Stomatologija, Baltic Dental and Maxillofacial Journal, 8:39-43, 2006

Soft tissue profile of children with impaired nasal breathing

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SUMMARY

The aim of the study was to evaluate soft tissue profile of the children with impaired nasal breathing.

Materials and methods. Soft tissue points relative to the true vertical line (TVL) were measured on the lateral cephalograms in natural head position of 54 subjects with diagnosed nasal obstruction (34 males, 20 females, mean age 13.3±2.7). As controls served 33 patients receiving orthodontic treatment for different types of malocclusion (19 males, 14 females, mean age 13.4±2.7). Nasal airflow measurements were performed for all children.

Results. Both groups had retrognatic soft tissue profile, and there were no statistically significant difference between the groups in the linear and angular measurements of the soft tissue measurements, except for the interlabial gap measurement. Soft tissue profile projections to TVL were dependent on craniocervical and cervical inclination angles. In addition head extension was associated with flattened mentolabial sulcus and increased lower face height. Some of the soft profile measurements correlated with age.

Conclusion. Soft tissue profile of the children with impaired nasal breathing in general is not different from the soft tissue profile of other orthodontic patients and mostly is dependent on the craniocervical posture and age.

Key words: soft tissue profile, nasal obstruction, true vertical line.

INTRODUCTION

The effect of altered mode of breathing on the development of occlusion and facial skeleton has been recognized by orthodontists. Most clinicians believe that growth of the dentofacial complex is a result of both genetic and environmental factors. The relationship between airway obstruction and facial morphology has been discussed in the literature since 1870s. A number of studies [1-9] have proved that obstructed upper airways are related to the typical dental and facial characteristics which can be summarized as follows: decreased facial prognathism, increased mandibular plane and gonial angles, narrowed maxilla with deep palatal vault, anterior crowding, lip incompetnce.

It has been observed [7, 10-13] that mouth breathers extend their head in an effort to increase their airway. The Soft Tissue Streching Hyphothesis was proposed to describe the aptation mechanisms for the nasal obstruction [14]. Further more some authors [15-17] found association between head posture and dentofacial morphology. Large craniocervical angle was seen in connection with maxillary and mandibular retrognathism, a large mandibular inclination, increased lower facial heights and retroclination of the upper incisors. However, soft tissue profiles were not analyses in the most of those studies. The soft tissue covering the teeth and bones may vary to a great extent camouflaging or exaggerating possible anomalies [18].

The recent publications suggest assessment of the facial esthetics in relation to natural head position (NHP) [19-21]. The additional advantage of natural head position is that it provides the use of extracranial reference line (true vertical or true horizontal) for cephalometric analysis, since intracranial reference lines are influenced by biological variation. In the present study the true vertical line (TVL) was selected, since this was the case - control study and reference line was not a subject of superimpositions of serial cephalogramms or orthodontic treatment alterations. Besides this method does not depend on the position of the chin or tip of the nose.

The aim of the study is to test a hypothesis that impaired nasal breathing has an effect on the facial profile.

MATERIAL AND METHODS

The study sample consisted of 54 consecutive patients who attended the University Children's Hospital for adenoidectomy or nasal septum operation from December 1999 to June 2001, who agreed to participate in the study. For the control sample were used patients, attending a dentist or oral hygienist in the Institute of Stomatology in July 2000. Patients with a history of adenoidectomy, allergic rhinitis and nasal septum deviations were not included in the control sample. Informed consent was obtained from all patients and their parents. The study was approved by the Ethical Committee of Latvia. In the study group were

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34 boys and 20 girls with the mean age 13.3±2.7, in the control group were 14 girls and 19 boys in the mean age 13.4±2.7.

Radiographic Lateral Cephalometry.

