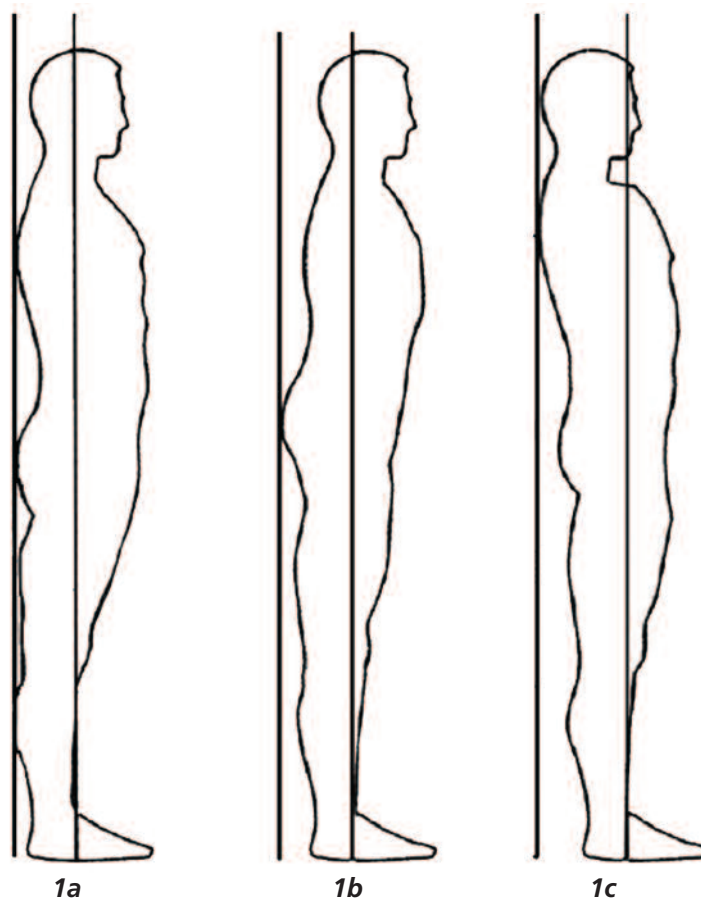


Figure 1: Body posture in lateral view (A. Ideal Posture ; B. Forward Posture; C. Backward Posture).

associations exist, possibly between orthodontic and body posture findings assessed in the same view: that is, between Class III malocclusion and backward body posture, or between Class II malocclusion and forward body posture in a lateral view,^{6,10} and between posterior crossbite and body asymmetry in the frontal view.¹¹⁻¹³

The aim of this study was to assess the associations between orthodontic and body posture features in a large sample of adolescents attending the 2nd year of secondary school (12-years old) by means of a population-based, cross-sectional study. Specific hypotheses to be tested were possible associations between orthodontic and postural findings when assessed in the same examination view (frontal and lateral).

Materials and Methods

Study population

Study population was defined as pupils attending the 2nd year of secondary school (corresponding to 8th grade) of public schools in Naples (Southern Italy) in the school year 2000-2001. The Deans of the schools were informed of the aims of the survey, and they provided information about the number of classes, and the corresponding number of pupils. According to their information, a population of about 13,000 pupils was estimated for the school year 2000-2001. Study subjects were

selected according to a cluster sampling design. Schools were first arranged by school district to avoid possible biases ensuing from social heterogeneity. Secondly, classes within schools were sampled systematically. The totality of the students belonging to the sampled classes were examined, both to improve study feasibility, and to not discriminate among pupils in the same class. All participating pupils and their parents provided written consent to examination.

Final sample

Due to the number of features to be assessed, sample size was calculated assuming a 50% prevalence rate for any characteristics to be estimated and a precision of the estimate of $\pm 3\%$ with a 95% confidence interval (sampling from finite population, nQuery Advisor, v. 4.0, Statistical Solution Ltd., Cork, Ireland). This assumption leads to the highest sample size with the given precision. Nine-hundred eighty-seven students were randomly sampled according to a cluster sampling design. Eight hundred eighty-eight students (along with their parents) were available for examination (90%). Subjects with complex craniofacial anomalies or with physical disabilities in their previous or current medical history were not considered for the final study. A hundred eighty five subjects had received some form of orthodontic treatment at the time of survey, and they

