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Morphological predictors of sleep apnoea severity

J. Wysocki[1, 2], M. Krasny[3], M. Prus[2]

[1]*Department of Dietetics and Food Evaluation, Institute of Health, Natural Faculty, Siedlce University of Natural Sciences and Humanities, Siedlce, Poland*
[2]*Department and Clinic of Otolaryngology, Warsaw Medical University, Warsaw, Poland*
[3]*Department of Orthodontics, Warsaw Medical University, Warsaw, Poland*

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Background: *Obstructive sleep apnoea (OSA) does not always depend on obesity but on a certain morphological configuration. The study objective was to verify a hypothesis about a relation between anthropometric features and OSA occurrence and severity.*
Materials and methods: *The study involved 138 patients, who had reported in Department and Clinic of Otolaryngology, Warsaw Medical University, due to suspected OSA. Each patient underwent morphological evaluation according to visual analogue scales. The assessment involved nasal septum morphology evaluation according to a 4-grade scale, palate morphology evaluation according to the 4-grade Friedman scale, whereas the facial profile, oropharyngeal isthmus, and the shape of the nasopharynx were assessed according to our own 3-grade scale.*
Results: *Statistical analysis confirmed the high concordance of the basic polysomnographic parameters with the Friedman scale and the shape of the oropharyngeal isthmus.*
Conclusions: *1. The modified Mallampati score as well as evaluation of the shape of the oropharyngeal isthmus demonstrated high concordance with the basic polysomnographic parameters. 2. The neck circumference is a significant predictor of the apnoea-hypopnoea index value in males suffering from the OSA syndrome.* (Folia Morphol 2016; 75, 1: 107–111)

Key words: obstructive sleep apnoea, nasopharynx, airway obstruction, risk factors

INTRODUCTION

It is common knowledge that a set of morphological traits may be identified, which makes the subject susceptible to the obstructive sleep apnoea (OSA) syndrome. In particular the obstruction of the lumen within the middle section of the oropharyngeal isthmus caused by a massive hypertrophy of the palatopharyngeal arch, palatine tonsils, uvula, and the tongue as well as the hyoid bone position and the length of the body of the mandible were demonstrated to be significantly associated with the occurrence and severity of the OSA syndrome [1, 10, 13, 14, 18].

However, not all the investigators agree on the actual meaning of some morphological traits in manifestation of OSA. The relation of apnoea-hypopnoea index (AHI) with a longer soft palate, retrognathia or overbite is being challenged [13]. Similarly, the considerable role of excessive volume of the tongue in the OSA syndrome aetiopathogenesis addressed by some investigators [13, 14] is being belittled by others [11, 15, 16]. The analyses conducted in large groups of OSA patients demonstrated that the significant yet still very low (0.13–0.264) correlation between the Mallampati score (class 1–4) and AHI did not justify prediction of occurrence or severity of OSA based on this single tool of morphological evaluation [7, 9]. Moreover, according to some investigators, cephalometric assessment of OSA patients did not show any

Address for correspondence: M. Krasny, PhD, Department of Orthodontics, Warsaw Medical University, ul. Nowogrodzka 59, 02–006 Warszawa, Poland, tel: + 48 508 145 966, fax:+48 22 783 82 70, e-mail: mkrasny@op.pl

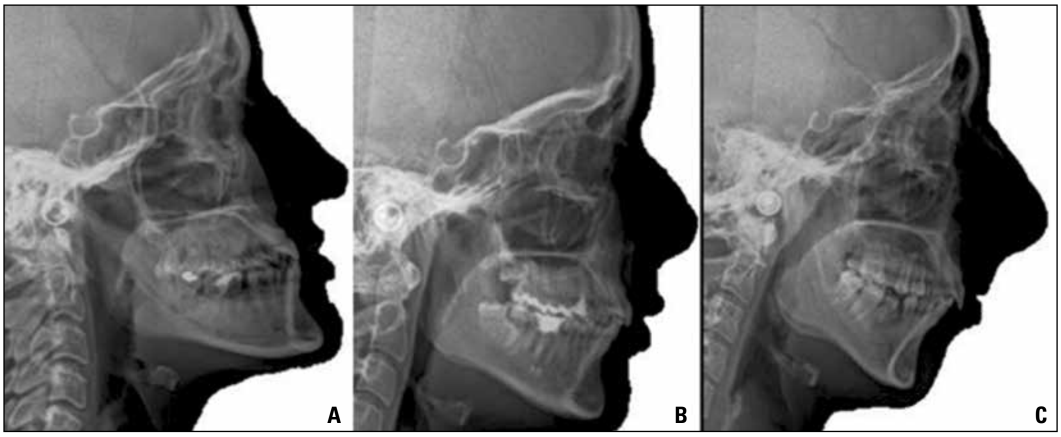

Figure 1. Prognathic (**A**), orthognathic (**B**) and retrognathic (**C**) facial profile.

statistically significant relation between exacerbation of OSA and the length of the soft palate [1].

