CEPHALOMETRIC EVALUATION OF THE AIRWAY SPACE AND HEAD POSTURE IN CHILDREN WITH NORMAL AND ATYPICAL DEGLUTITION: CORRELATIONS STUDY

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ABSTRACT

Head posture has been related to pharyngeal space, especially in the syndrome of obstructive sleep apnea (OSA) in adults. However no studies were found that evaluated the possible correlation between head posture and pharyngeal airway space measured in children with atypical swallowing. The purpose of this study was to evaluate the possible correction between head posture and the measurement of pharyngeal space on radiographs of children who were in the period of mixed dentition who demonstrated atypical swallowing and in children with normal deglutition. A retrospective clinical study, using cephalometric analysis of lateral radiographs to obtain measures of the antero-posterior dimension of the pharyngeal airway space (PAS) and the angle formed between the base of the skull and the odontoid process (CC1) between two groups: the 55 radiographs experimental group (with atypical swallowing) and 55 radiographs of the control group (normal swallowing). The Spearman Coefficient of Correlation was used to evaluate the possible relationship between PAS and CC1 was used. Results indicated a positive correlation between measures of CC1 and PAS (r = 0357) only in the control group (normal swallowing). Conclusions: There is positive correlation between head posture and measure pharyngeal airway space (PAS) in the group of normal swallowing. This correlation was not observed in the experimental group (atypical swallowing).

KEY WORDS: cephalometric – airway space – head posture - deglutition

INTRODUCTION

The mixed dentition stage is a phase of development in which there are numerous changes to the stomatognathic system. Studies indicate that it is at this stage that there should be transition from the infantile deglutition pattern (visceral) to the mature pattern (somatic) (Peng, Jost-Brinkmann, Yoshida, Chou, Lin, 2004; Ovsenik, Farcnik, Korpar, Verdenik, 2007; Medeiros, Ferreira, Felício, 2009; Machado Júnior & Crespo, 2010; Machado Júnior & Crespo, 2011; Machado Júnior & Crespo, 2012a, b, c). For a number of reasons which are still incompletely explained, 'infantile deglutition' may continue beyond the replacement of the deciduous teeth, and may be classified as atypical deglutition (Cheng, Peng, Chiou, Tsai, 2002; Peng et al., 2004; Machado Júnior et al., 2010, 2011, 2012 a, b, c). Atypical deglutition has been attributed to suction without nutritional purposes, such as a retained digit habit, use of bottles, oral breathing, central nervous system disorders and anatomical changes (Peng et al., 2004; Ovsenik et al., 2007; Medeiros et al., 2009; Machado Júnior et al., 2010, 2011, 2012a,b,c). There is no consensus regarding the etiology of atypical deglutition.

Studies have shown that deglutition is an activity which is coordinated with other oral functions, and requires an interaction among different muscle groups. In order to synchronize breathing, suction and swallowing, it is necessary to have an integrated relationship among the muscles in the oral region for the generation of suction pressure - to open and close the mouth,

during chewing, the tongue in order to form the bolus, and its peristaltic transportation to the pharynx (Valera, Travitzki, Mattar, Matsumoto, Elias, Anselmo-Lima, 2003). During oral feeding, respiratory mechanics involve the proper activation of the diaphragm, intercostal muscles and the upper airway muscles - from the nose to the glottis (Valera et al., 2003). Recent studies have reported that adenoid and palatine tonsil hyperplasia is the second most frequent cause of upper airway obstruction and, consequently, oral breathing in children (Valera et al., 2003; Maciel & Leite, 2005; Paskay, 2006). The relationship between oral breathing and atypical deglutition has been studied, but it is still controversial (Cheng Enlow, Papsidero, Broadbent, Oyen, Sabet, 1998; Malkoc, Usumez, Nur, Donaghyd, 2005).

Among the possible changes in cephalometric studies conducted with mouth breathing children, (Malkoc et al., 2005; Cuccia, Lotti, Caradonna, 2007) change in the head posture was a not a controlled variable (Roggia, Correa, Pranke, Facco, Rossi, 2010). Studies have evaluated head posture in individuals with: different malocclusions (Maciel & Liete, 2005), different facial types (Sonnesen, Kjær, 2008a; Akçam & Köklü, 2004), orofacial malformations (Sonnesen, Pedersen, Kjær, 2007) in airway space (Muto, Takeda, Kanazawa, Yamazaki, Fujiwara, Mizoguchi, 2008; Anegawa, Tsuyama, Kusukawa, 2008) and atypical swallowing (Machado Júnior et al., 2012a,b). Head posture has been related to pharyngeal airway space, especially in adults who were diagnosed with the syndrome of obstructive sleep apnea (OSA) (Hoekema, Hovinga, Stegenga, De Bont, 2003; Sonnesen et al., 2008b).

