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Cephalometric evaluation of the nasopharyngeal airway space in paediatric patients suffering from respiratory disorders

Ladniak B*, Pepe F, Petrazzuoli N, Brugnoletti O, Salucci A, D'Errico A, Polimeni A.

[1] Department of Oral and Maxillofacial Sciences, "Sapienza" University of Rome, Italy

*Corresponding author: Dr. Barbara Ladniak, Department of Oral and Maxillofacial Sciences, "Sapienza" University of Rome, Italy. Tel.: +39-3669089048; e-mail: ladniak.barbara@gmail.com

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Abstract

Obstructive Sleep Apnea Syndrome (OSAS) in children is a disorder of breathing during sleep charac-terized by prolonged partial upper airway obstruction and/or intermittent complete obstruction (ob-structive apnea) that disrupts normal ventilation during sleep and normal sleep patterns. It is associated with symptoms including habitual (nightly) snoring, sleep difficulties, and/or daytime neurobehavioral problems. Nocturnal polysomnography has generally been accepted as the gold standard for the diag-nosis of OSA syndrome but cephalometrics could be an adjunctive procedure for screening anatomical abnormalities in patients with OSAS.A sample of 66 children aged between 4 and 11 years (average age 7±2.6 years) from the "Centre for the Study and Care of Sleep Respiratory Disorders", were ana-lyzed at the Department of Pediatric Dentistry of the University of Rome "La Sapienza", in collabora-tion with the Second Pediatric Clinic.The subjects were divided into 3 groups: Group I: 22 OSAS-noMB subjects; Group II : 22 OSAS-MB subjects; Group III: 22 subjects with no breathing disorders (control group). Descriptive statistics for all the cephalometric variables was calculated in the 3 groups. The results of the present study showed that in OSAS groups, with or without mouth breathing, there was a significantly greater obstruction of the nasopharyngeal airway space compared with the control sample.When comparing the OSAS-MB group with the OSAS-noMB group, the sagittal dimensions were significantly smaller in the OSAS-MB subjects only for the lower portion of the nasopharynx (P3 and P4 measurements) while in the upper level (P1 and P2) there were no statistically significant differences between the 2 groups. This obstruction was mainly caused by an increase in the thickness of the adenoid tissue.

Keywords: *Obstructive Sleep Apnea Syndrome Introduction, cefalometric analysis*

1.Introduction

Obstructive Sleep Apnea Syndrome (OSAS) in children is a disorder of breathing during sleep charac-terized by prolonged partial upper airway obstruction and/or intermittent complete obstruction (ob-structive apnea) that disrupts normal ventilation during sleep and normal sleep patterns (1). It is asso-ciated with symptoms including habitual (nightly) snoring, sleep difficulties, and/or daytime neurobe-havioral problems. Complications may include growth abnormalities, neurologic disorders, and cor pulmonale, especially in severe cases. The prevalence of OSAS is relatively high in children (between 1 and 3%), with a peak age between 2 to 5 years (2,3). OSAS in children can be caused by adenotonsillar hypertrophy, neuromuscular disease, and craniofacial abnormalities (4,5).

Nocturnal polysomnography has generally been accepted as the gold standard for the diagnosis of OSA syndrome (2,4). But due to the high costs of installation and maintenance of polysomnography, clinicians have been diagnosing and treating OSA on the basis of history and physical examination alone. Some authors have suggested that cephalometrics could be an adjunctive procedure for screen-ing anatomical abnormalities in patients with OSAS (6). Dentofacial morphology of OSA children is characterized by a tendency to Class II skeletal pattern with reduced mandibular length (7,8), increased vertical skeletal relationships, a more anteriorly inclined maxilla, a shorter anterior cranial base, retroclined upper and lower incisors, and reduced airway space with respect to normal subjects (9).

