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Posture of the head, the hyoid bone, and the tongue in children with and without enlarged tonsils

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SUMMARY The purpose of this investigation was to analyse whether there were any differences between children with and without enlarged tonsils with regard to the posture of the head, the hyoid bone, and the tongue. Twenty-two children with enlarged tonsils were compared with a matched normal control group.

Of the children in the tonsil group, 59 per cent were mouth-breathers during the day and 82 per cent during the night. None of the control children was a mouth-breather.

The results showed that, compared with the control children, children with enlarged tonsils had an extended posture of the head, a lowered position of the hyoid bone, and an antero-inferior posture of the tongue. The vertical position of the hyoid bone also reflected the vertical position of the tongue. The antero-posterior position of the tongue was closely related to the oro-pharyngeal depth.

The postural pattern in children with enlarged tonsils appears to be associated with the need for maintenance of free oro-pharyngeal airway capacity.

Introduction

Enlarged tonsils, encroaching on the oro-pharyngeal space, may affect the posture and function of closely related structures such as the tongue and soft palate (Bluestone, 1979; Jonas and Richstein, 1981; Jonas and Mann, 1985; Behlfelt and Linder-Aronson, 1988; Henningsson and Isberg, 1988). Interactions between functional and postural patterns have been reported in several previous studies (Fränkel, 1980; Vig *et al.*, 1980; Harvold *et al.*, 1981; Wenzel *et al.*, 1983; Solow *et al.*, 1984; Hellsing, 1989). Furthermore, associations between functional and postural patterns on the one hand, and craniofacial morphology on the other, have been shown (Linder-Aronson, 1970, 1974, 1975; Subtelny and Subtelny, 1973; Solow and Kreiborg, 1977; Opdebeeck *et al.*, 1978; Adamidis and Spyropoulos, 1983; Vargervik *et al.*, 1984; Loewe *et al.*, 1985, 1986; Tallgren and Solow, 1984, 1987).

Behlfelt *et al.* (1989, 1990) demonstrated that children with enlarged tonsils compared to control children displayed, among other things, retroclined lower incisors, narrow upper dental arches, increased frequency of lateral cross-bites, retrognathic and posteriorly inclined mandibles, and large anterior total and lower facial heights. Therefore, it is of interest to evaluate whether children with enlarged tonsils also differ from normal healthy children with regard to posture of the head, hyoid bone, and tongue.

Subjects

The clinical material comprised 73 children with enlarged tonsils and 22 normal control children, with cephalometric registrations in natural head posture (Fig. 1). The subjects have been selected from a group of 73 children with enlarged tonsils and a matched control group of 73 normal children, presented by Behlfelt *et al.* (1989). Cephalometric registrations in natural head posture had been obtained for all children in the tonsil group and for 22 of the 73 control children, and these were the cases analysed here.

The tonsil group comprised 33 boys and 40 girls. Mean age for this group was 10.1 years with a standard deviation of 2.8 years. This group will, hereafter, be referred to as the total tonsil group. For *comparisons* between children with

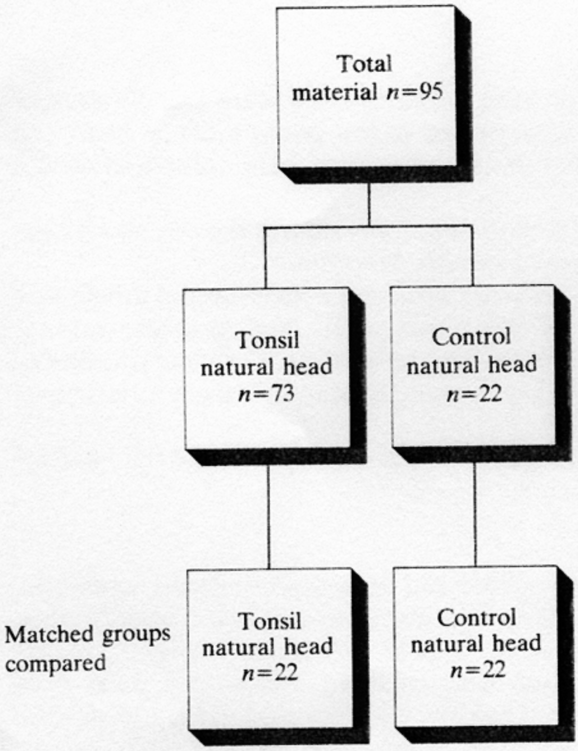

Figure 1 Patients and control groups studied.

and without enlarged tonsils, the groups were stratified according to age and sex. The 22 tonsil children, matching the 22 control children, were for this purpose drawn from the total tonsil group of 73 patients (see Fig. 1). Each matched group comprised 9 boys and 13 girls. Mean age for both groups was 13.1 years, with a standard deviation of 2.3 years for the tonsil group and 2.4 years for the control group.

