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Relationship of pharyngeal airway length to skeletal class

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ABSTRACT

Introduction: The study of the airways in orthodontics is essential because the respiratory function interferes with the proper development of the structures that form the craniofacial complex. Obstructions of the nasal passage favor functional imbalance and can even cause the development of malocclusions. **Objective:** To determine the association between the anteroposterior length (APL) of the upper (UP) and lower (LP) pharynx with skeletal class (SC), and with maxillary and mandibular length. **Material and Methods:** The study was carried out in the Orthodontics clinic of the Universidad Autónoma "Benito Juárez" of Oaxaca. Sixty lateral head radiographs of people aged 18 to 40 years without previous orthodontic treatment were analyzed; they were divided into groups based on SC. **Results:** 30 people with SCI and 30 with SCII were identified.

It was observed that the APL of the LP is greater in the SCI than in the SCII (11.8 ± 2.9 mm vs. 10.0 ± 2.4 mm; p=0.007), the APL of the LP correlates weakly with mandibular length (p <0.001, r = 0.44) and the APL of the LP is greater in men than in women (12.1 ± 3.0 mm vs. 10.0 ± 2.3 mm; p= 0.003). **Conclusion:** the APL of the LP is greater in the SCI than in the SCII and greater in men than in women; furthermore, APL correlates with mandibular length.

Keywords: Pharyngeal airway, skeletal classification, malocclusion

INTRODUCTION

The study of the airway in orthodontics is fundamental because respiratory function interferes with the proper development of the structures that form the craniofacial complex[1,2]. Obstructions of the nasal passage favor functional imbalance that can even cause the development of malocclusions, oral breathing patterns, changes in the position of the tongue and lips, mandibular rotations, dolichofacial patterns, maxillary constrictions and inferior positioning of the hyoid[3-6].

Despite the large amount of research that has been done on the airway and its influence on craniofacial growth and development, most of it yields unspecific data and leaves aside the individual measurement of the maxilla and mandible to obtain reliable and accurate information on this relationship[7,8]. It is important to perform a diagnostic evaluation before the execution of orthodontic treatments because these not only involve the oral cavity but also the naso-maxillary complex, musculature, and insertions related to the airways, which can modify and restructure vital functions such as breathing, swallowing, phonation, among others[9,10].

There are several methods for the evaluation of the airway, the cephalometric analysis in the lateral head film has been used as part of basic orthodontic records, with the advantages of having low costs and radiation doses, being easily accessible, with the advantage of existing standardization of measurements with high reproducibility in an anatomically defined sagittal plane. These advantages make this method common in research, which validates the methodology adopted in this study[11]. Lateral head radiographs allow us to evaluate the nasopharyngeal air space thanks to the observation of the bony contours and soft profile of the patient, obtaining static and two-dimensional information about the conditions of the upper airway; It is the ideal auxiliary diagnostic resource since it allows the realization of tracings that quantify the presence or not of disharmonies. The images are standardized because they are reproduced in the same reference position, which allows evaluating, measuring and comparing the changes caused by treatment or growth, so this is considered an important reliable detection tool[12].

Based upon the above we felt the need to know the relationship that may exist between the size of the upper airway and the skeletal class (SC) through lateral head radiographs of patients who will undergo orthodontic treatment, without excluding the individual measurements of the maxilla and mandible. Therefore, the present study aims to obtain specific data to generate new hypotheses about this relationship, and thus acquire clear and sufficient information to be applied to our patients to provide them with a better diagnosis and treatment plan. Any disorder of the airway should be identified, diagnosed and, if possible, treated.

MATERIALS AND METHODS

An observational, cross-sectional, prospective, and comparative study was conducted from January to December 2020. The selection of the sample was performed by convenience, including lateral cephalometric radiographs of people of age between 18 and 40, taken with the KaVo OP 300 Instrumentarium equipment, with 12.5 milli amperage and 90 kilo-voltage. Images that suggested any craniofacial pathology or syndrome, dental agenesis (except third molars), people who received previous orthodontic treatment or who were undergoing treatment at the time of radiographic acquisition, or people with fixed, removable, or maxillofacial prostheses that creates noise and hide anatomical details were excluded. Also, lateral cephalometric radiographs in which the Frankfort plane was not parallel to the floor and people with skeletal class III (SCIII) were eliminated.

