ORIGINAL RESEARCH

Correlation of Tonsillar Grading, Adenoid Grading, and Combined Adenotonsillar Hypertrophy with Various Inter- and Intra-arch Dental Parameters: An Early Predictor for Pediatric Sleep Apnea

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Abstract

Context: Enlargement of lymphoid tissue, in particular, the palatine tonsils and adenoids, has been associated with developmental aberrations in the craniofacial structures as well as a leading cause of pediatric obstructive sleep apnea (OSA). This correlation has been well documented in orthodontic literature but as yet remains subjective and variable.

Aims: In view of the above, a study is proposed to objectively correlate tonsillar grading, adenoid grade, and combined adenotonsillar hypertrophy with various intra- and inter-arch dental parameters.

Settings and design: A cross-sectional study design was utilized with the sample including 150 children reporting to the Department of Orthodontics and Dentofacial Orthopedics of Military Dental Facility and screened at the Department of Otorhinolaryngology of Military Hospital.

Methods and materials: The study subjects were subdivided into five groups based on an objective evaluation of tonsillar and adenoid grading. The dental arch measurements were recorded from study models.

Statistical analysis used: A Chi-square test was used for comparison between categorical variables (demographic). The strength of the association between the tonsillar grade, adenoid grade, combined adenotonsillar hypertrophy, and the quantitative dental measures were assessed by using Spearman's correlation coefficient (ρ). A Chi-square test was used to measure the strength of association of qualitative dental arch variables with the tonsillar grade, adenoid grade, and combined adenotonsillar hypertrophy. The significance threshold was set at $p < 0.05$.

Results: Enlarged adenoids are significantly and negatively correlated with intercanine, inter-premolar, and intermolar widths. The total depth of the palatal vault and the ratio of total depth of the palatal vault to maxillary interfirst molar width were significantly and positively correlated. Grade III/IV tonsils are strongly associated with an increased prevalence of Class III canine and molar relationship. Combined adenotonsillar hypertrophy is associated with the most significant changes in dental arch parameters.

Conclusions: The study highlights the paramount importance of the evaluation and screening of enlarged lymphoid tissue. Timely intervention can enhance nasal breathing and prevent potential, or reverse existing, abnormal facial growth and/or deleterious effects of pediatric OSA.

Keywords: Adenoids, Craniofacial growth, Dental arch parameters, Interceptive orthodontics, Tonsils.

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Key Messages

Otolaryngologists and orthodontists should appreciate the early impact of enlarged adenoids and tonsils, the most common obstructive agents of the posterior pharyngeal airway.

Introduction

The palatine tonsils, together with adenoids, lateral pharyngeal bands, and lingual tonsils, are parts of the Waldeyer's ring. This is a complex of lymphoid tissue that encircles the pharynx. The involvement of Waldeyer's ring hypertrophy in the development of dentofacial deformities has been documented in the orthodontic literature.[1–4]

Adenoids and tonsils play a part in the immunologic defense of the body. The immunologic process is of greatest importance during the first 4–5 years of childhood. Enlargement of the palatine tonsils and adenoids obstruct the vital upper airway involving the environment and the functional matrix.[5] Primate studies and longitudinal studies have substantiated the above quite convincingly.[6–8]

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However, there are very few studies quantifying the relationship of various tonsillar grading to dental arch anomalies.[9] The objective criteria for combined adenoid hypertrophy with tonsillar hypertrophy on dental arch parameters is also not well defined. Brodsky has set up a tonsillar hypertrophy grading scale based on the space it occupies in the pharynx.[10] Adenoids can be assessed vide lateral cephalograms and can be graded.[11–15]

The preliminary assessment by orthodontists almost always includes an analysis of lateral cephalograms to aid in diagnosis and treatment planning. In these situations, it can double up as a useful screening tool for further evaluation by an otolaryngologist in cases of nasopharyngeal obstructions. Early detection and management of these obstructions vide a close cooperation between the treating orthodontist and the otolaryngologist will not only aid in intercepting the deleterious effects on craniofacial morphology and dentoalveolar structures but also provide a more comprehensive and holistic orthodontic treatment.

Perhaps, the most significant outcome of this intervention will be in prevention or amelioration of sleep-disordered breathing in children. Adenotonsillar hypertrophy is a major cause of pediatric OSA.[16]

In view of the above, a study is proposed to objectively correlate tonsillar grading, adenoid grade, and combined adenotonsillar hypertrophy with various intra- and inter-arch dental parameters, with the null hypothesis being that there is no correlation between tonsillar grading, adenoid grade, and combined adenotonsillar hypertrophy and the various inter- and intra-arch dental parameters.

Methods

A total of 150 children reporting to the Department of Orthodontics and Dentofacial Orthopedics and screened at the Department of Otorhinolaryngology fulfilling the inclusion and exclusion criteria as given in Table 1 and those who gave informed consent were included as study subjects.

