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ORIGINAL RESEARCH

Cephalometric Evaluation of Oropharyngeal Airway Dimension Changes in Pre- and Postadenoidectomy Cases

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ABSTRACT

Aim: The aim is to compare and evaluate the airway dimension changes, adenoidal nasopharyngeal ratio (ANR), airway area and airway percentage in patients in pre- and postadenoidectomy with normal individuals.

Materials and methods: After obtaining informed consent, a sample of 15 patients (eight males and seven females) of 7 to 12 years were selected for adenoidectomy by an otolaryngologist, lateral cephalograms were taken in natural head position before adenoidectomy and after 1 month postadenoidectomy. Statastical analysis was done to evaluate the results using Statastical Package for Social Sciences. Results showed airway (P1, P2, P3, P4), airway percentage, airway area showed singinficant increase ($p < 0.0001$), whereas ANR showed singnificant reduction after 1 month postadenoidectomy.

Conclusion: One month postadenoidectomy showed increased airway area, airway percentage and reduced ANR.

Clinical significance: Obstructive mouth breathing due to adenoids in growing children can cause alteration in craniofacial morphology leading to adenoid facies, adenoidectomy procedure helps in alleviating the obstruction and facilitates the normal growth of craniofacial complex.

Keywords: Adenoids, Mouth breathing, Airway.

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INTRODUCTION

The enlargement of the lymphoid tissues, adenoids and tonsils are a common problem seen between the ages of 2 to 12 years, when unattended may lead to an obstruction of the upper- respiratory tract, which in turn affects normal dentofacial development.[1,2,5]

Solow and Kreiborg[28] explained the cascade of events leading to the development of the 'adenoid facies'. Obstruction of the airway causes a neuromuscular feedback eliciting a postural change due to stretching of the soft tissues which in turn results in the transmission of differential forces on to the craniofacial region causing a morphological change.

Harvold[6] summarized that the adaptive neuromuscular response was associated with the following craniofacial features, such as a deficient maxilla, high and narrow maxillary vault, increased lower facial height, open bite; the combinations of which are termed as the 'adenoid facies' or 'the long face syndrome'.

The surgical assessment of the oropharyngeal airway cephalometrically was first introduced in orthodontics by Schuloff[27] and has now recently been applied by Naoko Imamura[20] for the evaluation of the same in cleft palate patients.

Reports available in literature evaluating the efficacy of these surgical procedures for the adenotonsillar problem are rare.[7,8] Especially, for evaluations concerning the changes in the oropharyngeal airway dimension following surgery.

AIMS AND OBJECTIVES

The study was conducted with the following aims and objectives:

1. To compare and evaluate the nasopharyngeal airway dimensions in patients undergoing adenoidectomy with normal individuals.
2. To evaluate the pre- and postsurgical changes in nasopharyngeal airway dimensions following adenoidectomy.

MATERIALS AND METHODS

Sample: A sample of 15 patients (eight males and seven females) of mean age of 10.5 years (range: 7-12 years) were selected for the present study.

Criteria for case selection: Patients were diagnosed clinically and radiologically as having adenoidal hypertrophy and indicated for adenoidectomy by an otolaryngologist.

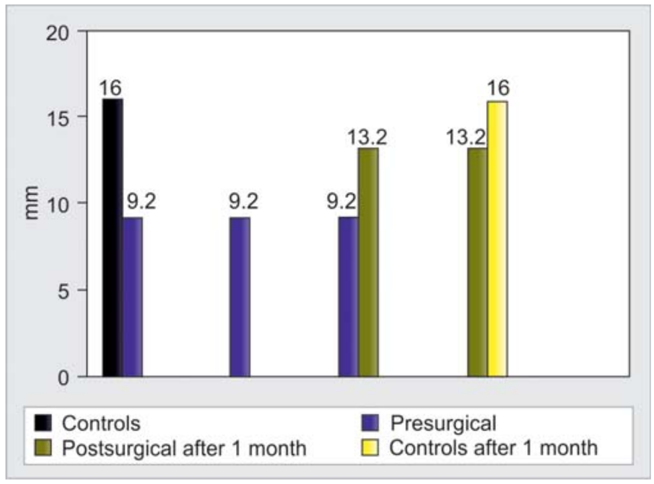
Control group: It consists of 15 individuals (eight males and seven females) of mean age 10.5 (range: 7-12 years) served as controls.