For the calculation of the sample size, a difference of 2 mm in the anteroposterior length (APL) of the pharyngeal airway between individuals with skeletal class I (SCI) and skeletal class II (SCII) was considered, a standard deviation of 2.5 mm, an alpha value of 0.05 and power of the test of 80%. Based on the above, the estimated sample size was 26 individuals per group. However, 30 people per group were included.

Once the sample was selected, the radiographs were visualized using Cefax software version 6.0.3 and the Sella-Nasion (S-N), Nasion–Point A (N-A), Nasion–Point B (N-B) points were traced, obtaining as a result the ANB angle measurement; based on Steiner's cephalometry they were classified into two groups (SCI and SCII)[13]. Subsequently, with the measuring tool we determined the maxillary APL in the sagittal view from the Anterior Nasal Spine (ANS) to the Posterior Nasal Spine (PNS); the mandibular APL was measured with the cephalometric points Gonion (Go) to Gnation (Gn) (Figure 1). Subsequently, measurements for the upper airway were performed using the method described by McNamara[14]. For the upper measurement, the posterior contour of the soft palate and the closest point of the posterior pharyngeal wall were located. In the lower pharynx (LP) the intersection of the posterior border of the tongue with the lower border of the mandible, and the closest point of the posterior pharyngeal wall (Figure 2) were measured.

Descriptive statistics were used for the analysis of the general characteristics of the sample. To make comparisons of the distance of the upper and lower pharyngeal airway between the study groups, gender, and age, the Student's t-test was used. To correlate the upper and lower pharyngeal airway distance with mandibular and maxillary length, the Spearman correlation was used. A significant difference was considered when $p < 0.05$.

RESULTS

Sixty lateral cephalometric radiographs (30 SCI and 30 SCII) of people who were about to start orthodontic treatment, taken with the same method and by the same specialized operator, were selected and analyzed. All radiographs were taken in 2020. The mean age of the SCI subjects from whom the radiographs were taken was 27.5 years (Range: 18-40 years) and 25.3 years (Range: 18-40 years) for SCII patients.

We found that the APL of the upper pharynx (UP) was similar between SCI and SCII subjects (12.1 ± 2.6 mm vs. 12.8 ± 2.4 mm; p=0.245), while the APL of the LP was higher in SCl patients than in SCII (11.8 ± 2.9 mm vs. 10.0 ± 2.4 mm; p=0.007) (Table 1 and Graph 1). On the other hand, no statistical correlation was observed between UP APL (p=0.233, r=0.14)