OSAS is typically caused by a recurrent, but temporary, obstruction of the upper airways, mainly during sleep. This obstruction produces snoring episodes and/or obstructive apnea at a varying intensity and duration at night (1). OSAS should be distinguished from mouth breathing (MB) that is de-termined by a nasopharyngeal obstruction which is complete and continuous over time with typical postural modifications and possible changing in the craniofacial development (10,11). Previous inves-tigations (6,7,12) analyzed the sagittal dimensions of the nasopharynx on lateral cephalograms in chil-dren affected by OSAS with respect to normal subjects. These studies, however, did not evaluate the presence or absence of mouth breathing in children with OSAS.

The aim of this cephalometric study was, therefore, to analyze the sagittal nasopharyngeal di-mensions in subjects with OSAS and no mouth breathing (OSAS-noMB) and in subjects with OSAS and mouth breathing (OSAS-MB) when compared with a control group of subjects with no breathing disorders (control group).

2.Subjects and methods

A sample of 66 children aged between 4 and 11 years (average age 7±2.6 years) from the "Cen-tre for the Study and Care of Sleep Respiratory Disorders", were analyzed at the Department of Pediatric Dentistry of the University of Rome "La Sapienza", in collaboration with the Second Pediatric Clinic.

The subjects were divided into 3 groups:

- Group I: 22 OSAS-noMB subjects
- Group II : 22 OSAS-MB subjects
- Group III: 22 subjects with no breathing disorders (control group)

The diagnosis of OSAS was carried out through the polysomnographic examination performed with Polysomnograph Alice3 or Grass Heritage. The polysomnographic examination consisted of a re-cording of the sleep physiological variables through the monitoring of the following parameters: elec-troencephalogram, electro-oculogram, electromyogram, oral and nasal airflow, thorax and abdomen movements, thorax and abdomen, oxygen saturation curve, and total sleep time in supine position.

None of the children in the sample had received orthodontic treatment. Every child underwent a lateral cephalogram in "fixed" position, using a cephalostat. During the exposition to X-rays, the sagit-tal posture of the head, as well as the cervical column, must be well defined, because differences in craniocervical posture could influence the diameters of the pharyngeal airway. The right side the pa-tient's face was turned toward the X-ray tube, with an orthodontic distance of 150 cm. The Frankfort Plane was parallel to the floor, while the sagittal plane of the head of the patient was parallel to the film plane and perpendicular to the X-ray, and the dental arches were in maximum intercuspation.

Data relating to the cephalometric analysis of the nasopharyngeal sagittal airway dimensions in the sample of OSAS-noMB children were compared with those in the OSAS-MB group and with a control group. The control group consisted of subjects selected randomly at the Department of Pediat-ric Dentistry of the School of Dentistry, among patients who had never any breathing problems and had undergone never previous orthodontic treatments.

Cephalometric analysis

All cephalograms were hand traced by one investigator (M.M.) and then verified for landmarks by a second (P.C.). An analysis of the nasopharyngeal airway space was performed according to the method described by Sørensen et al. (1980).

The analyzed variables were (Fig. 1):

- P1: The shortest distance from the most anterior part of the adenoidal mass to the posterior wall of the maxillary anthrum;
- P2: Linear distance from the posterior nasal spine (PNS) to the adenoid tissue along the line from PNS to the midpoint (SO) of the line Basion-Sella (Ba-S) line;
- P3: Linear distance from PNS to the adenoid tissue along the line from PNS to Ba;
- P4: The shortest distance from the upper surface of the palatine velum to the adenoid tissue;
- T1: Thickness of adenoids along the line PNS-SO;
- T2: Thickness of adenoids along the line PNS-Ba.

The method error for all the cephalometric variables was assessed on 20 sets of repeated meas-urements.

Statistical analysis

Descriptive statistics for all the cephalometric variables was calculated in the 2 groups. To assess between-group differences Bonferroni-adjusted p-value based on Mann-Whitney test was performed (SigmaStat

3.5, Systat Software Inc., Point Richmond, CA, USA). A two-tailed P value of less than 0.05 was considered significant.