Cephalograms were taken for sample patients 1 day prior to adenoidectomy and the cephalograms[3,4,11,13] were repeated after 1 month postadenoidectomy. Cephalograms were also taken for control group individuals and are repeated after 1 month.

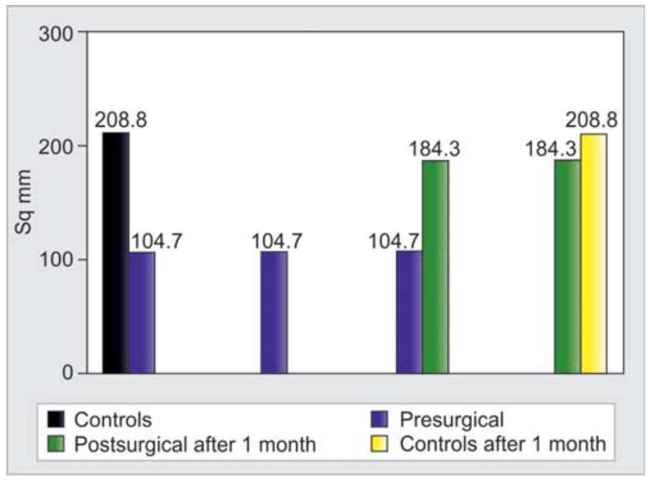
RESULTS

Postadenoidectomy

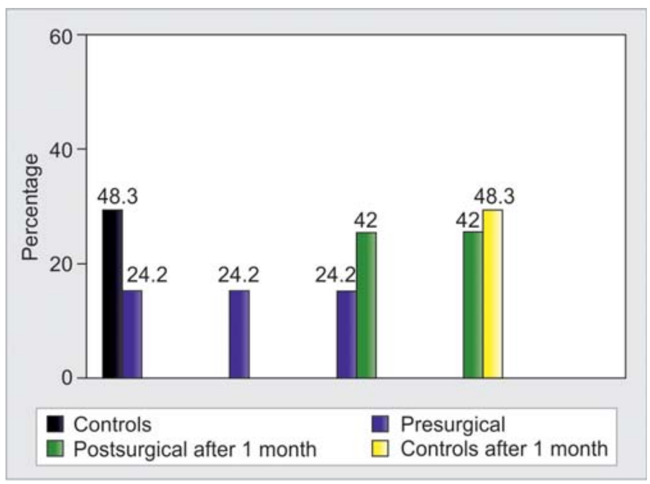
Airway: It (Graph 1 and Fig. 1A) is increased to 13 mm, adenoidal nasopharyngeal ratio (ANR-U2) is reduced to 0.43, ANR-Ba is reduced to 0.41 (Table 1 and Fig. 1B), airway area (see Table 1, Fig. 1C and Graph 2) is increased to 184 sq mm and airway percentage (Table 1, Fig. 1C and Graph 3) is increased to 42%.



Graph 1: Airway (P1 + P2 + P3 + P4)



Graph 2: Nasopharyngeal airway area



Graph 3: Nasopharyngeal airway percentage

DISCUSSION

Anatomically, the pharynx is a muscular tube that extends superiorly from the base of the cranium to the level of the inferior surface of the body of the sixth cervical vertebra. The pharynx lies dorsal to the nasal cavity, the oral cavity and the larynx. The nasal portion of the pharynx, the nasopharynx also provides space on its posterior and superior walls for lymphoid tissue in the form of the nasopharyngeal tonsil as part of the Waldeyer's tonsillar ring. This tissue, which often hypertrophies in childhood, is termed as 'adenoids'.