In the total tonsil group 62.5 per cent of the children were mouth-breathers during the day-time and 84.7 per cent during the night. The corresponding frequencies in the matched tonsil group were 59.1 and 81.8 per cent. None of the control children was a mouth-breather. This was a criterion for the initial selection of the controls (Behlfelt *et al.*, 1989).

Methods

The following twenty variables were analysed.

1. Fourteen variables, obtained from measurements on lateral skull radiographs, describing posture of the head, the hyoid bone and the tongue, naso- and oropharyngeal depths, and tonsil and pharyngeal areas. These variables are listed in Table 1.
2. One index variable ('the tonsil index'), calculated as the relationship between the cephalometric measurements of the sagittal tonsil and pharyngeal areas in per cent [tonsil area (S38)/pharyngeal area (S37) × 100].
3. Two anamnestic variables, describing mode of breathing during the day (A18) and during the night (A19).
4. Two clinical variables, one describing the transverse distance between the tonsils (C39) and one the tonsil size (C40).
5. Age (V6).

The method used for cephalometric registration in natural head posture (the mirror position) has been described by Solow and Tallgren (1971) and was performed according to Linder-Aronson (1979). Details about collection of medical history and clinical records, measurements on lateral skull radiographs and calculation of error of measurements have been previously reported by Behlfelt *et al.* (1989). In the same study definitions of cephalometric reference points and lines, description of variables, and results of error of method were given.

The measurements on the lateral skull radiographs are illustrated in Fig. 2. The variables describing mode of breathing (A18 and A19) were recorded in the tonsil group by one otolaryngologist. The assessments were based on patient history and a clinical evaluation, using a cold mirror in front of the patient's nose. In the control group nose-breathing was estimated by one orthodontist, using the same method (nose-breathing was denoted with '1' and mouth-breathing with '2'). The clinical measurement of tonsil diastasis (C39) and the subjective, clinical assessment of the tonsil size (C40) in relation to the surrounding space, were recorded by the otolaryngologist, and only in the tonsil group. Tonsil size (C40) was assessed clinically as being moderately enlarged, large, or very large.

Statistical methods

Means and standard deviations for the variables were calculated and the distributions were tested for normality. Differences between the matched tonsil and control group have been tested for significance with Student's *t*-test for normally distributed variables and with the non-parametric

Table 1 Variables describing posture of the head, hyoid bone, and tongue, as well as sagittal depth of naso- and oro-pharynx in the total tonsil group, and in the matched tonsil and control groups. In addition, description of tonsil variables in the total and matched tonsil groups are shown. Differences between the matched groups have been tested with Student's *t*-test for normally distributed variables (*t*-value) and with Mann–Whitney *U*-test for variables with skewed distribution (*z*-value; denoted with *z*). *n* = Number of cases, SD = standard deviation.

