Cephalometric evaluation of soft palate thickness and size of the adenoid as an indicator for development of obstructive sleep apnea in children with mouth breathing habit.

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Abstract- **STUDY OBJECTIVES:** To evaluate the size of the adenoid and thickness of soft palate in the test group consisting of children with mouth breathing habit and compare it with the control group which included children without mouth breathing habit. Also to correlate the occurrence of pediatric obstructive sleep apnea among such children.

METHODS: A total of forty children belonging to the age group ranging from 7 to 10 years were included in the study, the children were divided into two groups with and without mouth breathing habit consisting of twenty children in each group. Cephalometric tracings were done for all the children and ratio of air column to soft palate thickness was calculated and graded according to Cohen and Konak.

RESULTS: Children belonging to the test group had a reduced air column and thicker soft palate compared to that of the control group with a mean difference of 1.092. It was also shown on grading of adenoid that 100% children belonging to the control group and small sized adenoids whereas maximum number of children (80%) in the test group has medium sized adenoid.

CONCLUSION: Pediatric dentists do have an opportunity to recognize and make appropriate referrals of pediatric patients at risk for obstructive sleep apnea. Lateral cephalogram is a reliable and a simple diagnostic tool as it is readily available. Children with medium and large sized adenoid have an increased susceptibility to pediatric obstructive sleep apnea.

Index Terms- Mouth breathing, Adenoid hypertrophy, Pediatric obstructive sleep apnea, Lateral cephalogram, Air column

INTRODUCTION

Post natal craniofacial development and adequate occlusion is a multifarious complex phenomenon which is affected by genetic and environmental factors. It is believed that functions of the stomatognathic apparatus play an important role in craniofacial and occlusal development.[1-2] Muscle adaptations also influence the growth and development of dentoskeletal unit.

The powerful urge to breathe through the nose is present in all individuals and is considered physiological.[3] Chronic obstruction of the nasal airway causes mouth breathing and respiratory needs are the primary determinant of the posture of jaws and tongue.[4] This shift from nasal to oral breathing in children is considered to affect their growth. Chronic mouth breathing is known to cause variation in the configuration of dentoskeletal unit. Open lips, elongated face, narrowing of nasal fossae, hypoplasia of paranasal sinuses, constricted maxillary arch associated with posterior cross bite, high palatal vault, dorsocaudal mandibular displacement, increased mandibular inclination in relation to the cranial base, lower positioning of the tongue and maxillary anterior gingivitis may be observed in children with chronic mouth breathing habit.[2-6]

Adenoid hypertrophy is frequently considered to be one of the main causes of respiratory obstruction. The adenoidal nasopharyngeal space is narrowest at 4.5 years of age and then the adenoid reaches its greatest size between 7-10 years and it is during this time that the facial frame develops rapidly.[7]

Adenoid hypertrophy increased the risk of developing obstructive sleep apnea in children. Pediatric obstructive sleep apnea is characterized by repetitive episodes of partial or complete airway obstruction during sleep, which may or may not be associated with hypoxemia and sleep fragmentation.[8-9] In children, adenoid hypertrophy is known to be one of the common etiology of nasopharyngeal obstruction, preventing the child from adequately breathing through nose and compelling the child to breathe through the mouth during sleep and wakefulness. Such children may have a history of snoring, abnormal sleep patterns, daytime neurobehavioural problems and cognitive deficits. A positive association existed between the adenoid grade and Apnea-Hypopnea Indiex (AHI) in toddler, preschool and school children but not in the adolescent group.[7, 10-11]

The lateral cephalogram, a standardized skull radiograph is used universally to analyze both bony and soft tissue craniofacial relationships and morphology. A lateral cephalometric radiograph is an uncomplicated, economical and reproducible way to measure adenoid size and hence can be used as a reliable screening tool.[9-11]

Little attention has been paid to craniofacial and pharyngeal morphology in children with nocturnal breathing disorders even though there is little information regarding why snoring and sleep disruption may in some children develop into POSA.[12-14]

Hence, this study aims to evaluate the soft palate thickness and adenoid size in children with mouth breathing habit which can be an indicator to the developing pediatric obstructive sleep apnea in such patients. Therefore, an early diagnosis (if made) through simple techniques and timely management can improve a child's long term cognitive and social potential as well as the school performance.