The study was conducted using pretreatment clinical examination, study models, and lateral cephalometric evaluation. The selected study subjects were divided into groups based on tonsillar grading and adenoid obstruction. The tonsillar grading proposed by Brodsky[10] was adopted for the study and the same is depicted in Table 2.

The adenoid obstruction was measured using an evaluation of McNamara's line[14] on a lateral cephalogram, which is depicted in Figure 1.

The study subjects were divided into five groups and a summary of their distribution and criteria is given in Table 3.

All study subjects were screened at the Department of Otorhinolaryngology for enforcement of the exclusion criteria. The tonsillar grading was evaluated clinically according to Brodsky's criteria. On each selected patient, a tonsillar grade was determined by the same observer.

All study subjects were subject to the recording of lateral cephalograms as part of pretreatment records. All lateral cephalograms were taken with standard lateral cephalometric radiographic equipment (New Tom Giano). All lateral cephalograms were taken by a single observer with the Frankfurt's horizontal plane (FH) plane parallel to the floor and teeth in occlusion with relaxed facial musculature. All lateral cephalograms were stored in digitized DICOM format. The adenoid grading was calculated on the basis of McNamara's line.[14] The grading for adenoid obstruction was carried out digitally using a ruler tool available on digital cephalometric viewing software (NNT software version 8.0). A representative image of the same is depicted in Figure 2.

Upper and lower study models were made for all study subjects using standardized impression techniques with calcium/sodium

Source of support: Nil
Conflict of interest: None

Table 1: Inclusion and exclusion criteria

Inclusion criteria	*Exclusion criteria*
Boys and Girls between 6 and 12 years of age	• Previous history of tonsillectomy • Previous history of orthodontic treatment • Non-nutritive sucking habits beyond age 4 • Chronic allergic rhinitis, nasal valve collapse, and nasal septum deviation • Nasal polyp and turbinate hypertrophy • Hypertrophy of lingual tonsils • Diagnosed OSA • Any history of systemic disease or syndromic patients

Table 2: Tonsillar grading

Grade	*Definition*
0	Tonsils limited to the tonsillar fossa
I	Tonsils occupying up to 25% of the space between the anterior pillars in the oropharynx
II	Tonsils occupying 25–50% of the space between the anterior pillars
III	Tonsils occupying 50–75% of the space between the anterior pillars
IV	Tonsils occupying 75–100% of the space between the anterior pillars

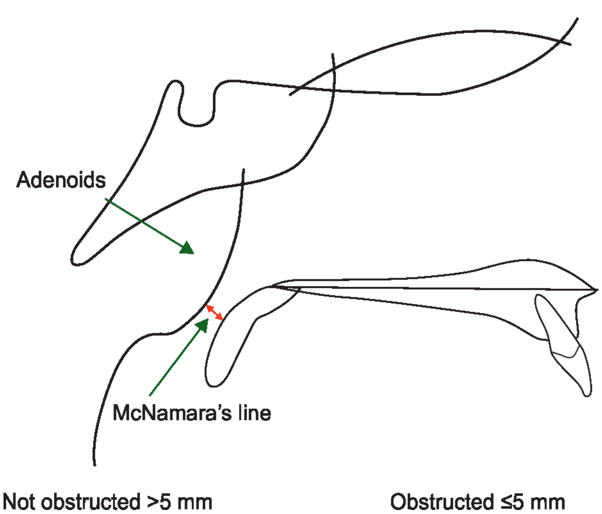

Fig. 1: McNamara's line: Upper pharyngeal width is measured from a point on the posterior outline of the soft palate to the closest point on the posterior pharyngeal wall. Airway obstruction is indicated by an opening of 5 mm or less

alginate and casts that were made with Type III dental stone. The dental arch measurements were made using a Mitutoyo (model no. 162) digital caliper with an accuracy of 0.01 mm. The palatal depth was assessed using a Korkhaus gauge.

The following dental arch parameters were recorded:

- Transversally
  - Presence/absence of anterior/posterior crossbite
  - Maxillary intercanine distance measured at the level of cusp tip
  - Mandibular intercanine distance measured at the level of cusp tip

Table 3: Distribution of Study Groups

Group	*Tonsillar grading*	*Adenoid grading*
Group I	0	Not obstructed
Group II	1 or 2	Not obstructed
Group III	1 or 2	Obstructed
Group IV	3 or 4	Not obstructed
Group V	3 or 4	Obstructed