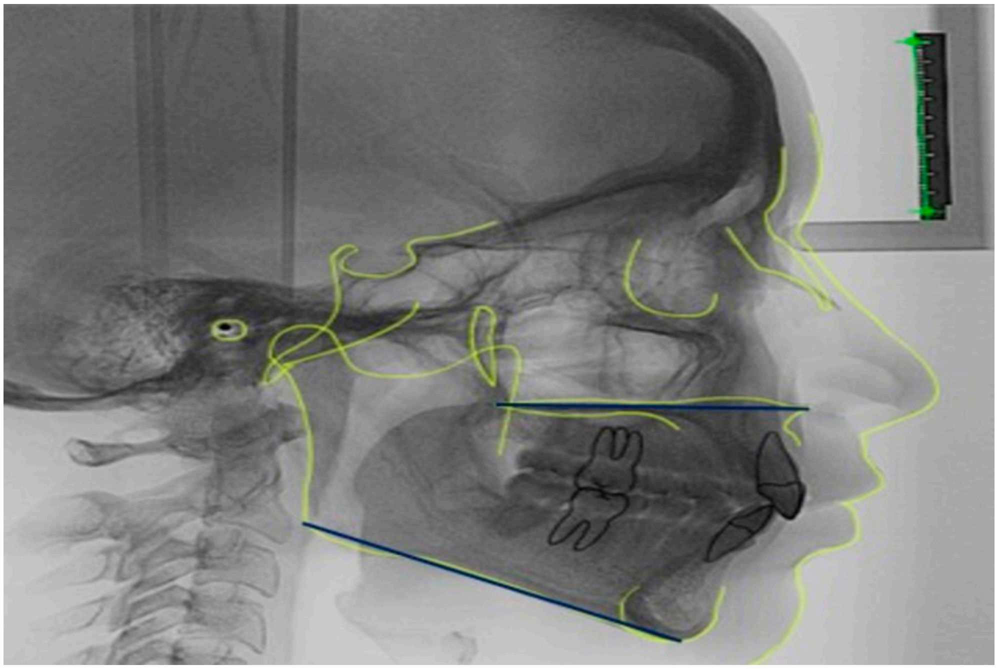


Figure 1. APL measurement of the maxilla and mandible. Anatomical drawing of the radiograph consisting of bony structures and soft profile (yellow lines). A sagittal view shows the measurement of the maxilla from ANS to PNS (upper blue line), and the mandible from Go to Gn (lower blue line). ANS: anterior nasal spine; PNS: posterior nasal spine; Go: cephalometric point Gonion; Gn: cephalometric point Gnation; APL: anteroposterior length.

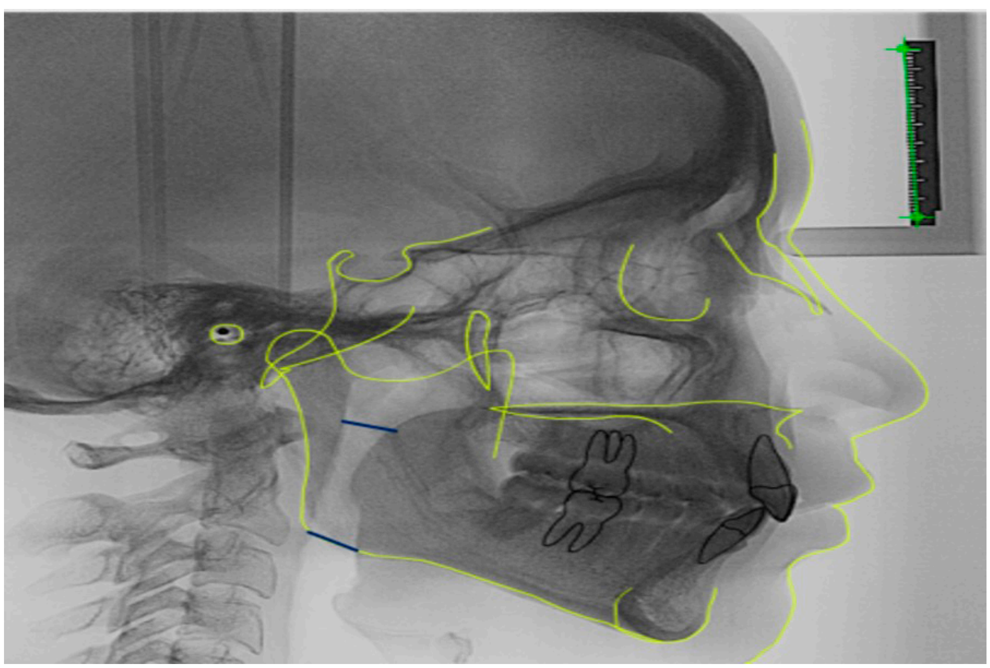


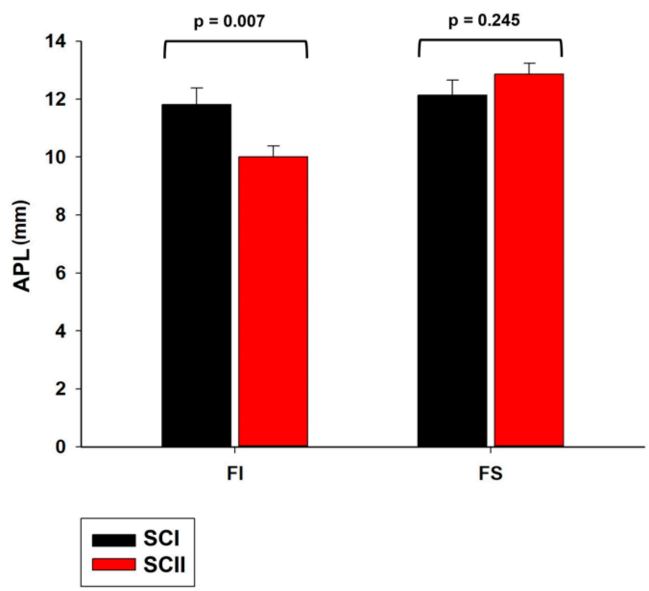
Figure 2. Measurement of UP and LP. Anatomical drawing of the radiograph (yellow lines). The UP measurement is observed: from the posterior contour of the soft palate to the closest point of the posterior pharyngeal wall (upper blue line), and the lower measurement, from the intersection of the posterior border of the tongue with the lower border of the mandible, to the closest point of the posterior pharyngeal wall (lower blue line). LP: lower pharynx; UP: upper pharynx.