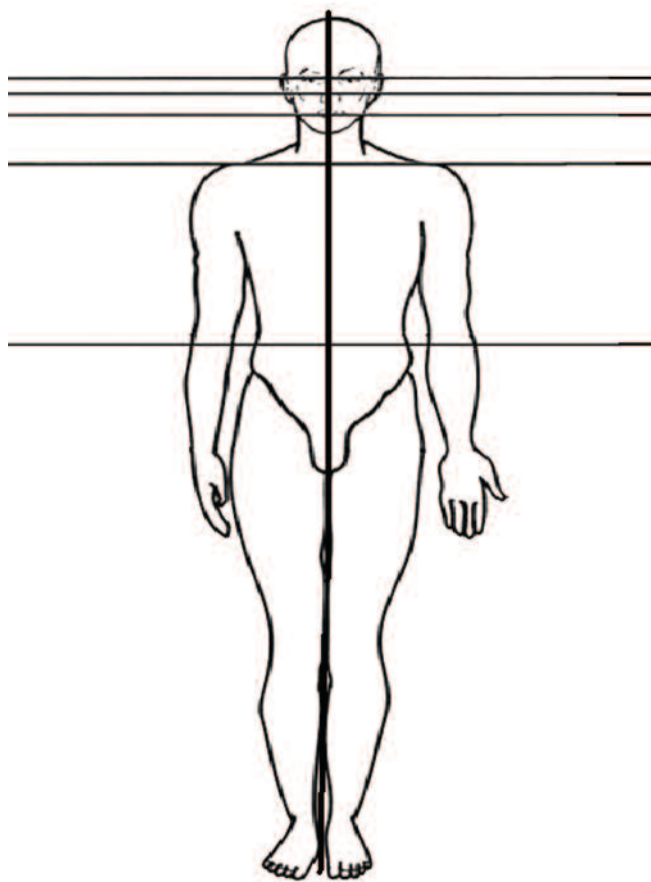


Figure 2: Body posture in frontal view.

were also excluded from the current study I: in 65 (7%) subjects the treatment had already ended, while in 120 (14%) was still ongoing.

Final analysis was performed in 703 students, 344 (49%) males and 359 (51%) females (Table 1). Mean age was equal to 12.2 years with a standard deviation of 0.65 years. 465 out of 703 subjects (66%) were 12-year old, 157 (22%) were 13-year old, and 55 (8%) 11-year old; only 26 subjects were 14- or 15-year old.

Physical examination

Medical examination included the clinical assessment of dental occlusion and posture. No radiographs were taken or dynamic tests carried out. On the whole, examination lasted approximately fifteen minutes per child, following the WHO guidelines.¹⁴ The examination was performed in a quiet classroom without external interference. A good light source was provided by artificial or natural lighting. Latex gloves and sterile instruments were used to assess the occlusion and a plumb-line to assess the posture. Two investigators, blind to each other, gathered separately information on occlusion and

posture. Prior to the survey, the investigators had a training course to calibrate and standardize their procedures.

1. Dental occlusion examination

The occlusal examination included both a lateral and a frontal view.

1.1 Lateral examination

In the lateral examination the relationship between the first lower and upper molars was determined according to the Angle classification.¹⁵ Molar relation was categorized as “Class III” when the upper molar was positioned more than half a cusp backward in relation to the lower molar; and as “Class II” when the upper molar was positioned more than half a cusp forward in relation to the lower molar. Where first molars were absent, second deciduous molars or canines were considered. Patients with subdivision malocclusions were included in the Class II or Class III groups on the basis of the predominant occlusal characteristic or according to the relationship between the canines.

1.2 Frontal examination

Posterior crossbite was defined as the cross-over of at least 2 teeth in the posterior segments of the dental arches. The subjects were classified into three groups: no crossbite, unilateral crossbite, or bilateral crossbite.

2. Body posture examination

The clinical examination of posture of the subjects was carried out from photographs of frontal and lateral views of the body, taken by a fixed camera.^{10,16,17,18} Subjects were asked to stand in an upright position, in contact with the wall, barefoot, without moving, looking straight ahead, with relaxed shoulders and arms resting at their sides for a natural head and body position.

2.1 Lateral examination

In the lateral photographic examination a plumb-line perpendicular to the floor was superimposed through the styloid apophysis of the fifth metatarsus of the foot. The distance of the external acoustic foramen from this line was measured.¹⁰ In the ideal posture in growing subjects, the external acoustical foramen is about 1 cm ahead of the plumb-line.^{10,16} Moreover, scapulae and glutei have to be on the same line and the distance between the wall and the points of maximal cervical curvature and lumbar curvature have to be 4 to 6 cm and 6 to 8 cm, respectively (Figure 1a). Posture was defined as ‘forward’ when only glutei reached the wall and the

Table 1
Occlusal and postural characteristics of the subjects (n=703) according to gender.
 Percentages are reported along with statistical comparisons.