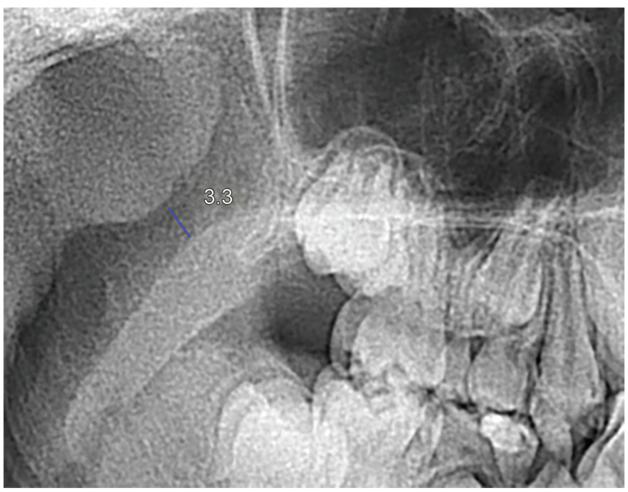

Fig. 2: Evaluating the McNamara line with the help of distances toolbar in NNT viewer software

  - Maxillary intermolar distance measured at the level of mesiobuccal cusp tip of first permanent molar
  - Mandibular intermolar distance measured at the level of mesiobuccal cusp tip of first permanent molar
  - Maxillary inter-premolar distance measured at the level of buccal cusp tip
  - Mandibular inter-premolar distance measured at the level of buccal cusp tip
  - Maxillary inter-deciduous first molar distance measured at the level of mesiobuccal cusp tip
  - Mandibular inter-deciduous first molar distance measured at the level of mesiobuccal cusp tip
- Sagittally
  - Angle's molar and canine relation
  - Measurement of overjet
- Vertically
  - Measurement of overbite
  - Depth of the palatal vault (distance measured between the inter maxillary first molar line at the level of the central fossa and a point on the mid-palatine raphe)
  - Ratio of the depth of palatal vault to the maxillary inter-first molar width
  - Representative images of tonsillar grading and adenoid enlargement of each of the groups are depicted in Figures 3 to 7.

Statistical Analysis

The collected data were entered into Microsoft Excel and analyzed using SPSS (Statistical Package for Social Sciences) package for relevant statistical comparisons. Results are presented in the form of tables and graphs. Descriptive statistics were performed by calculating mean, standard deviation, frequencies, and percentages. The Chi-square test was used for comparison between categorical variables (demographic). The strength of the association between the tonsillar grade, adenoid grade, combined adenotonsillar hypertrophy, and the quantitative dental measures was assessed by using Spearman's correlation coefficient (ρ). The Chi-square test was used to measure the strength of association of qualitative dental arch variables with a tonsillar grade, adenoid

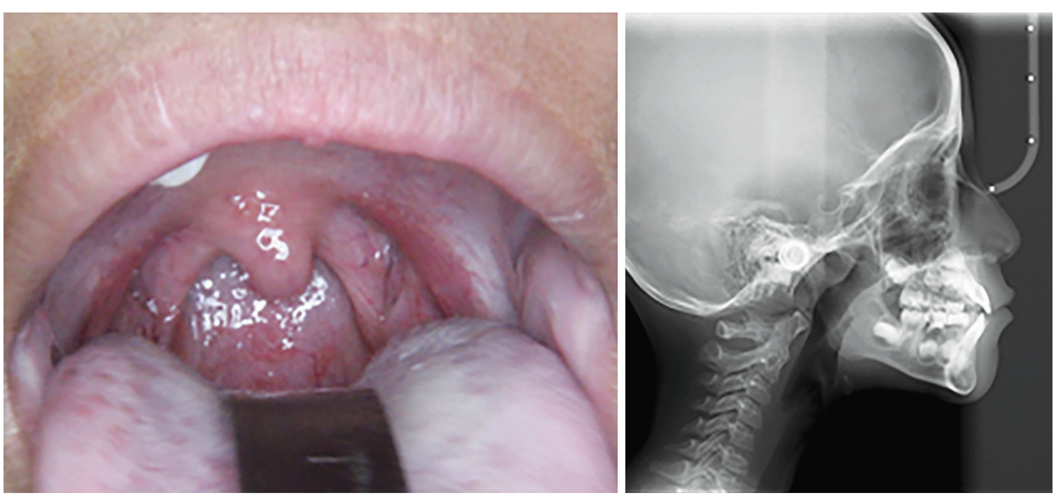

Fig.3: Group I: Tonsillar Grade 0 as per clinical examination. Adenoid unobstructed as per examination of McNamara's line on lateral cephalogram