and LP (p=0.627, r=0.06) with the maxilla, respectively. Similarly, no correlation was found between UP APL with mandibular length (p=0.280, r=0.13), but a weak correlation was found between LP APL with mandibular length (p<0.001, r=0.44) (Graph 2).

Table 1.
Comparison between APL of UP and LP

UP		LF	
SCI	**SCII**	**SCI**	**SCII**
12.1 ± 2.7 mm	12.9 ± 2.4 mm	11.8 ± 2.9 mm*	10.0 ± 2.4 mm

Table footer: Results are expressed as mean± standard deviation. SCI: skeletal class I; SCII: skeletal class II; LP: lower pharynx; UP: upper pharynx; APL: anteroposterior length. *: p = 0.007, between APL of SCI and SCII.

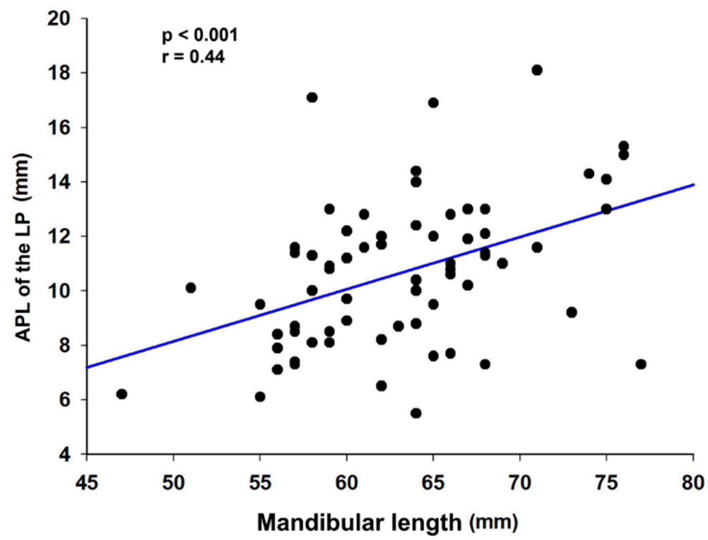


Graph 1. Comparison of APL of LP and UP in patients with SCI and SCII.
Graph footer: SCI: skeletal class I; SCII: skeletal class II; APL: anteroposterior length; LP: lower pharynx; UP: upper pharynx; APL: anteroposterior length.

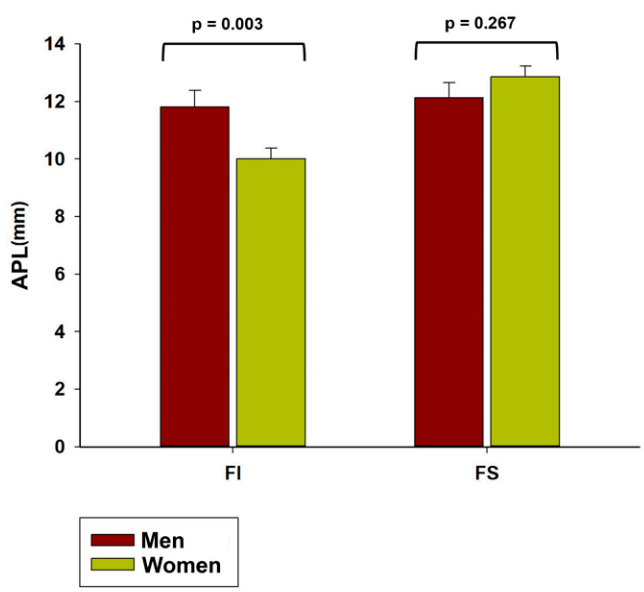
Regarding gender, it was observed that the APL of the LP is higher in men than in women (12.1 ± 3.0 mm vs 10.0 ± 2.3 mm; p= 0.003). In contrast, the APL of the UP between men and women was similar (12.0 ± 2.3 mm vs 12.8 ± 2.6 mm; p=0.267) (Graph 3). Finally, we failed to demonstrate a correlation between UP APL (p=0.299, r=0.28) and LP (p=0.485, r=0.08) with age, respectively.

