

## ORIGINAL PAPER

# Assessment of sagittal and vertical skeletal patterns in Romanian patients with obstructive sleep apnea

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### Abstract

**Objective:** To establish the sagittal and vertical skeletal pattern of the Romanian patients with obstructive sleep apnea (OSA). **Patients and Methods:** Lateral cephalograms of forty patients, divided in two groups, group I – twenty patients with OSA (15 males and five females) and aged between 34–76 years and group II (control group) – twenty patients with class II malocclusion (eight males and 12 females), aged between 22–40 years, were analyzed for linear and angular skeletal parameters. **Results:** For group I – most often, the mandible was in posterior position, the mean value for SNB angle being 76.77 degrees; maxilla tended to be retruded, too. The maxillo-mandibular antero-posterior (AP) relationship was class II in 90% of the cases. A clockwise rotation of the mandible was registered in a vertical plane (mean value SN, ML: 29.82 degrees), the facial height ratio being in a normal range of values. There was a medium positive correlation between ANB angle and apnea/hypopnea index (AHI), while SNA showed a quadratic relationship with AHI. Using *t*-test, in order to compare the sagittal and vertical skeletal pattern of the two groups, it can be stated that there is a statistical significant difference for antero-posterior (AP) position of the mandible, for the group II mandible retrognathia being more pronounced than in group I. **Conclusions:** Romanian patients with OSA had a retrognathic sagittal pattern with a class II antero-posterior relationship. A statistical significant positive correlation between AHI and ANB suggests that the class II antero-posterior maxillomandibular relationship can predispose to OSA.

**Keywords:** obstructive sleep apnea, sagittal and vertical pattern, cephalometrics, class II malocclusion.

### Introduction

Obstructive sleep apnea (OSA) affects approximately 0.3–4% of the middle-aged population, being a common condition defined on the basis of daytime sleepiness and objective measures of disordered breathing during sleep [1, 2]. The frequency of disordered breathing during sleep increases with age [3, 4], in adults, males being twice as likely to snore as females [5, 6]. Many studies have shown that the etiology of OSA includes genetically and environmentally induced changes, the craniofacial complex being probably one of the most important heritable determinants of OSA [7, 8]. Skeletal differences have been reported in sagittal (antero-posterior) and vertical plane [9–12]. There is a tendency to retrusion of the anterior cranial base and face, which leads to reduction of upper airway [13–15].

Although class II skeletal pattern is the most common feature for these patients [16], more recently a wide range of skeletal pattern has been confirmed. There is also a correlation between cephalometric characteristics and obstructive site in OSA syndrome [17]. Due to this fact, the aim of the following study was to establish the sagittal and vertical skeletal characteristics of Romanian patients with OSA.

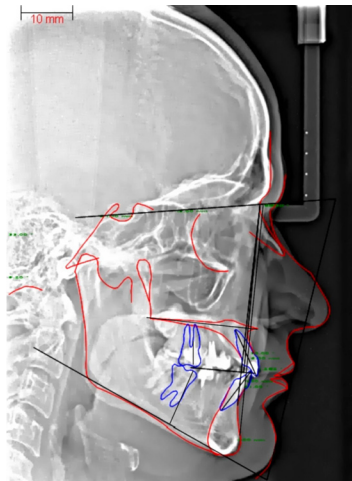
### Patients and Methods

Two groups of patients were analyzed. Twenty patients with OSA, mean age 52.7 years (SD 9.02) were recruited from "Marius Nasta" Institute in Bucharest, Department of Pneumology, for the group I. Among them, 15 were males. The inclusion criterion was eligibility for treatment with oral appliances. The BMI index

was also assessed. The group II – control group, contained twenty patients (eight males and twelve females), with class II malocclusion, without OSA, in fact no reported snoring, aged between 22–40 years, randomly selected from a private clinic.

Conventional cephalometric analysis was performed on lateral cephalograms by the same orthodontist, assessing the following parameters:

- angular measurements: BaSN, SNA, SNB, SNPg, ANB for sagittal skeletal pattern; SNNL, SNML for vertical skeletal pattern;
- linear measurements: upper molar – NF (U6–NF), lower molar – MP (L6–MP), HP/HA index.



**Figure 1 – Linear and angular measurements on lateral cephalograms.**

All patients underwent overnight polysomnographic monitoring in the Department of Pneumology, all measurements being performed by the same specialist. The severity of the OSA was expressed using obstructive apnea/hypopnea index (AHI). Taking into account that the mean value of AHI for group I was 13.93 (SD 5.86; range 5–23), AHI was considered as either mild or moderate, thus the patients had the indication for oral appliance treatment. The prevalence of the diagnosis of the group I was as follows: OSA 65%, and MSA (mix sleep apnea) 35%. Data were expressed as means, standard deviations (SD), ranges and percentages, as appropriate. Possible correlations between different angular and linear measurements were analyzed using the Pearson correlation test, while *t*-test was used to assess statistical significant differences between groups I and II. Furthermore, linear regressions were performed in order to define possible predictors for AHI. A *p*-value less than 0.05 was considered statistically significant. Stata 11C statistical software (Stata Corp LP, Texas, USA, 2009 version) was used for data analysis.