It is difficult to isolate the evaluation according to the morphological scale from assessment of the body adiposity status; therefore, the rule requires that results of morphological and morphometric evaluation should be analysed jointly with body mass index (BMI) and neck circumference [2, 3, 5, 8].

The literature review implied that there was a range of contradictory opinions referring to the significance of some features of head and neck morphology making a patient more prone to OSA. Further research on this issue, that would provide a bigger amount of data, could possibly shed some light on the problem.

The objective of the study was to evaluate the relation between selected features of facial morphology and occurrence and severity of the clinical course of OSA.

MATERIALS AND METHODS

The analysis involved 138 patients (121 males and 17 females) with diagnosed OSA hospitalised in the Department and Clinic of Otolaryngology, Warsaw Medical University. In each patient morphological evaluation was performed according to analogue visual scales. Nasal septum morphology was assessed according to the commonly used 4-grade scale. The morphology of the soft palate and the tongue was evaluated based on the 4-grade modified Mallampati classification. The width of the oropharyngeal isthmus associated with occurrence and the grade of palatine tonsils hypertrophy was evaluated according to the Pirquet scale. The facial profile was assessed with the 3-grade scale: prognathic, orthognathic, retrognathic (Fig. 1).

The shape of the oropharyngeal isthmus and the depth of the nasopharynx were evaluated based on our own, 3-grade scales. In case of evaluation of the oropharyngeal isthmus morphology grade 1 signified subjects who showed apron-shaped, palatopharyngeal arch, i.e. protruding medially from the palatolingual arch, and the palate was thick and showing hypertrophy. Grade 2 was assigned to subjects whose both arches overlapped within the optical axis and the palate was of moderate thickness. Grade 3 was for cases where the palatopharyngeal and palatolingual arches were not morphologically separated and the palate was thin and flabby.

The scale used to evaluate the depth of the nasopharynx consisted in allocating grade 1 to cases of shallow nasopharynx, grade 2 to moderately deep nasopharynx, and grade 3 to deep nasopharynx. The nasopharynx was considered shallow when at rest the soft palate touched the posterior wall of the pharynx (distance 0). The moderately deep nasopharynx was defined as the distance of the soft palate > 0 > from the distance between the palatolingual arch and the palatopharyngeal arch or the total thickness of both arches in case when they were not morphologically separated. The nasopharynx was described as deep in subjects where the distance between the palate and the posterior wall of the pharynx exceeded the distance between the palatolingual arch and palatopharyngeal arch or the total thickness of both arches if they were not morphologically separated.

The height and body mass were determined with the use of TANITA Corp. Analyser (BC 418 MA). The BMI was calculated as the quotient of the body mass by the squared height expressed in meters. The neck, waist, and hip circumference were measured with

Table 1. Measurement results of metric traits for the total material and subgroups distinguished by gender

Gender/parameter	Females		Males		Total		t-Student test
	Mean	SD	Mean	SD	Mean	SD	P
Age	53.8	11.2	49.37	11.52	50.7	11.6	0.1199
Apnoea-hypopnoea index	32.1	24.6	38.1	25.4	37.1	25.4	0.2801
SO_2nadir	75.9	18.9	80.0	12.2	79.3	13.7	0.3140
Arousal	34.6	33.2	28.4	18.5	29.2	21.2	0.5003
Neck circumference	36.6	2.99	42.5	3.11	41.3	3.89	**0.0000**
Waist circumference	96.9	15.9	106.0	12.9	104.0	14.1	**0.0033**
Hip circumference	111.2	14.38	109.6	10.07	109.9	11.1	0.4299
Body mass index	29.93	7.27	30.66	5.02	30.51	5.57	0.6845
Waist to hip ratio	0.87	0.06	0.97	0.06	0.95	0.07	**0.0000**