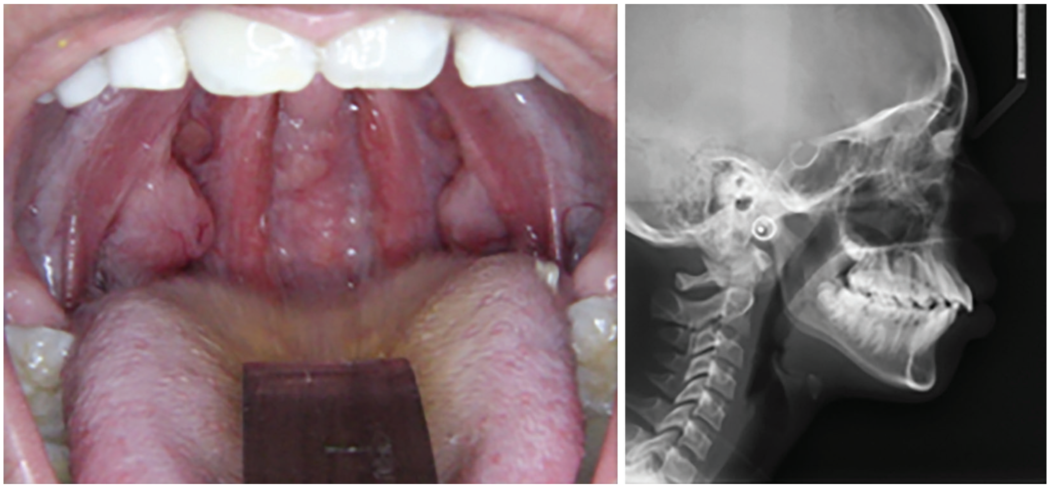

Fig. 4: Group II: Tonsillar Grades I and II as per clinical examination. Adenoid unobstructed as per examination of McNamara's line on lateral cephalogram

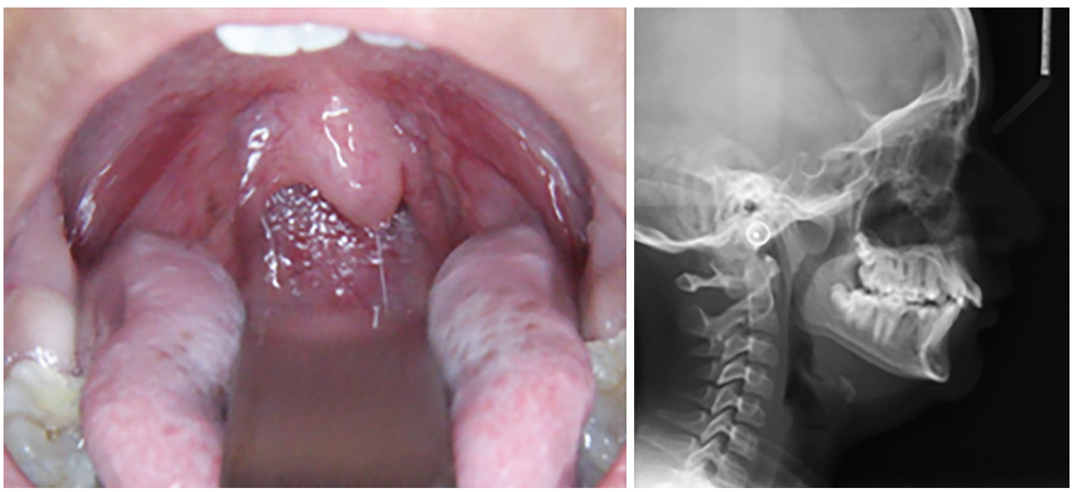

Fig. 5: Group III: Tonsillar Grades I and II as per clinical examination. Adenoid obstructed as per examination of McNamara's line on lateral cephalogram

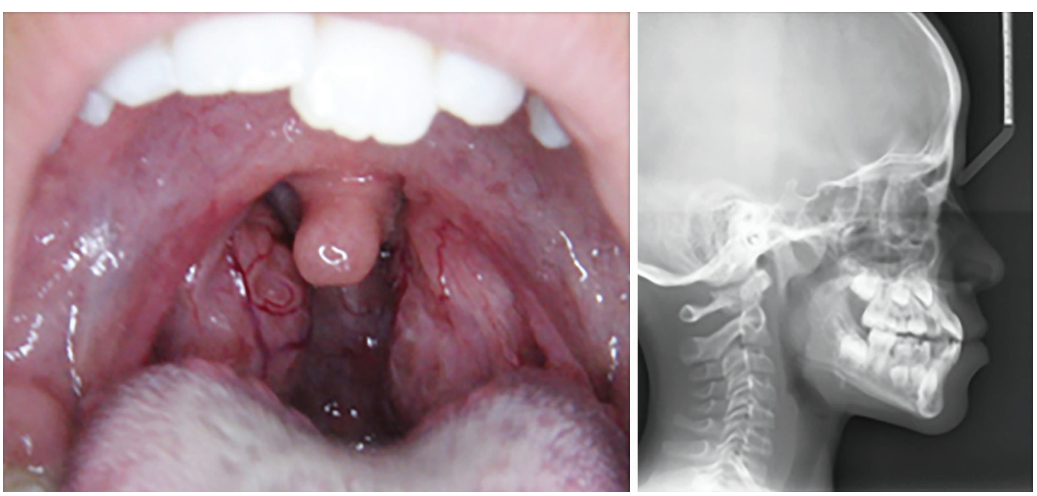

Fig. 6: Group IV: Tonsillar Grades III and IV as per clinical examination. Adenoid unobstructed as per examination of McNamara's line on lateral cephalogram