Linder-Aronson[14,15,17] demonstrated in a comprehensive study of children with nasal respiratory obstruction due to adenoids, that there were significant differences in the craniofacial morphology of these children as compared with normal controls. Follow-up studies by the same author on children who underwent adenoidectomies showed that the differences between the patients and the controls decreased significantly.[18,19]

Preston, Tobias and Salem[20] believed that a calculation of the area of the soft tissue contained by the nasopharynx, relative to the area of the bony nasopharynx, is the method of choice in studies of growth of the adenoids. Their studies have shown that the amount of adenoid tissue present must be assessed relative to the dimensions of the nasopharynx.[21-24] Dunn, Koski and Lahdemaki[12] reported evidence of altered craniofacial morphology in patients with nasal obstruction due to adenoids, as regards the mandibular form. Wankewicz and Harvold[6] reported that the changes did occur in the craniofacial morphology of animals after experimental inducement of nasopharyngeal airway obstruction. Contrary to these reported findings from numerous studies, there are also opposing viewpoints that argue that the typical features described in the long face syndrome and 'adenoid facies' are the expression of a hereditary pattern, and that such entities can exist without the presence of airway inadequacy.

Table 1: Airway dimensions

Variable	*Presurgical mean and SD*	*Postsurgical mean and SD*	*Change mean and SD*	*p-value**
P1	3.5 ± 1.5	5.1 ± 1.6	–1.5 ± 1.1	<0.0001*
P2	10.9 ± 3.0	15.2 ± 1.6	–4.3 ± 2.6	<0.0001*
P3	16.1 ± 3.7	21.7 ± 4.2	–5.7 ± 3.5	<0.0001*
P4	6.4 ± 1.8	10.7 ± 2.5	–4.3 ± 2.0	<0.0001*
Average (P1 + P2 + P3 + P4)	9.2 ± 2.1	13.2 ± 2.8	–4.0 ± 1.6	<0.0001*
Adenoid nasopharyngeal ratio:				
ANR-U2	0.62 ± 0.11	0.43 ± 0.11	0.19 ± 0.006	<0.0001*
ANR-Ba	0.53 ± 0.02	0.41 ± 0.09	0.13 ± 0.07	<0.0001*
Airway area	104.7 ± 32.2	184 ± 54.2	–79.6 ± 57.6	<0.0001*
Airway percentage	24.2 ± 7.5	42.0 ± 6.8	–17.8 ± 6.5	<0.0001*

*Significant; NS: Not significant; Level of significance: <0.05

It is further suggested that nasal obstruction, and its associated mouth-breathing pattern, is secondary to, rather than being the primary cause of, a dentofacial deformity. In addition, it has been pointed out that mouth breathing can be associated with a variety of different facial patterns.

Various studies have shown that alterations of nasorespiratory function modify the sensory feedback that reflexively induces changes in the neuromuscular function of the craniofacial muscles.[25,26] The adaptation of the craniofacial muscles during obstruction of the nasal cavity leads to a major neuromuscular change and an increase in secondary tonic activity. These neuromuscular changes involve the alteration of the discharge of specific craniofacial muscles in one of the two modes: (1) Inducing a periodicity in discharge correlated with rhythmic respiration; and or (2) initiating a sustained, tonic discharge. The long-term effects of these changes in craniofacial function correlate with changes in soft tissue and precede the morphological adaptations of the craniofacial skeleton.

Airway Size (Fig. 1A)

The airway size was lower in comparison to the controls presurgically and, though there was, a significant increase in this parameter following adenoidectomy the surgical outcome was still not comparable to the control group.