Gender	Total (n=703)	Male (n=344)	Female (n=359)	p*
Angle class				0.78
I	61.2	62.5	59.9	
II	36.1	34.9	37.3	
III	2.7	2.6	2.8	
Cross-bite				0.41
No	85.2	86.3	84.1	
Yes	14.8	13.7	15.9	
<i>unilateral</i>	12.1			
<i>bilateral</i>	2.7			
Body posture				0.30
Normal	61.3	59.6	63.0	
Forward	37.0	39.2	34.8	
Backward	1.7	1.2	2.2	
Head			0.19	
Normal	54.5	57.0	52.1	
Inclined	45.5	43.0	47.9	
Trunk			0.85	
Normal	10.2	10.5	10.0	
Asymmetrical	89.8	89.5	90.0	
<i>asymmetrical shoulders only</i>	41.3	44.2	38.4	
<i>asymmetrical iliac crest only</i>	2.8	2.9	2.8	
<i>omolateral asymmetry</i>	33.1	31.4	34.8	
<i>controlateral asymmetry</i>	12.5	11.0	13.9	

*chi-square test

external acoustic foramen was more than 1cm in front of the plumb-line (Figure 1b). Conversely, posture was defined as 'backward' when only scapulae and the head reached the wall and the external acoustic foramen was less than 1cm in front of the plumb-line or behind it (Figure 1c).

2.2 Frontal examination

In the frontal examination symmetry of the left and right side of the body was assessed (Figure 2). A plumb-line perpendicular to the floor was used to mark the midline of the body on the photographs, and five horizontal lines were drawn, three for the head and two for the trunk.¹⁰

2.1.1 Head posture assessment

Head inclination was assessed by a line drawn through the tragus of the ears; the head was inclined when this ear-line was

not perpendicular to the plumb-line.¹⁶

2.1.2 Trunk posture assessment

Trunk posture was assessed by the two lines drawn through the shoulders and the iliac crests, respectively; the trunk was asymmetrical when at least one of these two lines was not perpendicular to the plumb-line. Asymmetry was further defined as ipsilateral when the two lines, though not perpendicular to the plumb-line, were parallel, and controlateral, when the two lines, that were not perpendicular to the plumb-line, were not parallel either.

Statistical methods

Descriptive statistics was calculated for the prevalence rates (and confidence intervals) of both occlusal and postural findings. Associations between occlusal and postural features

Table 2
Association between Angle’s Class and body posture (lateral view)*. Absolute prevalence rates and percentages are reported.

Orthodontic treatment	No		
	I	II	III
Class			
Body posture			
Normal	261 (60.7)	157 (61.8)	13 (68.4)
Forward	161 (37.4)	93 (36.6)	6 (31.6)
Backward	8 (1.9)	4 (1.6)	0 (0.0)

* P-value = 0.94

were tested by means of chi-square tests ($p < 0.05$). Gender differences for tested variables were assessed by means of chi-square tests ($p < 0.05$) as well.

Results

Prevalence rates and 95% confidence intervals (CI) of Angle Class II and III malocclusion were equal to 36.1% (95% CI, 32.6%-39.8%) and 2.7% (95% CI, 1.6%-4.2%), respectively (Table I). The prevalence rate for posterior crossbite was equal to 14.8% (95% CI, 12.3%-17.6%). Unilateral crossbite (12.1%) was more frequent than the bilateral one (2.7%).

Overall postural disorders were observed in 39% of subjects, forward posture being much more frequent than backward. The trunk was found asymmetrical in more than 80% of the subjects, while an asymmetry in the posture of the head was recorded in about half of the students.

Distributions of subjects’ characteristics according to gender are reported in Table I. No significant between-gender differences were observed for any study variable.

The distribution of molar relations with respect to posture (lateral view) is reported in Table II. No difference was found for body posture in the lateral view among the different Classes according to Angle ($p = 0.94$), i.e. there was neither an increased prevalence rate for backward body posture in Class III malocclusion, nor an increased prevalence of forward body posture in Class II malocclusion.

The distribution of posterior crossbite and posture (frontal view) are reported in Table III. Once again no statistically significant association was found for any pair of variables.