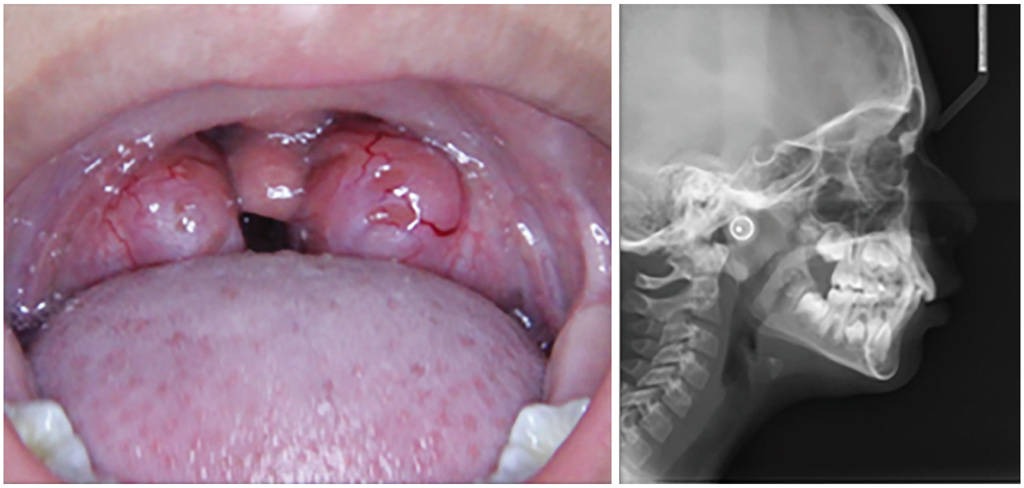

Fig. 7: Group V: Tonsillar Grades III and IV as per clinical examination. Adenoid obstructed as per examination of McNamara's line on lateral cephalogram

grade, and combined adenotonsillar hypertrophy. The significance threshold was set at $p < 0.05$.

Intraobserver reliability was checked. The readings from 20 randomly selected study models from the study sample were recorded. The same records were again analyzed after a period of 15 days to check for intraobserver reliability. To establish intraobserver reliability, Cronbach's alpha value was calculated.

Sample Size

The sample size was estimated by using nMaster software (2.1 version, CMC, Vellore). The data required for the estimation of sample size were procured from the pilot study conducted on 20 children. A sample size of 102 children was calculated to be satisfactory for two-sided tests, assuming a correlation coefficient 0.336 for maxillary intercanine width, a precision of 5%, a significance level of 5%, power of 80%, and a design factor of 2.

Results

The overall mean age of the study sample was 10.37 ± 1.47 years. The groups were well matched with age, and the difference was not statistically significant (p-value = 0.59) as depicted in Table 4.

Table 4: Demographic distribution

Group	*Number*	*Mean age*	*±SD*	*p-value (Chi-square test)**
I	34	9.94	±1.72	0.59
II	28	10.75	±1.32	
III	35	10.54	±1.46	
IV	23	10.17	±1.27	
V	30	10.47	±1.59	
TOTAL	150	10.37	±1.47	

**p*-value significant at <0.05

Correlation between Quantitative Dental Arch Parameters and Tonsillar Grade

There was no significant correlation between the dental variables (overjet) and tonsillar grade. However, in the vertical plane, the total depth of the palatal vault was significantly and positively correlated to grade ($\rho = 0.34$, $p = 0.001$). Transverse widths were significantly and negatively correlated to grade (Table 5).

Correlation between Quantitative Dental Arch Parameters and Adenoid Obstruction

There was a significant and positive correlation between the overjet and adenoid obstruction ($\rho = 0.47$, $p < 0.001$). Transverse widths were significantly and negatively correlated to adenoid obstruction. The combination of vertical and transverse dimensions shows a ratio of the total depth of the palatal vault to maxillary interfirst molar width that was significantly and positively correlated to grade ($\rho = 0.68$, $p < 0.001$) as depicted in Table 5.

Correlation between Quantitative Dental Arch Parameters and Combined Adenotonsillar Hypertrophy

There was significant and positive correlation between the overjet and adenotonsillar enlargement ($\rho = 0.41$, $p < 0.001$). Transversely, the maxillary intercanine width was significantly and negatively correlated ($\rho = -0.78$, $p < 0.001$) (Table 5).

Effect of Tonsillar Enlargement on Qualitative Dental Arch Parameters

When evaluating the effect of tonsillar enlargement on the presence or absence of crossbite, it is evident that increased tonsillar enlargement is associated with an increased frequency of anterior crossbite. Group IV has 39.2% subjects ($n = 9$) with anterior crossbite in comparison to 5.8% of subjects ($n = 2$) having anterior crossbite in Group I (Table 6).