## Results

The mean values of BMI and AHI for group I were 28.75 (SD 4.13), and 13.93 (SD 5.87), respectively. Regarding the BMI, all OSA patients were overweight. The sex distribution in the group of randomly selected patients with OSA was 1:3 females/males.

Regarding sagittal skeletal pattern of group I, the mean values of the angular measurements (SNA, SNB, SNPg) were lower than normal values (Table 1) and the mean value of ANB angle was 2.88 (SD 2.48).

The cranial base angle values were comprised in the normal range ( $132^\circ$ ) [18, 19].

**Table 1 – Descriptive analysis of linear and angular parameters for group I**

Variable	Mean	SD	Range
BaSN [ $^\circ$ ]	131.2	4.84	122 to 140
SNA [ $^\circ$ ]	79.65	4.90	72.5 to 92
SNB [ $^\circ$ ]	76.78	3.58	72 to 84
SNPg [ $^\circ$ ]	78.38	3.51	73 to 86
ANB [ $^\circ$ ]	2.88	2.49	-2.5 to 8
SN, NL [ $^\circ$ ]	7.48	4.07	-1 to 16
SN, ML [ $^\circ$ ]	29.83	5.11	19 to 37.5
U6–NF [mm]	26.83	3.81	19.5 to 35.5
L6–MP [mm]	38.63	3.44	31 to 45
HP/HA [%]	76.40	11.63	49.4 to 96.8

The mean value for SN, ML ( $^\circ$ ) was 29.83 (SD 5.1) and for L6–MP – 38.63 mm. The vertical positions of the upper jaw SN, NL ( $^\circ$ ) and upper molar (U6–NF) was in the normal range for the mean values (26.2 for U6–NF as described by Bosch C and Athanasiou AE [18]) (Table 1).

The cephalometric characteristics for AP and vertical skeletal and dental pattern of group II are listed in Table 2.

**Table 2 – Descriptive analysis of linear and angular parameters for group II**

Variables	Mean	SD	Range
BaSN [ $^\circ$ ]	134.3	4.24	128 to 141
SNA [ $^\circ$ ]	80.4	3.42	73.5 to 81
SNB [ $^\circ$ ]	74.9	3.42	69 to 81
SNPg [ $^\circ$ ]	76.32	3.88	69 to 84
ANB [ $^\circ$ ]	5.55	2.79	1 to 11
SN, NL [ $^\circ$ ]	9.4	2.91	5 to 17
SN, ML [ $^\circ$ ]	31.8	8.45	14 to 47
U6–NF [mm]	22.2	3.45	10.5 to 27
L6–MP [mm]	32.1	2.58	27.5 to 38.5
HP/HA [%]	73.9	11.80	50.35 to 100.12

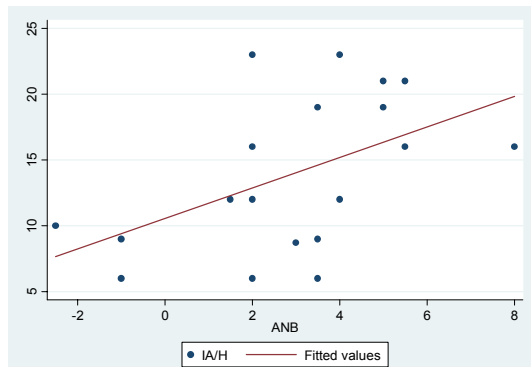
Using *t*-test for comparing the sagittal and vertical pattern of the two groups, it was found that the maxilla had a more anterior position in group II (control group), than in group I (Table 2), but the mandible was strong retrognathic, the BaSN angle having higher values than normal ones. Therefore, there were statistically marginal differences between the two groups, for SNB and SNPg angle ( $p=0.0495$  and  $0.0439$ , respectively), which established the sagittal position of the mandible and statistically significant difference for BaSN angle ( $p=0.0168$ ). The values of ANB angle in group II were higher than those in group I. Thus, a statistical significant difference was found, due to the normal or even prognathic position of the maxilla and strong retrognathic position of the mandible, in the control group. Regarding the skeletal vertical pattern, this was in normal range for both groups. There were statistically significant differences for vertical position of the upper and lower molars ( $p=0.002$  and  $0.0001$ , respectively), the values of U6–NF and L6–MP in group II being lower than in group I. There was also a more pronounced tendency for clockwise rotation of the mandible (Table 2), in group II.

Testing possible correlations between AHI and skeletal parameters, there were found only two statistical significant associations. A medium-positive correlation was found between ANB and AHI ( $r=0.5$ ,  $p=0.03$ ). By using linear regression test, we tested if ANB could be used as a predictor for AHI (Table 3, Figure 2). The results suggest that AHI can be predicted by ANB, following the equation:  $AHI=10.7+1.14\times ANB$ .