	Tonsil (total)			Tonsil (matched)			Control (matched)			Tonsil *v*. control matched groups
Variable	*n*	mean	SD	*n*	mean	SD	*n*	mean	SD	*t*-/*z*-value
Head posture										
S42 NSL/vert	71	83.9	5.56	22	83.8	5.68	22	88.0	3.68	−2.92**
S46 CVT/NSL	71	105.5	7.31	22	106.1	7.51	22	98.2	6.65	3.73***
S47 OPT/NSL	71	101.1	7.36	22	101.6	7.02	22	94.6	7.39	3.22**
Hyoid posture										
S52 h-gn	71	40.1	5.66	22	41.0	6.02	22	41.2	4.43	−0.13
S53 h-cv4^{ip}	71	46.5	4.69	22	49.8	4.60	22	49.4	5.75	0.20
S54 h-hl	71	17.3	5.83	22	17.8	5.08	22	11.1	5.71	*z* 3.85***
S57 h-gn/ML	71	25.9	8.33	22	25.9	7.25	22	14.9	7.28	*z* 4.26***
S61 h-pm	71	60.8	7.74	22	65.6	8.18	22	57.0	8.26	3.44**
Tongue posture										
S59 t1-pm	67	10.8	4.01	21	12.4	3.90	21	8.6	3.52	*z* 3.04**
S60 t2-p3	67	20.7	3.42	21	21.5	3.04	22	18.1	3.18	3.63***
Pharyngeal depth										
S35 ad1-pm	72	16.0	5.26	22	17.4	5.64	22	21.7	5.17	−2.61*
S40 cv2p-cv2t	71	15.4	4.14	22	14.4	3.89	22	10.1	2.38	*z* 3.95***
Tonsil										
C39 diastasis	70	4.8	3.12	21	6.2	3.55				
S37 pharyngeal area	71	581.6	166.75	22	547.1	142.95				
S38 tonsil area	71	509.4	149.04	22	481.8	123.90				
S38/S37 index	71	87.6	5.69	22	88.1	3.76				

***$P < 0.001$; **$P < 0.01$; *$P < 0.05$.

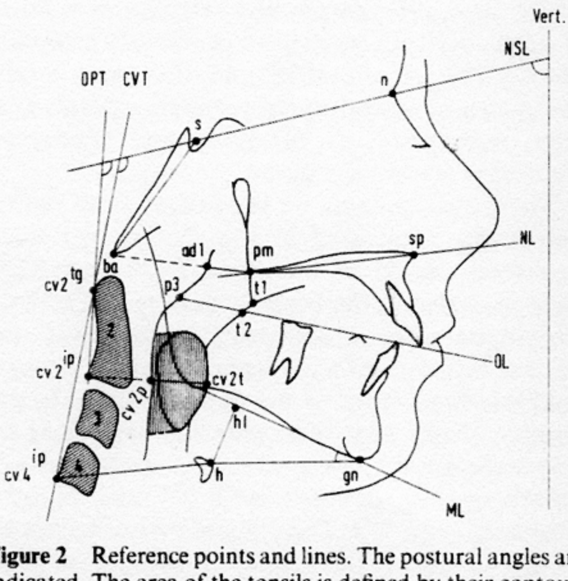

Figure 2 Reference points and lines. The postural angles are indicated. The area of the tonsils is defined by their contour. The pharyngeal area is vertically cross-hatched. Its superior and inferior borderlines are tangent lines of the contour of the tonsils, parallel with the nasal line (NL).

Mann–Whitney *U*-test for variables with skewed distributions.

One-way analyses of variance, with the clinically assessed tonsil size (C40) as an independent variable, were performed in the total tonsil group. Scheffè's multiple comparison test was used to analyse differences between pairs of sub groups, describing the clinical tonsil size. For variables displaying skewed distributions and variance inhomogenity (S59; t1-pm and C39; tonsil diastasis), the non-parametric Kruskal–Wallis one-way analysis of variance was used. Multiple comparison tests involving these two variables were performed according to Diehl and Kohr (1977). Relationships between the variables were studied with simple correlation analyses and multiple stepwise regression analyses.

All statistical analyses were performed using the SPSS/PC+ statistical package, at the University of Hamburg, FRG.

Results

Comparisons between the matched tonsil and control group

Results of comparisons between the children with enlarged tonsils and the control children for variables describing posture of the head, hyoid bone, and tongue, as well as the sagittal depth of naso- and oro-pharynx, are shown in Table 1. The children with enlarged tonsils had a significantly ($P<0.01$):

(1) more extended posture of the head relative to the true vertical (S42), as well as to the cervical spine (S46, S47);

(2) more caudal position of the hyoid bone relative to the mandibular and nasal planes (S54, S57, S61);

(3) more inferior (S59) and anterior (S60) position of the tongue;

(4) larger sagittal depth of oro-pharynx at the site of the tonsils (S40).

The naso-pharyngeal depth (S35) was slightly narrower in the tonsil group ($P<0.05$).

Influence of the degree of tonsillar enlargement

The influence of the degree of tonsillar enlargement (C40) on postural, pharyngeal, and tonsillar variables, analysed in the total tonsil sample, are shown in Table 2. Only variables significantly ($P<0.01$) influenced by the degree of tonsillar enlargement are shown.