Statistically significant correlations are highlighted in bold

Table 2. Evaluation results for Pirquet and Friedman classifications in the total material

Subgroup/parameter	Pirquet's score			
	1	2 + 3 + 4	P (t-Student test)	P (Mann-Whitney)
Apnoea-hypopnoea index	38.34 (26.87)	35.31 (24.36)	0.5008	0.5988
SO_2nadir	77.71 (15.99)	82.06 (6.92)	**0.0236**	0.1282
Arousal	32.12 (24.78	23.92 (11.07)	**0.0186**	0.1439
	Friedman score			
	1 + 2	3 + 4	P (t-Student test)	P (Mann-Whitney)
Apnoea-hypopnoea index	27.83 (21.28)	41.75 (26.77)	**0.0021**	**0.0014**
SO_2nadir	84.31 (5.00)	76.92 (15.63)	**0.0000**	**0.0001**
Arousal	26.55 (24.22)	30.71 (19.49)	0.3251	0.0972

Statistically significant correlations are highlighted in bold

a metal anthropometric tape and the measurements were rounded to the nearest whole number in cm.

The statistical analysis employed the STATISTICA 10 software.

RESULTS

Results of calculations for individual sleep parameters and morphological parameters with the genders taken into account were presented in Table 1. The table also contains the results of statistical tests investigating the differences of mean values. Mean values of selected sleep parameters (AHI, $S0_2$nadir, arousal index) in the individual subgroups distinguished by the obtained score of morphological evaluation presented a few statistically significant differences (median test, Kruskal-Wallis test). The differences were found between subgroups separated according to the Friedman scale regarding AHI and SO_2nadir (p value was 0.2498 for median test and 0.0160 for Kruskal-Wallis test and 0.0250 for median test and 0.0004 for Kruskal-Wallis test, respectively) and between subgroups distinguished according to the oropharyngeal isthmus evaluation score regarding AHI (p value was 0.0364 for median test and 0.0187 for Kruskal-Wallis test).

To increase the power of statistics the subgroups separated according to the Pirquet scale and Friedman scale were then consolidated and results of the statistics are presented in Table 2. Mean values of selected metric parameters in individual subgroups distinguished by the obtained score in the morphological classification with results of statistical testing are presented in Table 3. Table 4 presents values of Spearman's rank correlation coefficients between the individual investigated parameters for the whole material. Correlations in subgroups distinguished by gender are not presented because of great predominance of male individuals.

In the stepwise regression model only the neck circumference was significantly connected with AHI.

Table 3. Mean values of selected metric parameters in individual subgroups distinguished by the obtained score in the morphological classification with results of statistical testing (Median test, Kruskal-Wallis test)

	Pirquet's score			
	1	2 + 3 + 4	P (t-Student test)	P (Mann-Whitney)
Neck circumference	40.88 (4.22)	41.95 (3.03)	0.0565	0.1279
Waist circumference	104.21 (14.56)	103.55 (13.01)	0.7706	0.6547
Hip circumference	109.97 (11.69)	109.47 (9.78)	0.7749	0.8819
Body mass index	30.64 (5.84)	30.11 (5.01)	0.5463	0.5547
Waist to hip ratio	0.95 (0.07)	0.94 (0.06)	0.8260	0.4646
	Friedman score			
	1 + 2	3 + 4	P (t-Student test)	P (Mann-Whitney)
Neck circumference	40.20 (3.50)	41.73 (3.99)	**0.0150**	**0.0148**
Waist circumference	98.91 (13.08)	106.43 (13.93)	**0.0009**	**0.0006**
Hip circumference	107.27 (11.40)	111.09 (10.85)	**0.0341**	**0.0066**
Body mass index	29.28 (5.69)	31.06 (5.47)	**0.0461**	**0.0153**
Waist to hip ratio	0.92 (0.07)	0.96 (0.07)	**0.0014**	**0.0012**
	Oropharyngeal isthmus classification			
	1	2	3	P (ANOVA)
Neck circumference	42.8 (2.9)	41.12 (4.27)	39.7 (3.42)	**< 0.0000**
Waist circumference	108.73 (12.20)	103,33 (14.85)	99.4 (12.9)	**0.003**
Hip circumference	112.52 (11.25)	109.82 (11.09)	106.3 (8.05)	**0.02**
Body mass index	32.21 (6.01)	30.42 (5.31)	28.17 (4.35)	**0.037**
Waist to hip ratio	0.97 (0.05)	0.94 (0.07)	0.93 (0.07)	**0.003**