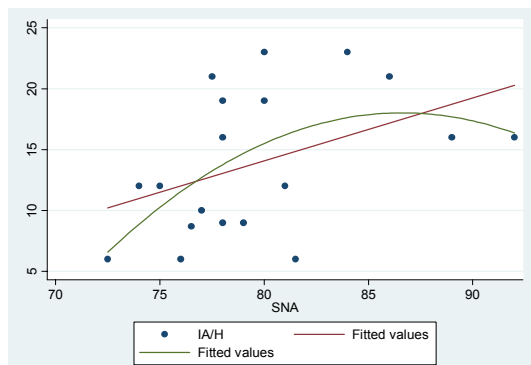
**Table 3 – Statistical evaluation of the coefficients used for the linear regression model**

AHI	Coefficients	Standard error	p-value	95% Confidence Interval
ANB	1.14	0.47	0.03	0.16 to 2.13
Constant	10.7	1.77	0.000	6.98 to 14.41

A medium-positive correlation was also found between AHI and SNA ( $r=0.44$ ,  $p=0.05$ ). Testing further by linear regression if SNA could be used as a predictor for AHI, it was observed that SNA most probably had a quadratic relationship with AHI (Figure 3).



**Figure 2 – Graphical representation of a possible linear relationship between AHI and ANB.**



**Figure 3 – Graphical representation of a possible quadratic relationship between AHI and SNA.**

## Discussion

The sex distribution for group I was 1:3 females/males, which is in agreement with other studies stating that OSA affects mostly males [20]. The age in both groups was matched so the subject's growth was ceased. Regarding the BMI, all OSA patients are overweight, but not obese [21].

The literature provides abundant evidence that the antero-posterior position of the mandible in OSA patients is retrognathic [22], and so it was found in the present study. Surprisingly, this feature was accompanied by a maxillary retrusion in Romanian OSA

patients. Maxillo-mandibular retrognathia was found also by V Tangugsorn V *et al.* (1995) [22], but in relation with N perpendicular plane (N\_LF), despite the normal angles of prognathism.

Although the mean value of ANB angle was 2.88 (SD 2.48), for retrognathic patients the mean value was higher than normal value, thus the mandible was in a severe posterior position (according to Hasund A cephalometric analysis [23]).

The ANB angle, used to assess the antero-posterior maxillo-mandibular relationship, was almost in the normal range of values (a little bit higher than normal mean value), but due to the fact that 90% of the patients were retrognathic, the sagittal skeletal pattern was class II, this being the reason for selecting patients with class II malocclusion as a control group. Only two patients were in a prognathic range of sagittal skeletal relationship, with a class III pattern, suggesting that OSA patients may have different sagittal skeletal patterns. OSA patients had a less pronounced retrusion of the mandible, but a retruded maxilla, while group II had (with a statistical significant difference) a more accentuated class II AP skeletal pattern. The strong retrognathic mandible in group I was also favored by the position of the cranial base, the BaSN angle having higher values than normal ones and group II mean values, which were almost normal. Therefore, the Romanian patients with OSA, mild or moderate AHI, had a retrognathic AP skeletal pattern and class II malocclusion, but less pronounced than class II patients without OSA.

Regarding the AP skeletal pattern, in contrast with our study Johal A *et al.* [13] in agreement with some other studies, found no statistical differences in the distribution of skeletal classification (SNA, SNB) in OSA patients and control group. However, in this study, the control group contained patients without OSA and different types of skeletal pattern, not class II angle malocclusion.

Regarding the vertical plane, although the mean value of SN, ML angle was higher than normal ( $28^{\circ}$ ) [18], the mandible being clockwise rotated in 70% cases [22], the facial height was found in the normal range of values. This contradicts Lowe AA *et al.* (1986, 1995), Bacon WH *et al.* (1990), and Tsuchiya M *et al.* (1992), who have reported that facial height increases in patients with OSA [24–27]. Tangugsorn V *et al.* [22] had also found a high mandibular plane angle for OSA patients, but the facial height was higher than normal values, too. The posterior rotation of the mandible was also favored by the elongation of the lower posterior teeth, the mean value for L6–MP being higher than normal value – 35.8 [18]. The elongated mandibular molars were also reported by Lowe AA *et al.*, who had also found elongated maxillary and mandibular incisors [24].

To our knowledge, this is the first published report about relationships between skeletal parameters and AHI in OSA Romanian patients. In our study, the mean value for the ANB angle was a little bit higher than the normal mean value and nevertheless there was a medium positive correlation between ANB and AHI. ANB can be a predictor for the AHI severity. Between

AP positions of the maxilla or mandible, that of the maxilla, assessed by the SNA angle is also a factor that can influence AHI, with which it had a medium positive correlation.

## ✉ Conclusions

The Romanian patients with OSA have a retrognathic antero-posterior facial pattern, the mandible and the maxilla having a posterior position with respect to the cranial base. The vertical skeletal pattern is normal with the predominance of the posterior rotation of the mandible. Use of ANB as a linear predictor for AHI may indicate OSA predisposition.

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