The clinically assessed tonsil size (C40), was significantly related to the cephalometric measurements of the vertical tongue posture (S59) ($P<0.001$), the oro-pharyngeal depth (S40) ($P<0.01$), the pharyngeal (S37) and tonsil areas (S38) ($P<0.01$), as well as with the clinically measured tonsil diastasis (C39) ($P<0.001$) (Table 2).

Multiple comparison tests between pairs of the sub groups for tonsillar enlargement showed that the vertical posture of the tongue (S59) differed slightly between 'moderately enlarged' and 'large' tonsils ($P<0.05$) and highly significantly between 'large' and 'very large' tonsils ($P<0.001$). It is notable that the tongue posture was lower in the group with 'large' tonsils than in the group with 'very large' tonsils (Table 2).

The tonsil diastasis (C39) was highly significantly larger in both the 'moderately enlarged' and 'large' categories, compared with the 'very large' category ($P<0.001$). For the oro-pharyngeal depth (S40), the pharyngeal (S37), and tonsil (S38) areas, significant differences were found only between 'large' and 'very large' tonsils ($P<0.01$).

Table 2 Description of variables, shown to be influenced by the degree of tonsillar enlargement (C40), for the subgroups of enlargement; moderately enlarged, large, and very large. Differences between means were tested for significance using one-way analyses of variance by 2 degrees of freedom. *F*-values are given. For the variables S59 and C39, showing skewed distributions and variance inhomogenity, the chi-square values (denoted with χ^2) are given. n = Number of cases, SD = standard deviation.

	Degree of tonsillar enlargement									
	Moderately enlarged			Large			Very large			Diff. btw. means
Variable	*n*	mean	SD	*n*	mean	SD	*n*	mean	SD	*F*-/χ^2 value
Tongue posture										
S59 tl-pm	4	7.0	1.22	44	11.9	3.99	15	8.5	2.99	χ^2 14.14***
Pharyngeal depth										
S40 cv20-cv2t	5	14.7	3.95	46	14.2	3.61	16	18.4	3.98	7.49**
Tonsil										
C39 diastasis	5	7.6	1.52	46	5.6	2.93	16	2.1	1.96	χ^2 22.91***
S37 pharyngeal area	5	498.4	126.71	46	542.7	149.54	16	687.9	175.64	5.87**
S38 tonsil area	5	430.4	112.31	46	473.5	136.47	16	606.4	147.72	6.25**

***$P<0.001$; **$P<0.01$.

Correlation analyses

Correlations within the total tonsil group between tonsil variables on the one hand and variables for age, posture of the head, hyoid bone and tongue, and naso- and oropharyngeal depths on the other hand, as well as between pairs of tonsil variables are shown in Table 3.

1. The tonsil diastasis (C39) was positively correlated with age (V6) and with linear measurements for sagittal and vertical postures of the hyoid bone (S52, S53, S54, S61), and also negatively with the clinical tonsil size (C40), and the cephalometrically measured tonsil and pharyngeal areas (S37, S38).
2. The clinical assessment of the tonsil size (C40) was, moreover, positively correlated with the cephalometrically measured oropharyngeal depth (S40), pharyngeal (S37), and tonsil (S38) areas.
3. The pharyngeal (S37) and tonsil (S38) areas, and the oropharyngeal depth (S40) were highly significantly, positively intercorrelated. In addition, the pharyngeal (S37) and tonsil (S38) areas were positively correlated with the antero-posterior posture of the tongue (S60).
4. The 'tonsil index' (S38/S37) was negatively correlated with the cranio-cervical headpostures (S46, S47) and positively with the tonsil area (S38).

Table 4 presents correlations in the matched sample between pairs of variables for posture of the head, hyoid bone and tongue, as well as for naso- and oro-pharyngeal depths, for mode of breathing, and between these variables and age.

1. Age (V6) was positively correlated with linear measurements of sagittal (S52, S53) and vertical (S54, S61) posture of the hyoid bone and with the vertical posture of the tongue (S59).
2. A large number of correlations were found between the postural, pharyngeal, and respiratory variables.

Regression analyses

Multiple stepwise regression analyses within the matched sample are shown in Table 5a–d.