However, no studies were found that evaluated the possible correlation between head posture and pharyngeal airway space as measured in children with atypical swallowing. Therefore, the aim of this study was to evaluate the possible correlation between head posture and pharyngeal airway space using lateral radiographs of children with atypical and normal swallowing in the mixed dentition stage of development.

MATERIALS AND METHODS

The research protocol of this study received unrestricted prior approval from the Research Ethics Committee of the Scholl of Medical Sciences, Unicamp (#619/2005). This observational study evaluated lateral teleradiographs from children of both sexes at the phase of mixed dentition. This was a retrospective analysis of lateral teleradiographs taken prior to treatment. These teleradiographs were stored in the archives, from patients whose treatment had been completed. The client's case history information was also available. The study did not involve carrying out experiments on human beings, therefore, it was deemed unnecessary to obtain written informed consent from the patients in order to conduct a retrospective analysis of previously obtained information in the records.

Archival patient records were reviewed, and the information contained in those records was used to define the control and experimental group for this study. An initial test of type of swallow used by the patient had been conducted by senior orthodontists simultaneously. Type of swallow had been determined by using forced opening of the lips during a saliva swallow (Machado Júnior et al., 2010, 2011, 2012a; Ovsenik et al., 2007; Peng et al., 2004). This assessment had been conducted on the initial visit, and information on the type of swallow used was available in each patient's record.

Prior to the study it was determined that a total sample size of 110 was necessary for the study with approximately 55 children in each group. The case history information provided on the type of swallow defined by consensus to which group the teleradiography of the child should belong: to the control group (normal swallowing) or to the experimental group (atypical swallowing). Records were reviewed on children who were in the stage of mixed dentition, and between 7 and 11 years of age. 110 patients' records were selected with 52 of those being female and 58 being male. 55 patients were assigned to the control group and 55 were assigned to the experimental group based on type of swallow.

Corresponding teleradiographs for each patient were reviewed. Teleradiographs selected for the present study were 18x24 cm, and were obtained using the same Siemens apparatus in one second at 6 kVp with a focal length of 1.5 meters. All were lateral views. The examinations were performed with the patient's head in a natural position (mirror position), and each examination was conducted by the same examiner. The cephalometric examination of the lateral teleradiographs was performed in a darkened room with a negatoscope. An acetate sheet was laid over the teleradiograph and the following anatomoradiographic landmarks were marked on the sheet (Figure 1):

PAS: the posterior tongue border crosses the lower mandible border, all the way to the point nearest the posterior pharyngeal wall (Muto et al., 2008; Machado Júnior et al., 2012a)

CC1: angle between the odontoid process and the base of the skull (Machado Júnior et al., 2012b).

Exclusion criteria for this study included:

- Lateral teleradiographs that did not provide a good view of the anatomical structures used in the cephalometric examination;
- Patients with dental agenesis, congenital poor orofacial formation, orthodontic and/or functional orthopedic treatment prior to the study;
- Doubts and imprecision regarding the diagnosis of deglutition;
- A lack of unanimity among the examiners on the clinical diagnosis was also a factor of exclusion of the sample.

The skeletal pattern and malocclusion of the patients were not taken into consideration in this study. The anatomical reference used in this study was the base of the skull.

The authors believe that measurements using this reference point suffer minimal external effects. It is also easily viewed on the lateral radiograph. The odontoid process was used as a reference because it is the anatomical structure responsible for the stabilization of the cervical spine in relation to the skull. Machado Júnior et al., 2012b).

The lateral teleradiographs from the experimental group and the control group were sequentially numbered at random. The examiner performing the manual measurements was blinded to patient data. The sequentially numbered teleradiographs were provided to the examiner for the standardized measurements of the PAS and CC1 to be completed. Measurement results were recorded to a data collection instrument. To minimize systematic errors, the same examiner carried out data collection of the entire sample on two occasions separated by a 20-day interval. After the collection of radiographic data, age and sex data were added. Typical or atypical deglutition information was also added. All appropriate measures were taken to ensure confidentiality of the subjects' personal data.