Statistically significant correlations are highlighted in bold

Table 4. Values of Spearman's rank correlation coefficients in total material

Parameter	Age	AHI	SO_2nadir	Arousal	Neck	Waist	Hip	BMI	WHR
Age	1.00	**0.12**	**–0.20**	**0.17**	–0.03	–0.02	–0.04	0.02	0.03
AHI	**0.12**	1.00	**–0.70**	**0.46**	**0.43**	**0.46**	**0.46**	**0.37**	**0.26**
SO_2nadir	**–0.20**	**–0.70**	1.00	**–0.34**	**–0.27**	**–0.43**	**–0.43**	**–0.44**	**–0.24**
Arousal	**0.17**	**0.46**	**–0.34**	1.00	**0.25**	**0.24**	0.17	**0.17**	**0.23**
Neck	–0.03	**0.43**	**–0.27**	**0.25**	1.00	**0.79**	**0.57**	**0.67**	**0.69**
Waist	–0.02	**0.46**	**–0.43**	**0.24**	**0.79**	1.00	**0.80**	**0.84**	**0.72**
Hip	–0.04	**0.46**	**–0.43**	0.17	**0.57**	0.80	1.00	**0.79**	**0.23**
BMI	0.02	**0.37**	**–0.44**	**0.17**	**0.67**	**0.84**	**0.79**	1.00	**0.50**
WHR	0.03	**0.26**	**–0.24**	**0.23**	**0.69**	**0.72**	**0.23**	**0.50**	1.00

AHI — apnoea-hypopnoea index; BMI — body mass index; waist to hip ratio; statistically significant correlations are highlighted in bold

DISCUSSION

According to most clinical observations, the neck circumference and BMI are the best OSA predictors as it was proved in this study [2, 4, 6, 8, 9, 12, 14, 17]. In the study by Davies et al. [2] the neck circumference and BMI, also correlated significantly with desaturations; however, the correlation coefficients were stronger (r = 0.63 and r = 0.54, respectively) when compared to our study.

Demonstration of a significant difference between subgroups distinguished by oropharyngeal isthmus morphology in terms of AHI complied with observations of Schellenberg et al. [13], according to which decreasing the distance between lateral pharyngeal walls caused by excessive growth of palatal arches was of the strongest predictive value for OSA, as proved by the odds ratio. The correlations between selected morphological traits and AHI calculated in this study implied that the higher Friedman score, the more severe OSA. In case of soft palate evaluation scale it was the opposite — the higher the score, the lower AHI was noted, in the female group in particular. However, the result in this subgroup should be approached cautiously due to a small number of subjects in the group. Nevertheless, it may be concluded that the more delicate and thin structures of palatal arches and the soft palate, the lower OSA risk and the milder course of the condition. This observation additionally emphasized the role of the palate in the Friedman classification. The statistically important correlations observed among some studied morphometric features and polysomnographic parameters presented low values of correlation coefficients (between 0.14 and 0.25), however comparable to the data presented by authors mentioned above. The width of the oropharyngeal isthmus, tonsils' size, and Friedman score demonstrated significant correlation to AHI also according to other authors [17].

The score in the palatal tonsils size evaluation significantly distinguished patients in terms of the arousal index and SO_2nadir, whereas the Friedman score — in terms of AHI and SO_2nadir. Based on the outcome of the study by Schellenberg et al. [13] soft palate lengthening, which is one of the elements of the Friedman classification, as an isolated feature may have no relation with OSA. Therefore, it seems that there is a point in using the Friedman scale only as a whole and there is no point in conducting separate analyses of the tongue or palate size. This study demonstrated that the subgroup with the higher Friedman score (3 or 4) is characterised by significantly larger neck, waist, and hip circumference, higher BMI and waist to hip ratio. This confirmed previous observations of other authors, according to whom the correlation between the Mallampati score and BMI (r = 0.208) is low but still significant [9].

CONCLUSIONS

1. The modified Mallampati score as well as evaluation of the shape of the oropharyngeal isthmus demonstrated high concordance with the basic polysomnographic parameters.
2. The neck circumference is a significant predictor of the AHI value in males suffering from the OSA syndrome.

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