In the study the lateral cephalogramms in NHP were taken subjects standing in orthoposition [15] and looking straight into a 20x100 cm mirror mounted at eye level on the wall at the distance 120 cm. Children's teeth were in centric occlusion and lips were relaxed. All lateral cephalogramms were obtained with Siemens Orthophos 3. Cephalogramms were traced with the digitizer AccuGridXNT and analysed with Dentofacial Planner 7.0 using modified regiments. The postural angles were used as described by Solow and Tallgren [15]. Reference points and lines for the soft tissue profile analysis are showed in Figure. and listed in the Table 1.

Rhinomanometry.

Posterior rhinomanometry was performed with a child seated after a rest of 30 minutes with Hortmann rhinomanometer connected to the computer operating Rhinosoft 10/95-2. No decongestant was used. Nasal cross-sectional area was calculated at the pressure of 75 Pa since for small subjects it is difficult to reach a high airflow.

Statistical analysis.

To test the hyphotesis, that there were no difference beween the soft tissue profiles of patients with impaired nasal function and control patients, the t test was used. To find associations between the soft tissue profile measurements and nasal cross sectional area, head posture, age and gender, multiple regression analysis was implimented. Data analysis was performed with SPSS for Windows 10.0 software.

Method error

Twenty randomly selected lateral cephalogramms were traced and digitized twice with a 6 weeks period. Houston's coefficient of reliability and systematic error was calculated. Since no statistically significant difference between the retraced measurements was recorded, it can be assumed that there were no systematic errors in the measurements. Random errors were assessed with Dahlberg's formula. Random error for the linear measurements ranged from 0.39 to 0.73 and for the angular measurements from 0.91 to 1.53. The random error greater than 1.5° was recorded for the upper incisors' inclination angle. Digitizer AccuGridXNT XNT error according to the specifications was 0.127 mm.

Fifty patients from the control group were available for repeated measurements to facilitate method error calculation for rinomanometry. Pearson product – moment test revealed that the correlation between the measurements was 0.827.

RESULTS

The nasal cross sectional area was statistically significantly differrent between the groups ($p<0.001$) and had tendency to increase with age ($t=2.179$, $p=0.032$).

In the main there were not statsitically significant differences between the control and study groups in the soft tissue profile (Table 2). Patients with impaired nasal function exhibited greater interlabial gap and thicker lower lips ($p<0.05$). There was statistically significant difference in the postural angles between the groups. Patients with impaired nasal function had increased craniocervcial angle and tendency to decreased cervical angle.

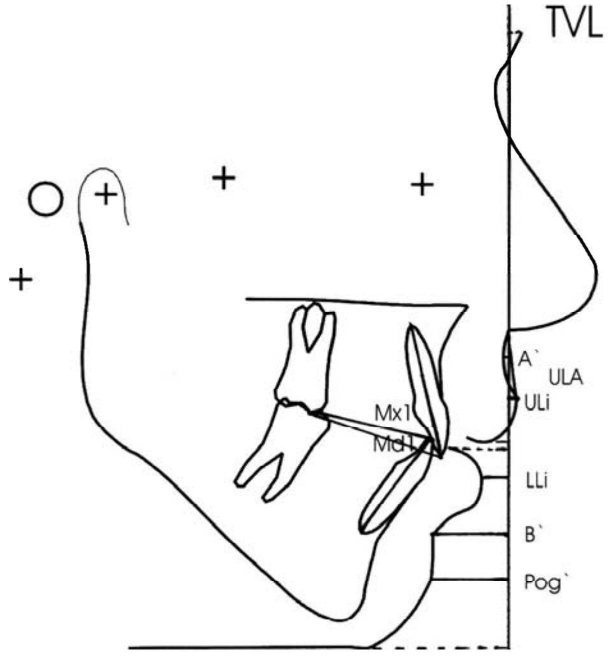

Fig. Reference points and lines for the soft tissue analysis. TVL is placed through subnasale parallel to the true vertical line

No substantial difference in the soft tissue profiles was found between boys and girls, except girls had more curved maxillary sulcus.

Multiple regression analysis was used to determine impact of the various factors on the soft tissue profile. Nasal cross sectional area, postural angles (cranial inclination angle (NS/Vert), craniocervical inclination angle (NS/Opt) and cervial inclination angle (Opt/Hor)), and age were included in the analysis as independent variables (Table 3 and 4).