Adenoidal Nasopharyngeal Ratio (Fig. 1B)

The ANR ratio in the pretreatment group was found to be increased in comparison to the control group and was similar to an assessment of the same parameter made by Kemaloglu.[11]

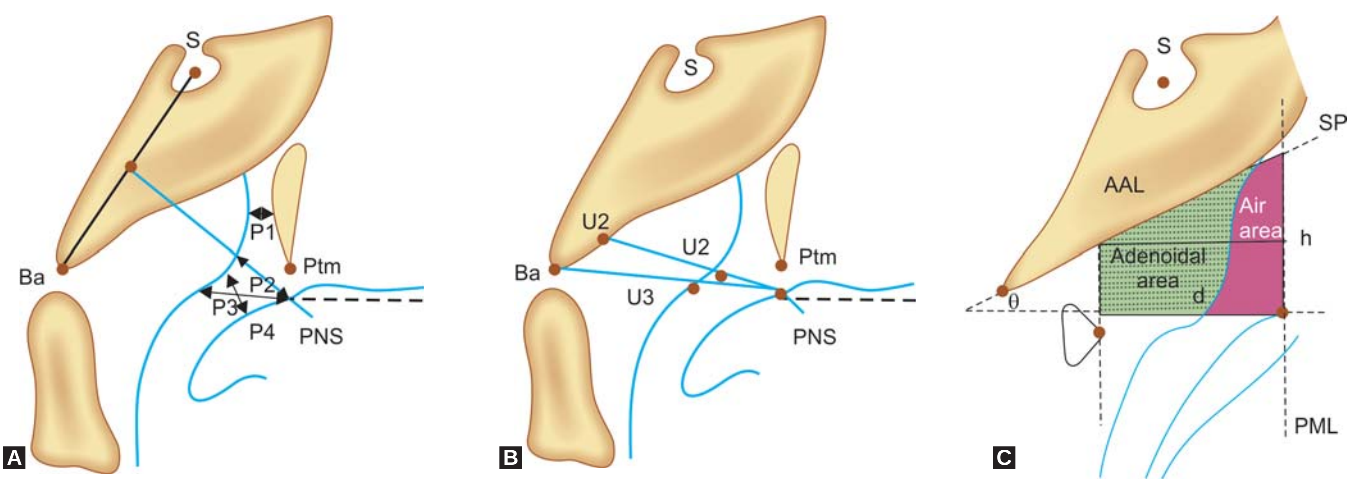
Although the postsurgical ratio showed a reduction of 0.19%, it was still larger by 0.10% when compared to the control group.

Airway Area (Fig. 1C)

The nasopharyngeal airway area, in the pretreatment sample was significantly lower than that of the controls by 104.1 mm^2. The postsurgical assessment of the airway area showed a marked increase of 79.6 mm^2. However, this increase observed postadenoidectomy was still lesser than that of the controls by 28.8 mm^2.

Airway Percentage (see Fig. 1C)

The nasopharyngeal airway percentage, in the pretreatment sample was also found to be much lower than that of the



Figs 1A to C: Comparison between presurgical samples and postsurgical samples: (A) Nasopharyngeal airway, (B) adenoid nasopharyngeal ratio, (C) airway area controls, the values were 24.2% compared to the control group value of 48.3%. The airway percentage after adenoidectomy increased by 17.8% compared to the control group, though in comparison to the control group, the percentage was lesser by 6.3%.

In summarizing the observations of the nasopharyngeal airway (area, percentage and ratio), the evaluation of the parameters were suggestive of a significant reduction in the overall airway dimension in the pretreatment group.[29-31] Although the contribution of the adenoidal mass is a representation of this inadequacy seen in the airway dimensions, the studies of Solow and Greve[29] have shown that factors other than the presence of the enlarged adenoids play a significant role in contributing to reductions and/or inadequacy of the airway. They observed that there was also an associated relationship between the adequacy of the airway and craniofacial morphology, reporting that airway adequacy was intimately related to the development and size of the mandible as well as to the craniocervical angulation or head posture.[32-34] Jeans[9] et al showed that there were differences in the size of the nasopharynx according to gender; differences have also been observed in different types of clefts.