METHODOLOGY

The present study was conducted in the Department of Pedodontics and Preventive dentistry, Rajarajeswari Dental College and Hospital, Bangalore. Forty children aged between 7-10 years were involved in the study. An informed consent was taken from the parent/guardian of the children involved in the study. The children were grouped into two categories, consisting of 20 children in each group. The first group – A (mean age 9.2 years) consisted of children with malocclusion in the anteroposterior spatial relation without mouth breathing as control and the second group - B (mean age 9.65 years) consisted of children with mouth breathing habit. The children were diagnosed with mouth breathing based on detailed history regarding position of the lips while in leisure and sleeping, drooling of saliva and wet pillow observed in the morning as well as clinical evaluation such as open lips during rest position. Water holding test was performed in order to confirm mouth breathing habit. Subjects with history of adenoidectomy, congenital abnormalities, mental disorders and debilitating diseases, children undergoing orthodontic treatment or appliances were excluded from the study.

Lateral cephalograms were taken for both the test and control groups (40 children) in the same Panoromic machine with Cephalometric projection- Orthophos XG 5 DS (Sirona) at the Department of Oral Medicine and Radiology at Rajarajeswari Dental College and Hospital. The cephalograms were obtained with constant physical and technical parameters (71 kVp; 10 mAs; focal length – 165 cm; distance from midline of the head to cassette – 14 cm). Since there might be a variation in the position of the soft palate to the pharynx in supine position, all the lateral cephalometric radiographs will be taken with the subjects in upright position with the Frankfurt plane parallel to the floor, teeth in maximal intercuspal position and lip relaxed (Fig – 1).

Cephalometric tracing was done using acetate sheet for all the forty cephalograms taken. Conventional cephalometric landmarks, reference lines, and measurements that were used for skeletal structures are as follows (Cohen D and Konak S)[15,16] as shown in fig 2.

- A : Point of maximal convexity along the inferior margin of the adenoid
- B: Posterior superior edge of the hard palate
- C: Point on the posterior border of the soft palate, 10 mm away from B
- AC : Distance between point A –C

- D: Thickness of the soft palate measured 10 mm away from point B

RESULTS:

The values thus obtained were subjected to statistical analysis. Table 1 shows the mean and standard deviation of the cephalometric measurements comparing the ratio of air column(AC) to soft palate thickness(D) between test and control group using independent student t test. Comparison of distribution of adenoids between control and test groups using chi square test is shown in Table 2.

The study shows an increase in the thickness of soft palate and decrease in dimension of air column in the test group compared to that of the control with mean difference of 1.092 ($p<0.001$). the assize of the adenoid was evaluated and it was observed that in the control group it 100% of the children had small sized adenoid (AC/D >/= 1) whereas in the test group it was observed to be large sized adenoid in 5% of the children (AC/D < 0.5), medium sized adenoid in 80% of the children (AC/D > 0.5 < 1.0) and 15% of them had small sized adenoid (AC/D >/= 1.0).

DISCUSSION:

Craniofacial development in children with respiratory obstruction have been studied extensively from the past few years though there is a considerable controversy in literature due to the absence of a direct relationship between the etiology of respiratory obstruction and its consequence on craniofacial growth.[9,17] According to Porter in 87.5% of the cases with mouth breathing had high arched palate. It would seem clear that on account of nasal obstruction in bilateral cases or partial obstruction in unilateral cases, the action of tongue in molding the palate has been interfered with.[3] During normal respiration there is decreased pressure of air during inspiration and an increased air pressure during expiration and that when the nasopharynx is blocked due to adenoid hypertrophy, this rhythmic increase and decease is lessened and peak inspiratory pressure differences between normal breathing and apnea can show the severity of obstructive sleep apnea syndrome.[18,19] Some studies suggest that the deformities of nose and face are more often the cause than the result of the nasal obstruction.

During sleep, the muscle activity is decreased and the resistance of the upper airways is increased.[20,21] This results in reduction in the muscle tone which can lead to obstructive sleep apnea syndrome in children with hypertrophic lymphatic tissue. It has been reported that sleep disturbances have an influence on the endocrine system, especially on the secretion of growth hormones.[9,22-24] Condylar cartilage seems to be a target and production site for hormonal agents as evidenced by insulin like growth factor I (IGF I) receptor and IGF I messenger RNA expression and children with sleep disorders have shown to have a reduced posterior facial height.[22,25] Children with obstructive sleep apnea have shown disturbances in the somatic growth because of abnormal nocturnal secretion of growth hormone.[26]
Children with sleep disordered breathing is shown to have an increased total and lower anterior facial height which refers to vertical growth pattern of the mandible (Agren et al, Lofstrand-Tidestrom et al, Zucconi et al, Kawashima et al).
In this study we have evaluated the soft palate thickness and adenoid size as an indicator for the development of obstructive sleep apnea in children with mouth breathing habit It was observed that children with mouth breathing habit had a decrease in the dimension of air column(AC) (mean-0.5025 mm) an increase in the thickness of soft palate (D) (mean-0.675 mm) compared to the control group (AC: mean-0.99mm and SP: mean-0.52 mm). The mean ratio of AC/D in the test group was 0.760 and that of the control group was 1.852.
A study conducted by Juliana B.R et al which included 73 children among which 29 were control subjects and 44 with adenotonsillar hypertrophy aged between 3-6 years. They were submitted to otorhinolaryngologic, speech pathologic and orthodontic assessment. The results so observed revealed a higher incidence of nasal obstruction, snoring, mouth breathing, apneas, nocturnal hypersalivation, itchy nose, repeated tonsillitis and bruxism in the test group. A study conducted Harari D et al in which they evaluated children with mouth breathing habit. They were classified into two groups, ages raging from 3 to 6