There was a positive association between the nasal cross sectional area and projection of the soft tissue profile points to the TVL, indicating that patients with smaller nasal cross sectional areas had more retrognathic profiles. Soft tissue profile measurements indicated that older children had thicker lips, less convex maxillary sulcus and more pronounced mandibular sulcus. As expected, older children showed less of the upper incisors.

Head posture thad the most significant impact on the soft tissue profile. Increased head extension was seen in relation with more retrognathic soft tissue profile, flattened lower lip and longer faces.

DISSUSSION

The mean nasal cross sectional area of the control group was smaller than could be expected according to the literature. But it should be noted that the control group consisted of the orthodontic patients and they have been

Table 1. Soft tissue profile measurements.

Variable	Definition
A'	Soft tissue A point projection to the TVL
ULi	Upper lip projection to the TVL
LLi	Lower lip projection to the TVL
B'	Soft tissue B point projection to the TVL
Pog'	Soft tissue Pog point projection to the TVL
ULA	Upper lip angle, the angle between the TVL and line between subnasal and upper lip point
ULthickness	Upper lip thickness, distance between upper lip point and stomion supe
LLthickness	Lower lip thickness, distance between lower lip point and stomion infe
Interlabial gap	Distance between stomion superior and stomion inferius
Convexity	Facial profile angle, connecting soft tissue glabella, subnasale, an tissue pogonion. In the study the angle was subtracted from the 180°
Nasiolabial angle	Angle formed by intersection of the upper lip point and columella at Sı
Maxillary sulcus	Maxillary sulcus angle, connecting soft tissue Sn, A and upper lip poin
Mandibular sulcus	Mandibular sulcus angle, connecting soft tissue Pog, B and lower lip p
Mentolabial depth	Distance from soft tissue B point to the line connecting stomion inferu soft tissue pogonion
Mx 1	Upper incisors' inclination to the occlusal plane
Md1	Lower incisors' inclination to the occlusal plane
Mx1exposure	Distance between stomion superius and upper incisor edge projection

Table 2. Soft tissue profile measurements: means, standart deviations and t test values.

Soft tissue measurements	Study patients	Control patients	t - test			
	Mean ± SD	Mean ± SD	t	p value	Conf. interval	
A'	- 1.5 ± 1.5	- 1.4 ± 1.4	- 0.470	0.640	- 0.778	0.481
ULi	0.5 ± 2.6	0.9 ± 2.5	- 0.659	0.512	- 1.450	- 0.090
LLi	- 5.1 ± 4.7	- 4.0 ± 4.3	- 1.159	0.250	- 3.116	0.825
B'	- 11.6 ± 7.2	- 10 ± 8.3	- 0. 982	0.330	- 5.204	1.777
Pog'	- 10.9 ± 7.6	- 8.9 ± 9.5	- 0.992	0.325	- 5.827	1.966
ULA	1.7 ± 10.4	2.6 ± 11.1	- 0.384	0.702	- 5.710	3.868
U1 thickness	14.6 ± 1.9	14.3 ± 1.8	0.552	0.583	- 0.591	1.044
L1 thickness	13.5 ± 1.6	12.3 ± 2.8	2.277	0.028*	0.141	2.303
Nasiolabial angle	115.9 ± 11.0	115.0 ± 12.2	0.377	0.707	- 4.211	6.171
Convexity	17.4 ± 5.5	16.5 ± 5.5	0.757	0.451	-1.496	3.325
Maxillary sulcus	149.0 ± 13.4	146.9 ± 14.7	0.460	0.647	- 0.867	1.387
Mandibular sulcus	124.6 ± 19.7	123.8 ± 13.6	0.223	0.825	- 6.306	7.895
Mentolabial depth	5.3 ± 1.3	5.2 ± 1.1	0.390	0.698	- 0.417	8.354
Interlabial gap	3.2 ± 3.7	1.6 ± 2.7	2.413	0.018**	0.290	3.003
Mx1 exposure	5.0 ± 2.8	4.7 ± 2.4	0.460	0.647	- 0.867	1.387
Face ratio	49.3 ± 2.5	49.3 ± 2.1	0.100	0.920	- 0.938	1.038
Mx1	60.4 ± 5.3	61.0 ± 5.7	- 0.510	0.612	-3.079	1.827
Md1	66.3 ± 10.2	64.8 ± 8.0	0.735	0.464	- 2.505	5.443
		Postural angles				
NS/VERT	97.6 ± 8.5	95.4 ± 15.7	0.723	0.473	-3.837	8.138
NS/OpT	98.9 ± 8.4	94.7 ± 9.5	2.089	0.041*	0.182	8.234
OpT/HOR	90.5 ± 8.1	93.3 ± 7.5	-1.666	0.100	-6.262	0.560
		Nasal cross sectional area				
	0,19 ± 0,15	0,33 ± 0,13	-4.820	0.000***	-0.203	-0.084