Additionally, Vig et al[10,35] have stressed the importance of correlating these observations simultaneously with objective rhinomanometric tests to evaluate the nasal and oral components of airflow and nasal resistance including an assessment of airflow dynamics, pressure gradients and the respiratory flow rate, which would provide for a more reliable quantification of the degree of nasorespiratory function and nasopharyngeal obstruction. The inclusion of these additional parameters would enable a more comprehensive assessment of the extent and functional significance of the nasopharyngeal obstruction and would be indicative of the need for, and likely success of, a surgical procedure, such as an adenoidectomy.

Due to the lack of a linear relationship between nasal respiration and the size of the epipharyngeal space, other investigators have questioned and made assessments of the efficiency of the surgical procedure itself by evaluating the actual amount of adenoid tissue removed and the resulting epipharyngeal space increase. These studies stressed the importance of the location of the excised adenoid tissue.

Postadenoidectomy, our observations have shown that there has been a considerable increase in the dimensions of the nasopharyngeal airway. This evaluation highlighted the efficacy of the surgical procedure and, as pointed out earlier, the correlation of these observations following adenoidectomy would have provided a more meaningful insight, if a simultaneous assessment of the dynamics of the airway, was carried out.[36] This highlights the vacuum in our study as the fact remains that direct and indirect measurements of nasal airflow have an obvious advantage.

SUMMARY

The following observations were made:

- Presurgical sample subjects when compared to controls showed significant reduction in the airway dimensions.
- Postsurgical sample subjects when compared to presurgical subjects showed significant increase in airway dimensions.
- The postsurgical samples showed lesser values in airway dimensions, when compared to controls after 1 month.

CONCLUSION

One month postsurgical airway dimensions increased markedly compared to their presurgical values but could not bring the values equal to that of controls, and may be attributed to the longer duration taken for complete healing and fibrosis of tissues.

- The study would have been more confirmative, if cephalometric values are correlated with additional studies of nasal airway resistance including an assessment of airflow dynamics, pressure gradients and the respiratory flow rate which would have provided a more reliable quantification of the degree of nasorespiratory function and nasopharyngeal obstruction.
- As the cephalograms are only two-dimensional representation of three-dimensional facial structures, future studies should be directed toward usage of advanced imaging techniques like three-dimensional MRI which would enable an accurate assessment of the true extent of the enlarged adenoid tissue and also help in evaluating the effectiveness of the surgical outcome.

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REFERENCES

1. Behlfelt K, et al. Dentition of children with enlarged tonsils compared to control children. EJO 1989:416-29.
2. Bresolin, Shapiro, Chapko, Dassel. Mouth breathing in allergic children: Its relationship to dentofacial development. AJO-DO 1983 Apr: 334-40.
3. Cooke, Wei. The reproducibility of natural head posture: A methodological study. AJO-DO 1988 Apr:280-88.
4. Fujioka M, et al. Radiographic evaluation of adenoidal size in children; adenoidal nasopharyngeal ratio. Adapted from Imamura et al. AJO 2002 Aug;122:189-95.
5. Handelman C, Osborne G. Growth of nasopharynx and adenoid development from 1 to 18 years. Angle Orthodont 1976;44:243.