Discussion

The present investigation was aimed to assess the associations between body posture findings and orthodontic variables in a large-scale population-based survey of adolescents. The relationship between occlusion and body posture has been suggested since the beginning of the twentieth century.¹⁹ The maintenance of posture requires a complex neuromuscular system with several afferent pathways from peripheral proprioceptors. The effect of occlusion on body posture has

been attributed to the convergence of afferents from the dental proprioceptors, the ganglion of Scarpa, and the facial muscular proprioceptors on nuclei of the brain stem.⁴ However, scientific evidence is still lacking with regard to the biunivocal relations between occlusal and postural aspects.^{1,4-9,11-13,20-23}

The present large-scale cross-sectional study did not find any significant association between specific postural attitudes and occlusal characteristics. Postural data were not related to different occlusions, when variables were assessed on the same view (lateral or frontal).²¹ More specifically, significant associations were not assessed in the lateral view between Class III malocclusion and backward body posture or between Class II malocclusion and forward body posture. No significant correlation was recorded between posterior crossbite and posture in the frontal view. These results are not in agreement with the ones reported by Nobili and Adversi⁶ and by Bricot.¹⁰ Conversely, the negative results found here are in accordance with previous findings.^{4,22,23}

Conflicting results may be explained, at least in part, by methodological differences in study design, variable assessment, and/or selection of subjects. As a matter of fact, previous studies presented with usually small sample size and/or low statistical power for detecting significant associations.^{4,5,7,8,12,21,22} Other biases could have arisen from lack of random selection of subjects, or from observation of dysfunctional patients.^{4,17,18} Moreover, some studies involved both children and adult subjects,^{5,22} although significant changes in body posture are known to be associated with aging.^{24,25}

The sample evaluated in the present investigation derived from the random examination of a well defined population, large enough to compensate for inherent occlusal and postural biological variability, and considerably larger than any previous study. The investigation is part of a larger population-based survey on 6, 12, and 18 years old students in Naples (Southern Italy), that is at the ages corresponding to the three most representative stages of the dentitional development (deciduous, mixed, and permanent). The present study focused on 12-year-old students, who, according to the Italian study

Table 3
Association between cross-bite and body posture (frontal view). Absolute prevalence rates and percentages are reported.

Orthodontic treatment	No		
	Yes	No	p
Cross-bite			
Head			
Normal	62 (59.6)	321 (53.6)	0.25
Inclined	42 (40.4)	278 (46.4)	
Trunk			0.24
Normal	14 (13.5)	58 (9.7)	
Asymmetrical	90 (86.5)	541 (90.3)	

curriculum, were randomly chosen from the 2nd year of the secondary school. The age of examined subjects was largely homogeneous, and 96% of them were 11 to 13 year old. A small percentage of subjects (10%) was not available for examination; however, non-responder bias was very unlikely, for the similarity of participating and non-participating subjects according to gender and age.

Eight hundred eighty eight students were available for examination (90% of the randomly chosen population). Twenty one percent of these students had already received some orthodontic treatment, or were currently in orthodontic therapy. As the prevalence/severity of malocclusion could be reduced in treated subjects, along with possible associations with posture, further analysis on the relationships between occlusion and posture was limited to the orthodontically-untreated students.

The epidemiological approach used in the present study prompted for a simple pragmatic design. Postural evaluation was performed through physical examination, and no radiographs were taken or dynamic tests carried out. This choice allowed feasibility of in loco visits and enhanced subjects' compliance, both needed to preserve the representativeness of the sample. In the effort to minimize variability of the subjective assessments, all examinations were performed blindly by the same two observers who, prior to the survey, attended a training course to calibrate and standardize the examination procedures, both clinically and on the photographic records. Previous studies evaluated the association between the presence (or removal) of occlusal disorders and body posture changes by using electromyography^{3,5,9} or balance platform.^{4,6-8} However, electromyography does not assess body positions or postural changes but rather their determinants, i.e. the activity of different antigravity muscular groups,^{3,5,9} whereas dynamic methods (platforms) measure the modification of the position

of an individual's centre of foot pressure (COP) on a force plate for a period of time,^{4,6-8} thus reducing the whole body to a point. Alterations of the standing position might not be reflected by COP modifications, so that the complex neuromuscular mechanism might respond with adjustments not detectable at the foot level.⁴ Further these studies are heterogeneous with regard to methods for postural recording and definition of postural attitude .

In addition to the investigated relation between occlusion and posture, the current large-scale population-based survey offered several epidemiologic indications for the prevalence of certain types of malocclusions and postural disorders in adolescents. The prevalence rate for posterior crossbite was almost 15% of the subjects, with unilateral crossbite (about 12%) more frequent than the bilateral one (about 3%). Postural disorders were observed in over one third of the subjects, with forward posture much more frequent than backward. An asymmetry of the trunk was found in more than 80% of the subjects, while an asymmetry in the posture of the head was recorded in about half of the students.