Effect of Adenoid Obstruction on Qualitative Dental Arch Parameters

When evaluating the effect of adenoid obstruction on crossbite, it is evident that there is an increase in the prevalence of posterior crossbite. About 14.2% of subjects ($n = 5$) in Group III have posterior crossbite in comparison to 3.1% ($n = 1$) in Group I as depicted in Table 6. About 51.4% of subjects ($n = 18$) in Group III have a Class II molar relationship compared to 20.6% ($n = 7$) in Group I (Table 6).

Table 5: Correlation between quantitative dental arch parameters and tonsillar grade, adenoid obstruction, and combined adenotonsillar hypertrophy

	Tonsillar grade		*Adenoid obstruction*		*Combined adenotonsillar hypertrophy*	
Variable	*Rho (ρ)*	*p-value**	*Rho (ρ)*	*p-value**	*Rho (ρ)*	*p-value**
Sagittal						
Overjet (mm)	−0.09	0.4	0.47	<0.001	0.41	0.001
Vertical						
Overbite (mm)	−0.044	0.69	0.29	0.017	0.25	0.053
Palatal depth (mm)	0.34	0.001	0.51	0.001	0.58	<0.001
Transverse						
Maxillary intercanine width (mm)	−0.57	<0.001	−0.73	<0.001	−0.78	<0.001
Mandibular intercanine width (mm)	−0.44	<0.001	−0.59	<0.001	−0.66	<0.001
Maxillary interfirst molar width (mm)	−0.51	<0.001	−0.74	<0.001	−0.78	<0.001
Mandibular interfirst molar width (mm)	−0.52	<0.001	−0.63	<0.001	−0.73	<0.001
Maxillary interfirst premolar width or interfirst deciduous molar width (mm)	−0.5	<0.001	−0.72	<0.001	−0.8	<0.001
Mandibular interfirst premolar width or interfirst deciduous molar width (mm)	−0.39	<0.001	−0.6	<0.001	−0.72	<0.001
Vertical and transversal dimensions						
Ratio of depth of the palatal vault/maxillary interfirst molar width (%)	0.45	<0.001	0.68	<0.001	0.74	<0.001

**p*-value significant at <0.05

Table 6: Correlation between quantitative dental arch parameters and tonsillar grade, adenoid obstruction, and combined adenotonsillar hypertrophy

	Group				
Crossbite	*I*	*II*	*III*	*IV*	*V*
Absent	31 (91.1%)	24 (85.7%)	29 (82.9%)	14 (60.8%)	23 (79.3%)
Present (ant)	2 (5.8%)	2 (7.15%)	1 (2.9%)	9 (39.2%)	0 (0.0%)
Present (post)	1 (3.1%)	2 (7.15%)	5 (14.2%)	0 (0.0%)	6 (20.7%)
Total	34 (100%)	28 (100%)	35 (100%)	23 (100%)	29 (100%)
	Group				
Molar relation	*I*	*II*	*III*	*IV*	*V*
Class I	26 (76.5%)	17 (60.7%)	17 (48.6%)	9 (39.1%)	16 (55.2%)
Class II	7 (20.6%)	10 (35.7%)	18 (51.4%)	6 (26%)	11 (37.9%)
Class III	1 (2.9%)	1 (3.6%)	0 (0.0%)	8 (34.9%)	2 (6.9%)
Total	34 (100%)	28 (100%)	35 (100%)	23 (100%)	29 (100%)
	Group				
Canine relation	*I*	*II*	*III*	*IV*	*V*
Class I	26 (76.5%)	17 (60.7%)	15 (42.9%)	11 (47.8%)	16 (55.2%)
Class II	7 (20.6%)	9 (32.1%)	19 (54.2%)	4 (17.3%)	11 (37.9%)
Class III	1 (2.9%)	2 (7.2%)	1 (2.9%)	8 (34.9%)	2 (6.9%)
Total	34 (100%)	28 (100%)	35 (100%)	23 (100%)	29 (100%)

Effect of Adenotonsillar Enlargement on Qualitative Dental Arch Parameters

To an extent, the effect of combined adenotonsillar hypertrophy on qualitative dental arch parameters appears to echo the effect of isolated adenoid obstruction. About 20.7% of subjects ($n = 6$) in Group V have posterior crossbite in comparison to 3.1% ($n = 1$) in Group I as depicted in Table 6. About 37.9% of subjects ($n = 11$) in Group V have a Class II molar relationship compared to 20.6% ($n = 7$) in Group I (Table 6).