years and 7-10 years, with respiratory obstruction due to isolated adenoid hypertrophy and two groups, ages ranging from 3-6 years and 7-10 years, due to adenotonsillar hypertrophy. It was found that there was an increase in the posterior lower facial height in children belonging to the test group. A study was conducted by Parkinnen et al to assess the cephalometric features in children with sleep disordered breathing (SDB). This study included 70 children with habitual snoring and symptoms of obstructive sleep disorder for more than 6 months. On the basis of polysomnographic findings, the children were further divided into subgroups of 26 children with diagnosed obstructive sleep apnea (OSA), 17 with signs of upper airway resistance syndrome (UARS) and 27 with snoring. A control group of 70 non obstructed children matched for age and gender were selected. Children with upper airway resistance syndrome(UARS) and OSA were associated with decreased pharyngeal diameter at the level of adenoids and tip of uvula, a thicker soft palate and anteriorly positioned maxilla in relation to the cranial base. The results in our study also showed a decrease in the air column at the level of adenoids and also a thicker soft palate among the test group.

Studies have shown that normal linear measurement of superior posterior airway space (SPAS) value is 10 mm and every 1 mm decrease increases the susceptibility to severity of snoring by 1.61 times. A study conducted by Rabasco J et al on children with apparent life threatening events (ALTE) displayed a higher frequency of snoring, apneas, habitual mouth breathing, restless sleep and night sweating than the control group. The life threatening events (ALTE) group also had a history of adenotonsillectomy.[27]

Adenoid is said to be a simple 3- dimensional structure and when it is compressed in to 2- dimensional image as in case of a lateral cephalogram, there seems to be no loss of information. Studies conducted by Jean et al and Maw et al have shown fairly strong correlation of the size of the adenoid measures on a lateral cephalogram with that which were surgically excised by adenoidectomy. Studies conducted by Linder Aronson et al have also shown correlation between the adenoid measures in lateral cephalogram with that viewed and graded using endoscopy.[28] Hence, lateral cephalograms have shown to be reliable for diagnosis of adenoid hypertrophy and has a strong correlation with standard intra-operative mirror nasopharyngoscopy and flexible endoscopic nasopharyngoscopy. It was also observed in a study that children undergoing diagnositic procedures by flexible endoscopy were above 10 years of age whereas those who underwent the procedure by lateral cephalograms where of youner age group children.[29]

CONCLUSION

Lateral cephalogram is a reliable and a simple diagnostic tool as it is readily available. Children with medium and large sized adenoid have an increased susceptibility to pediatric obstructive sleep apnea (POSA). A multidisciplinary approach is essential in order to manage the children as the severity may vary among the individuals belonging to this category and so will be the associated symptoms and manifestations which may be related to craniofacial development as well as overall health and well being of the child. Diagnosing the condition at a premature stage is possible through the pattern of breathing and an aberrant discrepancy in the growth and development of the child. Pediatric dentists may usually be the first to recognize this issue. There is limited information and statistics available regarding the present matter in India. Hence, an awareness regarding uncomplicated diagnostic method using a lateral cephalogram with non complex anatomical landmarks can lead to early intervention of this condition serving to modify and conduct the growth pattern as well as to enhance the quality of life among such children.