To investigate the intra-examiner consistency, a Wilcoxon test for related samples was used to detect possible differences between measurements obtained on the two different occasions during which measurements were obtained and recorded. No statistically significant difference between the related samples was observed at p=0.05. The Mann-Whitney U-Value, a non-parametric statistic, was used to determine significance between groups for the PAS comparison, and also for the CC1 comparison because this test does not assume a normal distribution of values within each group. The null hypothesis was that there is no significant difference between the median for the normal swallow and the atypical swallow groups on pharyngeal airway space dimension. The null hypothesis was also used for the odontoid process and the base of the skull between the medians for the normal swallow and atypical swallow groups. A Spearman Rank Correlation analysis was performed to investigate the possible relationship between the variables CC1 and PAS for each group.

RESULTS

The Mann-Whitney Test was used to compare the measurements between the two groups. The median of the variable CC1 was 99 degrees in the experimental group and 95 degrees in the control group, which was statistically significant (p = 0.0131) (Table 1) (Machado Júnior et al., 2012b) . The angle between the odontoid process and the base of the skull was larger for the atypical swallow group than for the normal swallow group. This indicated that the backward tilt of the natural head position in the atypical swallow group was significantly greater than in the group with normal swallow (Figure 2). The null hypothesis was rejected.

The median PAS, as assessed in the study was 7 mm in the experimental group and 10 mm in the control group (Table 1) (Machado Júnior et al., 2012a), which was statistically significant (p <0.001). The null hypothesis was rejected. This indicates that the pharyngeal airway space was narrower in the experimental group with an atypical swallow pattern than in the control group with the typical swallow pattern. Significance was maintained for each result after the application of analysis of covariance (ANCOVA) to control for the variables of age and sex of the samples.

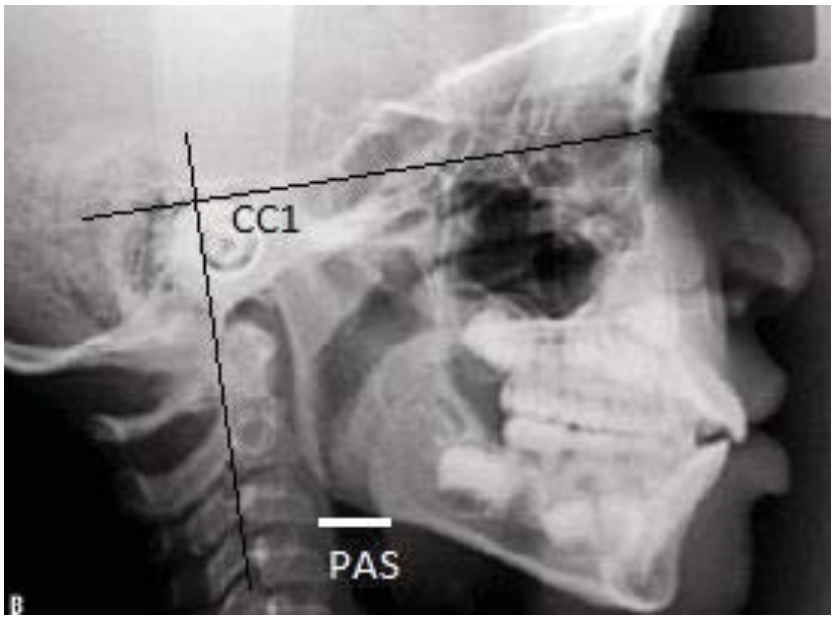
A positive correlation between measures CC1 and PAS (r = .0357) was observed only in the control group (normal swallowing) (Table 2). This indicates that for the normal swallow group, the greater the pharyngeal airway space, the greater the angle between the odontoid process and the base of the skull. While for the atypical swallow group there was no significant correlation between the width of the pharyngeal airway space and the angle between the odontoid process and the base of the skull.

Table 1: Comparison of variable CC1 and PAS.

	CC1 degrees	CC1 degrees	PAS Mm	PAS mm
deglutition	normal	atypical	normal	atypical
N	55	55	55	55
Mean	96.42	99.95	10.53	7.82
Sd	8.22	6.92	2.43	2.93
Minimum	83.00	87.00	5.00	3.00
Median	95.00	99.00	10.00	7.00
Maximum	116.00	115.00	15.00	13.00
p-value Mann-Whitney	0.0131*		<0.0001*	

* There was a significant difference: p-value<0.05.