Conclusions

The present large-scale population-based survey did not support the evidence of clinical associations between body posture and dental occlusion in adolescents, both in the sagittal and transverse dimensions.

References

1. Huggare J. Postural disorders and dentofacial morphology. *Acta Odontol Scand.* 1998;56:383-386.
2. Michelotti A, Manzo P, Farella M, Martina R. Occlusion and posture: is there evidence of correlation? *Minerva Stomatol.* 1999;48:525-534.
3. Brunt D, Andersen JC, Huntsman B, Reinhert LB, Thorell AC, Sterling JC. Postural responses to lateral perturbation in healthy subjects and ankle sprain patients. *Med Sci Sports Exerc.* 1992;24:171-176.

4. Ferrario VF, Sforza C, Schmitz JH, Taroni A. Occlusion and center of foot pressure variation: is there a relationship? *J Prosthet Dent.* 1996;76:302-308.
5. Festa F, D'Emidio F, Castaldo A. Modificazioni dei rapporti occlusali dopo terapia posturale. *Ortognat It.* 1996;5:667-677.
6. Nobili A, Adversi R. Relationship between posture and occlusion: a clinical and experimental investigation. *Cranio.* 1996;14:274-285.
7. Bracco P, Deregibus A, Piscetta R, Ferrario G. Observations on the correlation between posture and jaw position: a pilot study. *Cranio.* 1998;16:252-258.
8. Gangloff P, Louis JP, Perrin PP. Dental occlusion modifies gaze and posture stabilization in human subjects. *Neurosci Lett.* 2000;293:203-206.
9. Kibana Y, Ishijima T, Hirai T. Occlusal support and head posture. *J Oral Rehabil.* 2002;29:58-63.
10. Bricot B. La reprogrammation posturale globale. Marseille: Sauramps médical; 1996.
11. Prager A. Vergleichende untersuchungen uber die haufigkeit von zahnstellungs-undkieferanomalien bei patienten mit deformitaten der wirbelsaule. *Fortschr Kieferorthop.* 1980;41:163-168.
12. Huggare J, Pirttiniemi P, Serlo W. Head posture and dentofacial morphology in subjects treated for scoliosis. *Proc Finn Dent Soc.* 1991;87:151-158.
13. Lippold C, Van den Bos L, Hohoff A, Danesh G, Ehmer U. Interdisciplinary study of orthopedic and orthodontic findings in pre-school infants. *J Orofac Orthop.* 2003;64:330-340.
14. Oral health surveys – basic methods. 4th ed. Geneva: World Health Organization; 1997.
15. Proffit WR. Contemporary orthodontics. 3rd ed. St Louis: Mosby; 2000.
16. Gagey PM, Weber B. Posturologie. Régulation et dérèglements de la station debout. Paris: Masson; 1995.
17. Schiau YY, Chai HM. Body posture and hand strength of patients with temporomandibular disorder. *Cranio.* 1990;8:244-251.
18. Zonnenberg AJ, Van Maanen CJ, Oostendorp RA, Elvers JW. Body posture photographs as a diagnostic aid for musculoskeletal disorders related to temporomandibular disorders(TMD). *Cranio.* 1996;14:225-232.
19. Robin P. Demonstration pratique sur la construction et la mise en bouche d'un nouvel appareil de redressement. *Rev Stomatol.* 1902;9:561-590.
20. Leitao P, Nanda RS. Relationship of natural head position to craniofacial morphology. *Am J Orthod Dentofacial Orthop.* 2000;117:406-417.
21. Milani RS, De Periere DD, Lapeyre L, Pourreyron L. Relationship between dental occlusion and posture. *Cranio.* 2000;18:127-134.
22. Makofsky HW. The influence of forward head posture on dental occlusion. *Cranio.* 2000;18:30-39.
23. Motoyoshi M, Shimazaki T, Sugai T, Namura S. Biomechanical influences of head posture on occlusion: an experimental study using finite element analysis. *Eur J Orthod.* 2002;24:319-326.
24. Ashton-Miller JA, He Y, Kadhihsan VA, McCubbrey DA, Faulkner JA. An apparatus to measure in vivo biomechanical behavior of dorsi- and plantarflexors of mouse ankle. *J Appl Physiol.* 1992;72:1205-1211.
25. Alexander NB. Postural control in older adults. *J Am Geriatr Soc.* 1994;42:93-108.