3.Results

Descriptive statistics and statistical comparisons of the cephalometric measurements of the na-sopharyngeal space in the three groups are reported in Table 1. All the linear measurements describing the sagittal dimensions of the nasopharyngeal space were significantly smaller in OSAS children, with or without mouth breathing with respect to the control group. The only exception was the linear dis-tance between PNS and the adenoid tissue along the line from PNS-Ba (P3) that did not show a statis-tically significant difference between OSAS-noMB subjects and the control group.

Table 1 –Caption: Medians plus/minus interquartile ranges and Bonferroni-adjusted p-value based on Mann-Whitney test for comparison of OSAS-noRo with OSAS-RO groups.

	OSAS-noRO	OSAS-RO	P-value
AD1-PNS mm	17± 7,88	12±6,50	0,069
AD2-PNS mm	13± 4,62	11 ±4,38	0,21
AD-PTV mm	5,25 ±3	3 ± 5,12	0,078
P1 mm	2±1,38	3 ±1,75	0,249
P2 mm	12,50 ±5	10,85 ±3,75	0,988
P3 mm	16±6,88	12,5 ±6,50	0,172
P4 mm	6±5,75	3,5 ±2,88	0,027
T1 mm	25 ±4,12	18,3 ±4,50	<0.001
T2 mm	26,5±7	31±4,75	0,044

When comparing the OSAS-MB group with the OSAS-noMB group, the sagittal dimensions were significantly smaller in the OSAS-MB subjects only for the lower portion of the nasopharynx (P3 and P4 measurements) while in the upper level (P1 and P2) there were no statistically significant differences between the 2 groups.

As for the sagittal dimensions of the adenoid tissue (T1 and T2) both OSAS groups showed a significantly greater thickness with respect to the control group. OSAS subjects with mouth breathing presented a significantly greater thickness of the adenoid tissue along the PNS-Ba line (T2) when compared with the OSAS-noMB children, while the opposite relation was observed for the T1 meas-urement.

4.Discussion

Few studies (6,9,12,13) have analyzed the sagittal pharyngeal dimensions in children with OSAS with respect to non-affected children by using cephalometrics. However, no study has com-pared the airway dimensions in OSAS children with and without MB.

The results of the present study showed that in OSAS groups, with or without mouth breathing, there was a significantly greater obstruction of the nasopharyngeal airway space compared with the control sample. This obstruction was mainly caused by an increase in the thickness of the adenoid tis-sue.

A significant reduction of the nasopharyngeal airway space in OSAS-MB vs OSAS-noMB chil-dren was recorded in the lower portion of the nasopharynx (P3 and P4). OSAS-noMB children and control subjects showed a similar value for the sagittal dimension of the nasopharyngeal airway space at P3. The reduction of P3 in OSAS-MB was associated with an increased thickness of the adenoid tis-sue (T2). This increased thickness of the adenoid tissue can be ascribed to the habit of OSAS-MB sub-jects to constantly breathe with open mouth, thus preventing a normal purification of the breathed air, facilitating the hypertrophy of the adenotonsillar tissue in this area. When analyzing the P4 measure-ment, the OSAS-MB children showed a greater reduction of the perviety of the lower portion of the nasopharyngeal airway space when compared with both the OSAS-noMB subjects and the control group.

The results at the P2 and P1 levels did not reveal any statistically significant difference between OSAS-MB and OSAS-noMB subjects. It should be noted that both measures are located in a more cranial nasopharynx zone than those previously analysed. The P2 measurement is correlated with the thickness of the adenoid tissue at T1 which was greater in OSAS-noMB subjects than in OSAS-MB subjects. P2 and T1 measure the extent of the airways along the line linking the basion to the sella tur-cica, at a higher level than P3 and T2, so it has to be considered that at this level some factors may de-termine significant differences between the two study groups. Generally, in the OSAS-MB child, the hypertrophic adenoids and the occurrence of allergic phenomena modify the respiratory function. The onset of mouth breathing causes a further increase of the lymphoid tissue volume, due to lack of the nose filter, generating a vicious circle. While OSAS-noMB children do not show a constant mouth breathing, the adenoid hypertrophy is surely an important co-factor, along with others, such as hypoto-nia and/or anomalous muscle insertions, neuromuscular disorders, for the onset of the pathology.