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Table 1 – Comparison of mean ratio of air column (AC) to soft palate thickness (SP) between test and control group using independent student t test

Group	**N**	**Mean**	**SD**	**S.E.M**	**Mean diff**	**t**	**p-value**
Control	20	1.852	0.627	0.140	1.092	7.418	<0.001*
Test	20	0.760	0.200	0.045			

*- Statistically significant

Table 2 – Comparison of distribution of adenoids between control and test group using Chi square test

Adenoid size	**Control**		**Test**		**X^2 Value**	**P- Value**
	n	%	n	%		
Small	20	100	3	15	29.565	<0.001*
Medium	0	0	16	80		
Large	0	0	1	5		

*- Statistically significant

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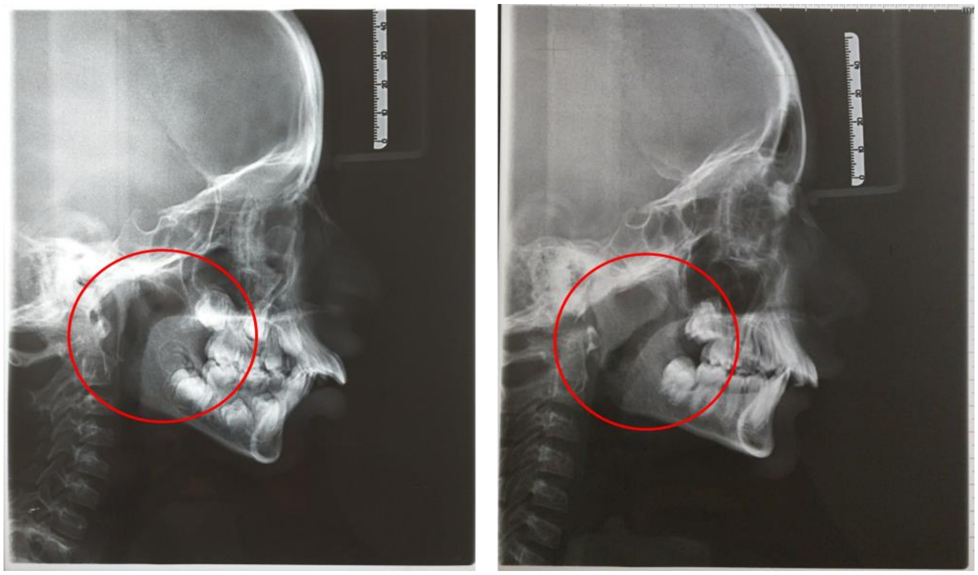

Fig 1 Lateral cephalogram of one of the children belonging to Group A(left) and Group B(right)

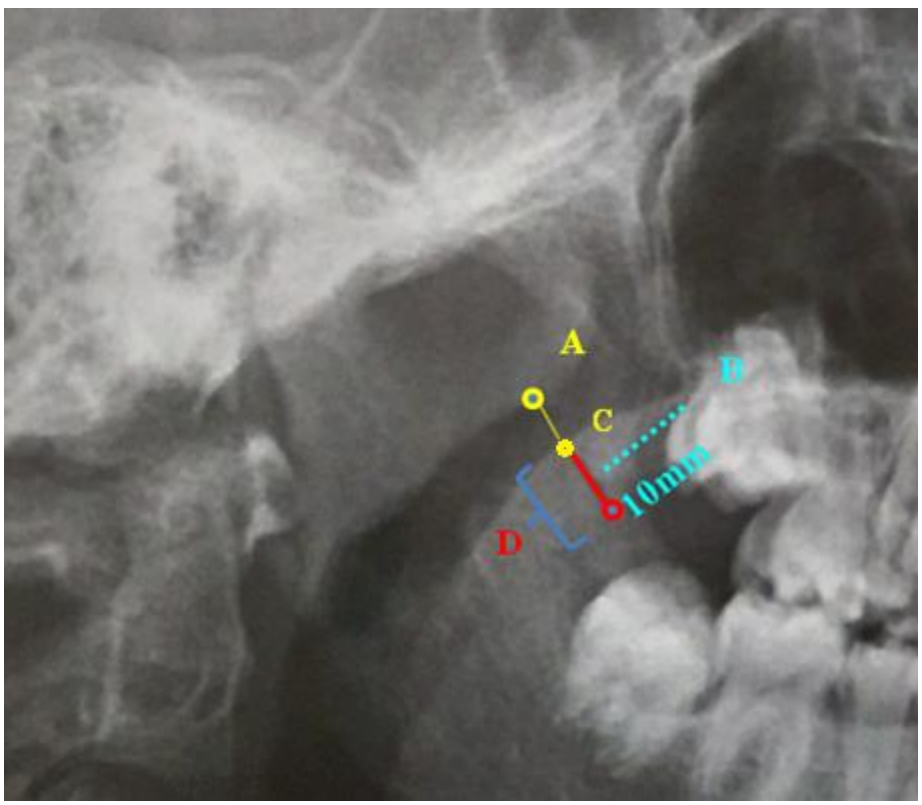

Fig.2 Cephalometric landmarks and reference point used for tracing