Figure 1: Sample Radiograph From Each Group



NORMAL DEGLUTITION



ATYPICAL DEGLUTITION

Table 2: Analysis of Spearman correlation between PAS and CC1.

Spearman correlation (r).	
Normal deglutition	
	CC1
PAS	0.357
	0.0074*
Atypical deglutition	
	CC1
PAS	0.312
	0.0207

* There was a significant correlation.

DISCUSSION

The results of this study demonstrate that there is a positive correlation between the pharyngeal airway space (PAS) measurement and the angle between the odontoid process and the base of the skull (CC1) measurement only in the group of normal swallowing - the higher the slope of the skull, the greater the extent of the pharyngeal airway space (PAS). Although the measure CC1 was greater in the experimental group (atypical swallowing) (Machado Júnior et al., 2012b) this correlation was not maintained, possibly because the measurement of the PAS group decreased when accompanied by atypical swallowing. The authors feel that this observation indicates that the natural head posture adapts its position to maintain a pharyngeal airway space that is suitable for maintaining the flow of oxygen in the air column. The authors also believe that for the group with atypical swallowing this angle indicates increased posterior rotation of the head for the purpose of rectifying the PAS and facilitating the passage of air. The observations of posterior tilt of the head and decreased PAS has already been observed in children (Cuccia et al., 2007), however a statistical correlation was not reported. The observation of head tilt and the confirmation of this pharyngeal airway space measurement in children with atypical swallowing leads the authors to believe that there really is a close relationship between tongue thrusting and mouth breathing. However, because the samples were obtained from dental evaluation only, and because there was no clinical information about method of breathing (nasal or oral) used by the patients that was noted in the records used in this study, the potential co-occurrence between tongue thrust and mouth breathing warrants further study. Specific methods using instrumentation, such as fibronasopharyngolaryngoscopy, should be conducted to assess airway patency in children with atypical swallowing.

The relationship between head posture and pharyngeal airway space has been suggested in a study on syndrome of obstructive sleep apnea (OSA) (Hoekema et al., 2003; Sonnesen et al., 2008a). The rotation of the posterior skull has also been observed in a group of adult patients with OSA which also has been attributed to rectification of the pharyngeal airway in order to facilitate the passage of air.

Extra-oral radiographs are routinely used in orthodontic diagnosis/functional orthopedics, and have been used in numerous studies of craniofacial growth. This method demonstrates the relationship between skull, vertebrae, jaw, and airway. Radiographic studies are often taken in the standing position with the head stabilized in a craniostat using ear rods and a nasal stabilizing bar. A variable in this present study is the use of radiographs taken in the natural head position. The authors believe that the change in the tilt of the head when using the orthostatic radiograph could possibly change the results of the craniofacial measurements, however further studies are needed to evaluate this variable.

This study was a retrospective correlation analysis, and therefore a causative relationship was not identified between the amount of pharyngeal airway space and the angle between the odontoid process and the base of the skull is a consequence of decreased pharyngeal airway space, a consequence of head rotation or a consequence of tongue thrust swallow (atypical swallow). There was also no indication for the lack of correlation in the atypical swallow group, nor what other variables may contribute to this result. Further studies are warranted to address these questions. Some additional variables that may be accounted for in future studies include: the presence or absence, and type of dental malocclusion; the relationship between head posture and malocclusion; the size of the palatine tonsils and/or adenoids; the position of the hyoid; the size of the tongue base.

Perhaps the methodology used in this study will be helpful in assessing the diagnostic variables which may contribute to functional change. Moreover, the proposed methodology can be used in other studies favoring the diagnosis of changes in growth and development of facial bones resulting from unfavorable functional deviations to the stomatognathic system, such as mouth breathing, mouth breathing as a residual habit, and suction without nutritive purposes, since these variables often co-occur with atypical swallowing, and may also be considered harmful oral habits.

CONCLUSIONS

There was a positive correlation between head posture (CC1) and measure pharyngeal airway (PAS) in the group of normal swallowing. This correlation was not observed in the experimental group (atypical swallowing). Additional research should be conducted to identify what variables contributed to the lack of correlation in the atypical swallow group.

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ACKNOWLEDGEMENTS

The authors thank CAPES for the financial support.

Original article - Part of PhD thesis - Discipline of Otorhinolaryngology – School of Medical Sciences - State University of Campinas - Brazil.

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