Table 3 Correlations in the total tonsil group between tonsil variables and age, posture of the head, hyoid bone, and tongue, sagittal depth of naso- and oropharynx, mode of breathing, as well as between pairs of tonsil variables. Only correlations significant at the 5 per cent level ($P<0.05$) are included in the table. Minimum number of cases is 68.

	Tonsil diastasis C39	Tonsil size C40	Pharynx area S37	Tonsil area S38	Index S38/S37
V6 age	0.54				
S42 NSL/vert					
S46 CVT/NSL					−0.28
S47 OPT/NSL					−0.26
S52 h-gn	0.35				
S53 h-cv4^{ip}	0.29				
S54 h-h1	0.24				
S57 h-gn/ML					
S61 h-pm	0.39				
S59 t1-pm					
S60 t2-p3			0.39	0.37	
S35 ad1-pm					
S40 cv2p-cv2t		0.37	0.84	0.81	
A18 m.o.b./day					
A19 m.o.b./night					
C40 tonsil size	−0.53				
S37 phar. area	−0.24	0.37			
S38 tonsil area	−0.24	0.38	0.97		
S38/S37 tonsil index				0.24	

Table 4 Correlations in the total matched material between pairs of variables for posture of the head, hyoid bone, tongue, and for naso- and oro-pharyngeal depths, as well as for mode of breathing. Only correlations significant at the 5 per cent level are shown in the table ($P < 0.05$). Number of cases is 42 for correlations with variables S59 and S60, for the rest of the correlations the number of cases is 44.

	NSL/v. S42	CVT/NSL S46	OPT/NSL S47	h-gn S52	h-cv4ip S53	h-h1 S54	h-gn/ML S57	h-pm S61	t1-pm S59	t2-p3 S60	ad1 S35	cv2p-cv2t S40	m.o.b. day A18	m.o.b. night A19
S46 CVT/NSL	−0.68													
S47 OPT/NSL	−0.69	0.90												
S52 h-gn		0.36												
S53 h-cv4ip														
S54 h-h1	−0.46	0.58	0.54	0.36										
S57 h-gn/ML	−0.40	0.51	0.47			0.92								
S61 h-pm		0.42	0.41		0.49	0.81	0.80							
S59 t1-pm	−0.38	0.48	0.57		0.31	0.65	0.64	0.67						
S60 t2-p3			0.36			0.37	0.34		0.58					
S35 ad1-pm						−0.32	−0.43							
S40 cv2p-cv2t			0.33			0.38	0.49	0.39	0.47	0.59	−0.38			
A18 m.o.b./day	−0.40	0.45	0.47			0.42	0.36	0.43	0.41					
A19 m.o.b./night	−0.33	0.46	0.38			0.44	0.48	0.42	0.39	0.44	−0.30	0.42	0.78	
V6 age				0.34	0.51	0.38		0.57	0.32					

Table 5 (a–d) Multiple stepwise regression analyses in the total matched sample. Regression coefficients, their SE, level of significance, fraction of explained variance (R^2) and the multiple regression coefficient (R). Number of cases is 42. ***$P<0.001$; **$P<0.01$; *$P<0.05$.

Table 5a Regressand S46; Cranio-cervical inclination (CVT/NSL).

Variable	Coefficient	SE	*T*-ratio
Regressand (S46)		5.62	
S54 h-h1	0.67	0.15	4.34***
S35 ad1-pm	0.65	0.18	3.71***
A19 m.o. breathing/night	6.87	2.06	3.34**
Constant	69.38	5.53	

$R^2=0.56$; $R=0.75$.

Table 5b Regressand: S57; vertical hyoid bone posture (h-gn/ML).

Variable	Coefficient	SE	*T*-ratio
Regressand (S57)		6.16	
S59 t1-pm	0.90	0.28	3.25**
S35 ad1-pm	−0.64	0.18	−3.50**
S46 CVT/NSL	0.39	0.14	2.83**
Constant	−16.22	12.69	

$R^2=0.59$; $R=0.77$.

Table 5c Regressand: S59; Vertical posture of the tongue (t1-pm).

Variable	Coefficient	SE	*T*-ratio
Regressand (S59)		2.66	
S54 h-h1	0.30	0.07	4.21***
S60 t2-p3	0.48	0.13	3.78***
S53 h-cv4ip	0.20	0.08	2.44*
Constant	−13.28	4.72	

$R^2=0.62$; $R=0.79$.