DISCUSSION

The prevalence of class III malocclusions varies depending on race, ethnic group, and geographic region; in the Americas, the prevalence is 5%[15]. Our study included SCI and SCII subjects, but not SCIII because only 3 lateral cephalometric radiographs were compatible with SCIII.



Graph 2. Correlation of APL LP with mandibular length.
Graph footer: The correlation coefficient and *p*-value are shown in the graph. APL: anteroposterior length; LP: lower pharynx.



Graph 3. Comparison of APL of LP and UP between men and women.
Graph foote: LP, lower pharynx; UP, upper pharynx; APL, anteroposterior length.

The present study demonstrated that there is a relationship between APL of LP with SCI; subjects belonging to the SCII group have a collapsed lower pharyngeal airway compared to subjects with SCI, who have a more patent lower pharyngeal airway. As mentioned by Linder-Aronson[8], altered pharyngeal breathing is capable of modifying facial morphology and dentition. However, when comparing UP measurement in SCI and SCII patients, no significant differences were found, thus inferring that UP size is independent of SCI or SCII.

The results showed that there is no relationship between UP and LP APL with maxillary length; however, when relating it to the mandible, we found a weak correlation, which demonstrates that patients with SCII and decreased mandibular length have greater collapse of the inferior pharyngeal pathway, which is unprecedented since there is no other study in which maxillary and mandibular length have been evaluated individually.

Tourné[16], Handelman and Osborne[17], Taylor *et al*.[18] mention that patients between 14 and 18 years of age present a resting period in the growth of the pharyngeal structures and that this period is the most stable for studying the naso- and oropharyngeal regions. However, in our study we included people aged 18 to 40 years, who did not present significant differences in size in the APL of the LP and UP despite the wide age range, suggesting that age is not a determining factor of pharyngeal length. When comparing the pharyngeal dimensions, we found that LP is greater in men than in women, the same as reported by Celikoglu *et al*.[19] and Chiang *et al*.[20] who mention that the nasopharyngeal and oropharyngeal length is significantly greater in men; this relationship could be explained because women mature at 18 years of age while men do at 21 years of age, thus men take more time to develop and grow[21].

CONCLUSIONS

Because respiratory problems interfere dentofacially causing changes in growth, the role of the orthodontist is key to making an early diagnosis that helps to improve the quality of life of patients with airway collapse. The clinician should also be able to refer the patient to the otolaryngologist or allergist to achieve higher success of the orthodontic treatment. Therefore, it is recommended that the orthodontist, as part of the initial diagnosis, performs a clear and specific evaluation of the airway of patients who will undergo orthodontic and maxillary orthopedic treatment.

BIBLIOGRAPHIC REFERENCES

1. Ceylan I, Oktay H. A study on the pharyngeal size in different skeletal patterns. *Am J Orthod Dentofacial Orthop*. 1995; 108(1): 69-75. DOI: 10.1016/s0889-5406(95)70068-4
2. Chuang LC, Hwang YJ, Lian YC, Hervy-Auboiron M, Pirelli P, Huang YS, *et al*. Changes in craniofacial and airway morphology as well as quality of life after passive myofunctional therapy in children with obstructive sleep apnea: a comparative cohort study. *Sleep Breath*. 2019; 23(4): 1359-1369. DOI: 10.1007/s11325-019-01929-w
3. Rubin RM. Mode of respiration and facial growth. *Am J Orthod*. 1980; 78(5): 504-510. DOI: 10.1016/0002-9416(80)90301-2
4. Pereira TC, Furlan RMMM, Motta AR. Relação entre a etiologia da respiração oral e a pressão máxima da língua. *CoDAS*. 2019; 31(2): e20180099. DOI: 10.1590/2317-1782/20182018099
5. Abreu RR, Rocha RL, Lamounier JA, Guerra AFM. Etiologia, manifestações clínicas e alterações presentes nas crianças respiradoras orais. *J Pediatr (Rio J)*. 2008; 84(6): 529-535. https://www.scielo.br/j/jped/a/FKG4ppj4WYngNhVy4N45Mnc/
6. Jiménez EL, Barrios R, Calvo JC, de la Rosa MT, Campillo JS, Bayona JC, *et al*. Association of oral breathing with dental malocclusions and general health in children. *Minerva Pediatr*. 2017; 69(3): 188–193. DOI: 10.23736/S0026-4946.16.04288-2