Discussion

In the practice of orthodontics, it has to be appreciated that each malocclusion has its own distinctive slot in the genetic/environmental spectrum, and, therefore, the goal of orthodontic diagnosis is to determine the relative contribution of genetics and environment.[17] Orthodontic correction of a particular malocclusion is, in essence, an alteration of the phenotypic expression of a particular morphogenetic pattern under the ambit of environmental influences. Nasopharyngeal and oropharyngeal obstruction is a powerful environmental stimulus, which can alter the delicate functional and muscular balance surrounding the developing dentition and jaws leading to significant discrepancies. These environmental stimuli, if detected, can often be intercepted at an earlier age possibly predicating the need for comprehensive orthodontic treatment.

The purpose of our study was to correlate the changes in dentition with varying degrees of tonsillar and adenoid enlargement. This was to be accomplished by assessment of adenoid obstruction on standardized lateral cephalograms. Tonsillar grading was evaluated clinically using Brodsky's criteria and five-point measuring scale.[10] To reduce the subjectivity in the clinical evaluation of tonsillar enlargement, Grades I and II were grouped together and Grades III and IV were grouped together. This increased the reliability of the clinical examination. The various dental parameters were measured directly on the study models.

In our study, the groups were well matched with respect to age and the difference between them was not statistically significant. The overall mean age of the sample was 10.37 ± 1.47 years. Kozak[18] has shown that atrophy of the tonsils starts after age 10 years and ends at adulthood. The same finding was endorsed by Diouf et al.[9] in their study evaluating tonsillar grading and dental arch parameters. With regard to the adenoid lymphoid tissue, Subtelny commented that the peak of adenoid growth is attained by 10 years of age and the adenoid tissue begins to regress after that.[1] Brodsky mentioned that adenoids reached their maximum size between 4 and 10 years of age.[10]

When examining the correlation between the quantitative dental parameters and tonsillar grades in our study, it was found that the increase in tonsillar grading was significantly and negatively correlated with intercanine, inter-premolar, and intermolar widths ($\rho > -0.50$, $p < 0.001$). Transverse dimensions are statistically and clinically reduced with an increase in tonsillar size. Enlarged tonsils lead to obstruction of the oropharyngeal passage leading to periods of hypoventilation. As a compensatory mechanism, an open mouth posture, low and anterior positioning of the tongue, and a lower position of the hyoid bone are observed, which are the functional disturbances involved in the changes to the dentition. Similar findings were reported by Behlfelt et al.,[19] Hultcrantz et al.,[20] and Diouf et al.[9]

Enlarged tonsils are more frequently associated with a Class III canine and molar relationship with a functional shift of the mandible anteriorly. This can be due to a more anterior positioning of the tongue. Behlfelt et al.[19] suggested that enlarged tonsils encroach on the sagittal space for the tongue, which has to be kept in an anterior position in order to secure a free oropharyngeal airway passage. Hultcrantz et al.[20] also reported a higher incidence of anterior crossbite in their study sample of children with enlarged tonsils. Diouf et al.[9] on the other hand reported an increased incidence of Class II malocclusion with Grade III and Grade IV tonsils. A few of our study subjects with enlarged tonsils also showed a Class II molar and canine relationship with an increased overjet. It can be hypothesized that a Class II molar relationship is more likely to develop when the patient resorts to mouth breathing along with a lowered tongue posture and downward and backward rotation of the mandible. However, a Class III sagittal relationship with a functional shift of the mandible in the anterior direction is more likely to develop when the child breathes through the nose predominantly and postures his/her mandible forward to clear the oropharyngeal passage of the obstructing tonsils.

In evaluating the correlation between enlarged adenoids and quantitative dental parameters in the transverse dimensions, the intercanine width, inter-premolar width, and intermolar width are significantly and negatively correlated with adenoid obstruction ($\rho > -0.70$, $p < 0.001$). The previous studies[2,7,10,21–26] have also commented on the occurrence of a narrow maxillary arch with enlarged adenoids. The modus operandi remains similar. As a consequence of nasopharyngeal obstruction secondary to enlarged adenoids, the patient tends to breathe through the mouth with a lowered tongue posture. This alters the balance between pressure from the tongue and cheeks against the upper first molars. A low tongue position reduces the buccal pressure from the tongue and, if the pressure from the cheek muscles remains unchanged, the upper molars will tend to shift in a palatal direction. It is evident that there is an increase in the prevalence of posterior crossbite. About 14.2% of subjects in Group III have posterior crossbite in comparison to 3.1% in Group I. Our study supports the previous findings of an increased prevalence of Class II malocclusions in subjects with enlarged adenoids. More than 50% of subjects in Group III have Class II molar and canine relationship compared with 20% in Group I.