Table 5d Regressand: S60; Sagittal posture of the tongue (t2-p3).

Variable	Coefficient	SE	*T*-ratio
Regressand (S60)		2.50	
S40 cv2p-cv2t	0.41	0.12	3.51**
S59 t1-pm	0.38	0.11	3.51**
S53 h-cv4ip	−0.19	0.08	−2.32*
Constant	20.14	3.80	

$R^2=0.53$; $R=0.73$.

Regressand: cranio-cervical inclination (CVT/NSL; S46). The following eight variables were regressors: ad1-pm (S35), cv2p-cv2t (S40), h-gn (S52), h-cv4ip (S53), h-h1 (S54), t1-pm (S59), t2-p3 (S60), and mode of breathing during the night (A19). The results are presented in Table 5a.

Extended posture of the head relative to the cervical spine (S46) was associated with low posture of the hyoid bone (S54), a large naso-pharyngeal airway passage (S35), and with mouth-breathing during the night (A19). The regressors included in the first two steps of the analysis (S54 and S35) were both significant at the 0.1% level and the third regressor (A19) at the 1% level. Together these three regressors explained 56% of the variation in cranio-cervical inclination.

Regressand: vertical posture of the hyoid bone (h-gn/ML; S57). The following nine variables were regressors: ad1-pm (S35), cv2p-cv2t (S40), NSL/vert.(S42), CVT/NSL (S46), h-gn (S52), h-cv4ip (S53), t1-pm (S59), t2-p3 (S60), and mode of breathing during the night (A19). The results are presented in Table 5b. Low posture of the hyoid bone (S57) was associated with low posture of the tongue (S59), a narrow nasopharyngeal airway (S35) and an extended posture of the head relative to the cervical spine (S46). These three regressors were all significant at the 1 per cent level ($P<0.01$) and together they explained 59 per cent of the size of the regressand.

Regressand: vertical posture of the tongue (t1-pm; S59). The following nine variables were regressors: ad1-pm (S35), cv2p-cv2t (S40), NSL/vert.(S42), OPT/NSL (S47), h-gn (S52), h-cv4ip (S53), h-h1 (S54), t2-p3 (S60), and mode of breathing during the day (A18). The results are presented in Table 5c. Low posture of the tongue (S59) was associated with low posture of the hyoid bone (S54), anterior position of the tongue (S60) and a large hyo-cervical distance (S53). The regressors included in the first two steps of the analysis (S54 and S60) were both highly significant ($P<0.001$), whereas the hyo-cervical distance (S53) only contributed slightly to the explanation of the variation in the regressand ($P<0.05$). The coefficient of determination for the equation (R^2) was 0.62.

Regressand: sagittal posture of the tongue at the level of the occlusal plane (t2-p3; S60). The following nine variables were regressors: ad1-pm

(S35), cv2p-cv2t (S40), NSL/vert.(S42), OPT/NSL (S47), h-gn (S52), h-cv4^{ip} (S53), h-h1 (S54), t1-pm (S59), and mode of breathing during the night (A19). The results are presented in Table 5d. Anterior posture of the tongue (S60) was significantly associated with a large oropharyngeal depth (S40) ($P<0.01$), a low position of the tongue (S59) ($P<0.01$) and to some extent with a small hyo-cervical distance (S53) ($P<0.05$). These three regressors explained 53 per cent of the variation in sagittal tongue posture.

Discussion

Degree of tonsillar enlargement

Diamond (1980) claims that tonsil size from a clinical standpoint is a difficult assessment. There is no recognized 'normal' size for a tonsil. It is, therefore, arguable whether tonsils can be described as enlarged. Other authors have described classifications for clinical division into different tonsil sizes (Linder-Aronson, 1970; Bluestone, 1979; Jonas *et al*., 1982). Similarly, Bushey (1979) describes clinical assessment of tonsil size.

In the present study the selection of the patients was made by one otolaryngologist, based on the subjective, clinical criterion 'enlarged tonsils'. A clinical subdivision into 'moderately enlarged', 'large', and 'very large' tonsils was made subsequently. A significant correspondence between the clinical assessment, and the subsequent cephalometric measurements of tonsil size indicates conformity of the clinical and cephalometric evaluations.