7. Watson RM Jr, Warren DW, Fischer ND. Nasal resistance, skeletal classification, and mouth breathing in orthodontic patients. *Am J Orthod*. 1968; 54(5): 367-379. DOI: 10.1016/0002-9416(68)90305-9
8. Linder-Aronson S. Effects of adenoidectomy on dentition and nasopharynx. *Trans Eur Orthod Soc*. 1972: 177-86. PMID: 4523533
9. Meredith GM. The airway and dentofacial development. *Ear Nose Throat J*. 1987; 66(5): 190-195. PMID: 3582221
10. Chambi-Rocha A, Cabrera-Domínguez ME, Domínguez-Reyes A. Breathing mode influence on craniofacial development and head posture. *J Pediatr (Rio J)*. 2018; 94(2): 123-130. DOI: 10.1016/j.jped.2017.05.007
11. McClure SR, Sadowsky PL, Ferreira A, Jacobson A. Reliability of digital versus conventional cephalometric radiology: a comparative evaluation of landmark identification error. *Semin Orthod*. 2005; 11(2): 98–110. DOI: 10.1053/j.sodo.2005.04.002
12. Ponnada SR, Ganugapanta VR, Perumalla KK, Naqeed MA, Harini T, Mandaloju SP. Airway analysis in skeletal class I and class II subjects with different growth patterns: A 2D cephalometric study. *J Pharm Bioallied Sci*. 2020; 12(Suppl 1): S161-S167. DOI: 10.4103/jpbs.JPBS_49_20
13. Steiner CC. Cephalometrics for you and me. *Am J Orthod*. 1953; 39(10): 729-755. DOI: 10.1016/0002-9416(53)90082-7
14. McNamara JA. A method of cephalometric evaluation. *Am J Orthod*. 1984; 86(6): 449-469. DOI: 10.1016/s0002-9416(84)90352-x
15. Zere E, Chaudhari PK, Sharan J, Dhingra K, Tiwari N. Developing class III malocclusions: challenges and solutions. *Clin Cosmet Investig Dent*. 2018; 10: 99-116. DOI: 10.2147/CCIDE.S134303.
16. Tourné LPM. Growth of the pharynx and its physiologic implications. *Am J Orthod Dentofacial Orthop*. 1991; 99(2): 129-139. DOI: 10.1016/0889-5406(91)70115-D
17. Handelman CS, Osborne G. Growth of the nasopharynx and adenoid development from one to eighteen years. *Angle Orthod*. 1976; 46(3): 243-259. DOI: 10.1043/0003-3219(1976)046<0243:GOTNAA>2.0.CO;2
18. Taylor M, Hans MG, Strohl KP, Nelson S, Broadbent BH. Soft tissue growth of the oropharynx. *Angle Orthod*. 1996; 66(5): 393-400. DOI: 10.1043/0003-3219(1996)066<0393:STGOTO>2.3.CO;2
19. Celikoglu M, Bayram M, Sekerci AE, Buyuk SK, Toy E. Comparison of pharyngeal airway volume among different vertical skeletal patterns: a cone-beam computed tomography study. *Angle Orthod*. 2014; 84(5): 782-787. DOI: 10.2319/101013-748.1
20. Chiang CC, Jeffres MN, Miller A, Hatcher DC. Three-dimensional airway evaluation in 387 subjects from one university orthodontic clinic using cone beam computed tomography. *Angle Orthod*. 2012; 82(6): 985-992. DOI: 10.2319/122811-801.1
21. Tsai HH, Ho CY, Lee PL, Tan CT. Sex differences in anthropometric and cephalometric characteristics in the severity of obstructive sleep apnea syndrome. *Am J Orthod Dentofacial Orthop*. 2009; 135(2): 155-164. DOI: 10.1016/j.ajodo.2008.10.001