Finally it is interesting to observe that at the level of P1 there was a greater obstruction (though not statistically significant) in OSAS-noMB children compared to the OSAS-MB. The adenoid hyper-trophy measured at P1 e T1 could not be the cause but rather a consequence of OSAS. Therefore, in OSAS-noMB subjects the increased thickness of the adenoid tissue in the upper region of nasopharynx could be due to a secondary manifestation of the pathology, subsequent to disorders related to it (aller-gies, otitis, rhinitis etc.).

5.Conclusion

The main objective of this study was to compare, on the basis of the cefalometric analysis, the perviety of the nasopharyngeal airway space between a group OSAS-noMB children, a group of OSAS-MB subjects, and subjects with no breathing disorders.
The most important findings were:

- OSAS-MB subjects showed a greater reduction of the nasopharyngeal airway space chil-dren in the lower portion of the nasopharynx when compared to OSAS-noMB subjects and the control group;
- OSAS-noMB children presented with a greater thickness of the adenoid tissue in the up-per portion of the nasopharynx with respect both to OSAS-MB subjects and the control group. This hypertrophy of the adenoid tissue did not lead, however, to a reduced perviety of the upper airways in OSAS-noMB vs OSAS-MB children.

References

1. Schechter MS. Technical report: diagnosis and management of obstructive sleep apnea syndrome. Pediatrics 2002:109:e69,
2. Chan J, Edman JC, Koltai P. Obstructive sleep apnoea in children. American Family Physician 2004:69:1147-1154
3. Goldbart AD, Tal A. Inflammation and Sleep Disordered Breathing in children: a State of the art review. Pediatric Pulmonology 2008: 43:1151-1160
4. Rosen CL .Obstructive sleep apnea syndrome (OSAS) in children: diagnostic challenges. Sleep 1996: 19:S274-77
5. Jain A, Sahni JK. Polysomnographic studies in children undergoing adenoidectomy and/or tonsil-lectomy. Journal of Laryngology and Otology 2002:116:711-715
6. Kawashima S, Niikuni N, Chia-hung L, Takahasi Y, Khono M, Nakajima I, Akasaka M, Sakata H, Akashi S. Cephalometric comparisons of craniofacial and upper airway structures in young children with obstructive sleep apnea syndrome. Ear Nose and Throat Journal 2000: 79:499-506
7. Cozza P, Polimeni A, Ballanti F. A modified monobloc for the treatment of obstructive sleep ap-noea in paediatric patients. European Journal of Orthodontics 2004:26:523-530
8. Marino A, Malagnino I, Ranieri R, Villa MP, Malagola C. Craniofacial morphology in preschool children with obstructive sleep apnoea syndrome. European Journal of Paediatric Dentistry 2009:10:181-184.
9. Zettergren-Wijk L, Forsberg CM, Linder-Aronson S. Changes in dentofacial morphology after adeno-/tonsillectomy in young children with obstructive sleep apnoea--a 5-year follow-up study. European Journal of Orthodontics 2006: 28:319-326
10. Linder-Aronson S. Adenoids: their effect on mode of breathing and nasal air flow and their rela-tionship to characteristics of the facial skeleton and dentition: a biometric, rhino-manometric and cephalometro-radiographic study on children with and without adenoids. Thesis, Acta Oto-Laryngologica 1970: Supplement 265
11. Solow B, Siersbaek-Nielsen S, Greve E. Airway adequacy, head posture, and craniofacial mor-phology. American Journal of Orthodontics 1984: 86:214-223
12. Zucconi M, Caprioglio A, Calori G, Ferini-Strambi L, Oldani A, Castronovo C, Smirne S. Cranio-facial modifications in children with habitual snoring and obstructive sleep apnoea: a case-control study. European Respiratory Journal 1999: 13:411-417.
13. Sørensen H, Solow B, Greve E. Assessment of the nasopharyngeal airway. A rhinomanometric and radiographic study in children with adenoids. Acta Oto-Laryngologica 1980;89:227-232.