6. Harvold. Neuromuscular and morphological adaptations in experimentally induced oral respiration. Adapted from naso-respiratory function and craniofacial growth, monograph 9, craniofacial growth series.
7. Hibbert R, Whitehouse GH. The assessment of adenoidal size by radiological means. Adapted from Imamura et al. AJO August 2002;122:189-95.
8. James, et al. Discussion on mouthbreathing and nasal obstruction. Adapted from naso-respiratory function and craniofacial growth, monograph 9, craniofacial growth series.
9. Jeans, et al. A longitudinal study of the growth of the nasopharynx and its contents in normal children. Adapted from Imamura et al. AJO 2002 Aug;122:189-95.
10. Vig KWL. Nasal obstruction and facial growth: The strength of evidence for clinical assumptions. AJO-DO 1998 Jun;603-11.
11. Kemaloglu YK, et al. Radiographic evaluation of children with nasopharyngeal obstruction due to the adenoid. Adapted from Imamura et al. AJO 2002 August;122:189-95.
12. Koski K, Lahdemaki P. Adaptations of the mandible in children with adenoids. Adapted from naso-respiratory function and craniofacial growth, monograph 9, craniofacial growth series.
13. Linder-Aronson S, Henrikson CO. Radiocephalometric analysis of anteroposterior nasopharyngeal dimensions in 6 to 12 year old mouth breathers compared with nose breathers. Adapted from Imamura et al. AJO 2002 Aug;122:189-95.
14. Linder-Aronson S. Adenoids: Their effect on mode of breathing and nasal airflow and their relationship to characteristics of the facial skeleton and the dentition. Adapted from Imamura et al. AJO 2002 Aug;122:189-95.
15. Linder-Aronson, Woodside, Lundstrom. Mandibular growth direction following adenoidectomy. AJO-DO, 1986 Apr; 273-84.
16. Linder-Aronson, Woodside, Hellsing, Emerson. Normalization of incisor position after adenoidectomy. AJO-DO, 1993 May; 412-27.
17. Linder-Aronson. Naso-respiratory function and craniofacial growth. Adapted from naso-respiratory function and craniofacial growth, monograph 9, craniofacial growth series.
18. Kean ME. Natural head position, a basic consideration in interpretation of cephalometric radiographs. Am J Phy Anthropol 1958;16;213-34.
19. Yoshihara M, et al. 3D analysis of pharyngeal airway morphology in growing japanese girls with and without cleft lip and palate. AJO-DO 2012 April.
20. Imamura M, et al. Comparison of the sizes of adenoidal tissues and upper airways of subjects with and without cleft lip and palate AJO 2002;122:189-95.
21. Opdebeek H, et al. Comparative study between the SFS and LFS rotation as a possible morphogenetic mechanism. Adapted from naso-respiratory function and craniofacial growth, monograph 9, craniofacial growth series.
22. Vig PS. Nasal airflow in relation to facial morphology, AJO-DO 1981 Mar;79.
23. Mehra P, et al. Pharyngeal airway space changes after counterclockwise rotation of the maxillomandibular complex AJO 2001;120:154-59.
24. Rayan, Gallagher, La Banc, Epker. Relation between nasorespiratory function and dentofacial morphology: A review AJO-DO 1982 Nov:403-10.
25. Bushey RS. Adenoid obstructionof the nasopharynx. Monograph 9, craniofacial growth series.
26. Rubin. Mode of respiration and facial growth. AJO- DO 1980 Nov.
27. Schulhof RJ. Consideration of airway in orthodontics. J Clin Orthodont 1978;12;440-44.
28. Solow, Kreiborg. Soft tissue stretching: A possible control factor in craniofacial morphogenesis, adapted from naso-respiratory function and craniofacial growth, monograph 9, craniofacial growth series.
29. Sorensen H, Solow B, Greve E. Assessment of nasopharyngeal airway, A rhinomanometric and radiographic study of childrens with adenoids. Acta Otolaryngol 1980;89:227-32.
30. Subtelny JD. The significance of adenoid tissue in orthodontia. Angle Orthodont 1954;24:59.
31. Tarvonen, Koski. Craniofacial skeleton of 7-year-old children with enlarged adenoids. AJO-DO. 1987 Apr;300-04.
32. Tetsuro Yamada D, et al. Influences of nasal respiratory obstruction on craniofacial growth in young Macaca fuscata monkeys AJO-DO 1997 Jan;38-43.
33. Timms, Trenouth. A quantified comparison of craniofacial form with nasal respiratory function. AJO-DO 1988 Sep;216-21.
34. Arun TI, et al. Vertical growth changes after adenoidectomy. Angle Orthod 2003;73:146-50.
35. Vig. Respiratory mode and morphological types: Some thoughts and preliminary conclusions. Adapted from naso-respiratory function and craniofacial growth, monograph 9, craniofacial growth series.
36. Kim YJ, et al. 3D analysis of pharyngeal airway in pre adoloscent children with different antero-posterior skeletal patterns. AJO-DO March 2012.

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