The results show significant correlations between both the clinically assessed tonsil size and the cephalometrically measured size on the one hand, and the cephalometric measurement of the oropharyngeal depth at the site of the tonsils on the other hand. The latter measurement was performed without difficulty in all subjects and may thus serve as an usable indirect evaluation of the tonsil size. As the oropharyngeal depth was highly significantly larger in the tonsil group, compared with the matched control group, it indicates that the children in the tonsil group actually had larger tonsils than the control children.

Another important point of view is the size of the tonsils relative to the surrounding space, i.e. the degree of obstruction (Bluestone, 1979).

On lateral and frontal cineradiographs Henningsson and Isberg (1988) classified tonsils as large if they obstructed two thirds of the oropharyngeal depth and/or two-thirds of the total pharyngeal width.

In the present tonsil sample the tonsils on average obstructed 88 per cent of the lateral aspect of oropharynx, thus causing considerable obstruction. The degree of obstruction (the tonsil index) did not differ between the subgroups of tonsillar enlargement.

In the transverse aspect, the tonsil diastasis may give some information on the degree of obstruction. In the present tonsil sample this distance on average was 5 mm, ranging from 0 to 15 mm.

In the clinical, otolaryngological practice of one of the authors (PN), on average 20 mm tonsil diastasis is regarded as normal for 10 years old children.

Mode of breathing

The method used for diagnosing mode of breathing can be subjectively influenced and its accuracy is uncertain. Thüer *et al.* (1989) have discussed the difficulty in finding appropriate methods, suitable for the registration of mode of breathing. Mouth-breathing during the night has been described as a typical feature in individuals with large tonsils (Bluestone, 1979; Recamiér, 1985). As 62.5 per cent of the children in the total tonsil group were mouth-breathers during the day and 85 per cent during the night, the present findings agree with these observations.

Posture of the head

In comparison with the control group, the children with enlarged tonsils had extended posture of the head relative to the true vertical as well as relative to the cervical spine. This is in accordance with earlier findings (Behlfelt and Linder-Aronson, 1988). In the present study extended head posture was found to be associated with a low hyoid bone posture and mouth-breathing. These associations are in accordance with findings reported in several studies (e.g. Linder-Aronson, 1979; Adamidis and Spyropoulos, 1983; Solow *et al*., 1984; Hellsing *et al*. 1986; Hellsing, 1989).

Within the tonsil group an extended craniocervical headposture was related to a lesser degree of relative oropharyngeal obstruction, expressed by the tonsil index. Opdebeeck *et al.*

(1978) proposed that the head may be extended to restore the pharyngeal space at the level of the base of the tongue. It, thus, might be suggested that, in the children with enlarged tonsils, the cranio-cervical head posture had had some influence on the degree of relative oropharyngeal obstruction.

Posture of the hyoid bone

Whereas no differences were found between the tonsil and control group for the sagittal posture of the hyoid bone relative to gnathion or to the cervical spine, marked differences were revealed in its vertical position. Relative to the mandible and the maxilla the hyoid bone was positioned significantly more caudally in the tonsil group. Ricketts (1979) suggested that the hyoid bone may be lowered to create an oral airway. The present findings support this assumption, as a low tongue posture, a narrow nasopharyngeal airway passage, and a large cranio-cervical inclination were isolated as most important determinants for a low hyoid bone posture.

Posture of the tongue

The children with enlarged tonsils had a more antero-inferior position of the tongue in comparison with the control children.

The vertical tongue and hyoid postures were closely related. This is in accordance with Tallgren and Solow (1984, 1987), who suggest an interrelationship between tongue and hyoid bone posture.

An anterior position of the tongue was also associated with a large oropharyngeal depth. This is logical as 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 (Thurow, 1975).

An interesting finding was the non-linear association between the degree of tonsillar enlargement and vertical tongue posture. A low tongue posture facilitates mouth-breathing. In cases with large tonsils encroaching on the oropharyngeal airway passage, the maintenance of the oropharyngeal airway adequacy is vital, whether the nasopharynx is narrow or not. The tongue posture is changed, creating space for the tonsils and thus improving the airway passage through oropharynx.

Conclusion

Extended head posture, a low position of the hyoid bone and an antero-inferior posture of the tongue seem to have some association with the need for maintenance of free oro-pharyngeal airway passage in children with enlarged tonsils. The degree of tonsillar enlargement seems to be of importance for the vertical posture of the tongue.

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