** p<0.05; *** p<0.001

reported to have higher nasal resistance [22].The control sample consisted of the orthodontic patients and all of them possessed some orthodontic anomaly. However the aim of the study was to investigate general growth and developing influencing mechanisms and such mechanisms are supposed to opperate in all subjects whether or not malocclusion is present. For the same reason all patients were included together in the multiple regression analysis. The finding that the interlabial gap differed between the groups, but no correlation was found with the nasal cross sectional area, could be attributed to the fact, that the nasal function measurements are limited to the time point and lip posture was rather habitual.

Noticeable associations were found between head posture and the soft tissue profile. Since various soft tissue profile measurements and cranial inclination have common reference line, the geometrical correlation between the measurements may be perceived as a biological association. However significant associations with decreased cervical flexion were observed, so it can be concluded that the head posture has an impact to the soft tissue profile. Increased craniocervical extension was correlated to increased soft tissue profile retrognathia and flattened mandibular sulcus indicating lower lip tension. We can hypothise that the neuromuscular changes induced by the nasal obstruction can alter soft tissues of the face. Thus findings of our study support the statement that the nasal obstruction alters the head position that futher trigger the neuromuscular adaptation mechanisms as described by Solow and Kreiborg [14].

The soft tissue profile studies shoud be compared with caution as some of the them include nasal changes, while others do not. Studies describing soft tissue changes in relation to the intracranial reffernce lines are not very well suited for comparison with the present data.

The nasolabial angle in both groups was somewhat smaller than reported in other samples [23-24], as the one of the explanations could serve the finding that upper incisors in the study were less proclined than reported elsewhere [25]. The convexity angle was larger than in other studies [18,26], indicating increased profile retrusion of the patients in both groups.

Both upper and lower lip thickness was dependent on age and that is in agreement with majority of the past longitudinal studies [18, 23-24, 26-28].

The finding that the only soft tissue profile measurement dependent on gender was the maxillary sulcus recordings is in agreement with Spradley et al. study, but is diverse from other reports suggesting gender dimortphism of the profile [27-29]. That could be explained with the consideration that the refference line TVL is drawn through subnasale the point, which drifts with age downward and forward, in boys more that girls with dissimilar growth velocity [28]. Besides the control sample consisted from patients with various types of malocclusions and according to Ferrario and Sforza data [30] gender differences increase with age except for Class II patients who had thicker soft tissues than Class I patients. When the soft tissue profiles were measured to the true vertical line in young adults, no dissimilarities were found between genders [19, 24-25]. Studies describing soft tissue profiles to TVL reported more straight profiles, which could be attributed to different age and population standarts used in the studies. In those studies, as well as in the present study, standart deviations became progressively larger from superior labial sulcus to soft tissue pogonion both in the study and control samples. The findings of our study support the view [24] that the relative positions of the lips and chin to TVL are likely to remain constant with maturation of the child and this could be taken into account in treatment planning.

Table 3. Summary of multiple regression analysis between postural angles and soft tissue profile measurements.