There are a few studies that have evaluated the changes occurring in dentition following combined adenotonsillectomy.[27–30] One study found that adenotonsillectomy procedures carried out in the prepubertal age-group have positive effects on dental arch dimensions in all three planes of space compared to the control group.[28] A systematic review by Zhu et al.[29] and another systematic review and meta-analysis by Sun et al.[30] attempted to find the effects of adenotonsillectomy on dentition in prepubertal children. Both reviews reported beneficial effects on dentofacial development. However, most of the studies in the reviews have not mentioned the usage of standardized scales for the evaluation of adenoid enlargement or tonsillar obstruction. A recent systematic review and meta-analysis by Markkanen et al. reported that tonsillectomy has a positive effect on the dentofacial development of afflicted children.[31]

A combined adenoid and tonsillar enlargement is often more pernicious than an individual affliction to either the adenoids or tonsils. The effects are apparent in all three dimensions. In the transverse plane, there is a significant and negative correlation between adenotonsillar enlargement and intercanine, inter-premolar, and intermolar dimensions. The strength of the association is large ($\rho = -0.8$, $p < 0.001$). In the sagittal plane, there is a strong association between adenotonsillar enlargement and a Class II molar and canine relationship. About 37.9% of subjects in Group V have a Class II molar and canine relationship compared to just 20.6% in Group I. In the vertical plane, there is a positive correlation between adenotonsillar enlargement and the total depth of the palatal vault ($\rho = 0.58$, $p = 0.001$). The ratio of palatal vault depth to the intermolar width was also significantly and positively correlated with adenotosillar enlargement ($\rho = 0.74$, $p < 0.001$).

The prevalence rate for pediatric OSA is 1–3% with no gender predilection.[32] Pediatric OSA is associated with systemic effects including cardiovascular and metabolic diseases.[33,34] In addition to the systemic effects of OSA, a worrying sign is the presence of behavioral and neurocognitive deficiencies. Pediatric OSA has been associated with hyperactivity, aggression, and learning problems. These effects are partially reversible, but there may be a residual learning deficit representing a "learning debt."[35,36] Evidence of abnormal dental parameters in the presence of adenotonsillar hypertrophy should raise the index of suspicion for the treating clinician, and a follow-up questionnaire based on history should be taken for the patient. If required, the patient should be referred to a sleep physician for confirmatory diagnosis by overnight polysomnography, which remains the gold standard for the detection of both pediatric and adult OSA.[37] Surgical management of pediatric OSA by adenotonsillectomy is the treatment of choice.[38] This can be augmented with dentofacial orthopedic appliances, which expand the transverse dimension of the maxillary arch and/or stimulate mandibular growth in the sagittal dimension. A recent systematic review and meta-analysis showed significant improvement in apnea–hypopnea scores following rapid maxillary expansion with adenotonsillectomy.[39]

There have been various studies in the past evaluating the aberrant role of adenoid obstruction on craniofacial and dentoalveolar growth.[2,7,10,19,21] Similarly, there have been studies correlating tonsillar enlargement and its effect on craniofacial and dental variables.[8,9,19,20,25,31] However till date, there is no study in the literature that has compared adenoid grading, tonsillar grading, and combined adenotonsillar hypertrophy on dental variables. Herein lies the biggest advantage of our study. It provides a ready reckoning for orthodontists to evaluate the effects of nasopharyngeal and oropharyngeal obstruction on dental variables. The critical clinical issue is determining the optimal time of lymphoid tissue removal to enhance nose breathing and prevent potential, or reverse existing, abnormal facial growth. Timely intervention can also reverse the potential debilitating systemic and cognitive effects of pediatric OSA, which is a significant sequela of adenotonsillar hypertrophy. Otolaryngologists and orthodontists should appreciate the early impact of enlarged adenoids and tonsils, the most common obstructive agents of the posterior pharyngeal airway.

Conclusion

The following conclusions can be drawn from the study:

- Enlarged adenoids are significantly and negatively correlated with intercanine, inter-premolar, and intermolar widths. The total depth of the palatal vault and the ratio of the total depth of the palatal vault to maxillary interfirst molar width were significantly and positively correlated.
- Obstructed adenoids are strongly associated with Class II canine and molar relationship and a posterior crossbite.
- Maxillary intercanine, inter-premolar, and intermolar widths were significantly and negatively correlated to tonsillar grading. The total depth of the palatal vault and the ratio of total depth of the palatal vault to maxillary interfirst molar width were significantly and positively correlated to grade.
- Grade III/IV tonsils are strongly associated with an increased prevalence of Class III canine and molar relationship with a functional forward shift of the mandible.
- Combined adenotonsillar hypertrophy is associated with the most noticeable changes in dental parameters. All three dimensions, namely, transverse, sagittal, and vertical are significantly affected. In the transverse dimension, the intercanine, inter-premolar, and intermolar widths are significantly and negatively correlated. In the vertical dimension, palatal depth is positively correlated with adenotonsillar hypertrophy. In the sagittal dimension, there is a strong association between Class II molar and canine relationship.
- Adenotonsillar hypertrophy is the major causative agent for pediatric OSA. Early identification of aberrant dental parameters in the presence of lymphoid tissue enlargement and timely management can reverse the potentially debilitating systemic and neurocognitive effects associated with pediatric OSA in addition to creating a favorable environment for optimal dentofacial growth.

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