Soft tissue measurements	NS/ Vert		NS/ Opt		Opt/Hor	
	Coeficient	P value	Coeficient	P value	Coeficient	P value
A’	-0.004	0.767	0.104	0.000	0.134	0.000
ULi	-0.013	0.610	0.180	0.000	0.245	0.000
LLi	-0.080	0.035	0.498	0.000	0.610	0.000
B’	-0.953	0.236	0.479	0.001	0.602	0.000
Pog’	-0.113	0.192	0.438	0.005	0.693	0.000
ULA	-0.333	0.754	0.668	0.001	0.884	0.000
U1 thickness	0.017	0.366	-0.042	0.206	-0.024	0.524
L1 thickness	-0.003	0.914	0.001	0.979	-0.586	0.224
Nasiolabial angle	0.002	0.988	0.140	0.540	0.001	0.997
Convexity	0.071	-.241	0.158	0.143	0.060	0.630
Maxillary sulcus	0.056	0.704	0.253	0.332	0.261	0..389
Mandibular sulcus	-0.145	0.436	0.900	0.008	0.789	0.043
Mentolabial depth	0.016	0.210	-0.752	0.002	-0.091	0.001
Interlabial gap	-0.034	0.372	0.089	0.190	0.070	0.374
Mx1 exposure	0.017	0.552	-0.007	0.893	-0.784	0.187
Face ratio	-0.038	0.131	0.114	0.013	0.175	0.001
Mx1	0.068	0.259	-0.133	0.288	- 0.030	0.779
Md1	0.010	0.772	0.016	0.795	-0.066	0.358

Table 4. Summary of multiple regression analysis between nasal cross sectional area, age, gender and soft tissue profile measurements

Soft tissue measurements	Nasal cross sectional area		Age		Gender	
	Coeficient	P value	Coeficient	P value	Coeficient	P value
A’	46.612	0.061	- 0.052	0.367	0.084	0.775
ULi	113.71	0.011	- 0.161	0.874	0.486	0.352
LLi	224.294	0.001	0.0820	0.583	1.331	0.084
B’	243.390	0.078	- 0.234	0.464	0.048	0.977
Pog’	308.222	0.039	- 0.386	0.263	- 0.367	0.835
ULA	466.2513	0.012	- 0.462	0.277	1.858	0.393
U1 thickness	23.237	0.464	0.327	0.000	0.472	0.213
L1 thickness	39.710	0.318	0.192	0.040	- 0.750	0.115
Nasiolabial angle	-211.410	0.337	- 0.543	0.290	- 1.772	0.511
Convexity	- 57.458	0.578	0.112	0.641	- 0.977	0.428
Maxillary sulcus	- 69.903	0.779	- 1.192	0.043	- 6.575	0.030
Mandibular sulcus	- 25.723	0.935	1.807	0.016	-1.101	0.771
Mentolabial depth	- 11.577	0.601	- 0.022	0.672	- 0.103	0.695
Interlabial gap	107.196	0.102	- 0.150	0.321	-1.112	0.153
Mx1 exposure	-18.252	0.708	- 0.261	0.024	0.290	0.618
Face ratio	90.634	0.040	- 0.009	0.929	0.233	0.653
Mx1	-89.591	0.389	0.342	0.159	- 0.620	0.616
Md1	- 30.094	0.872	-0.295	0.498	- 2.04	0.361

CONCLUSIONS

- No statistically significant differences were found between the soft tissue profile of patients with impaired nasal breathings and orthodontic patients without nasal obstruction, except for the interlabial gap measurement.
- Soft tissue profile measurements were related to the head posture, head extention was associated with more retrognathic soft tissue profile, flattened lower lip and longer faces.
- Relative measurements of the soft tissue profile to the true vertical line remained comparatively constant regardless of the patients‘s age, while lip thickness, convexity of mandibular and maxillary sulcus, exposion of the upper teeth changed with age of patients.

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Received: 21 03 2006
Accepted for publishing: 27 06 2006