Characteristics of Lateral Cephalometric by X-Ray in the Obstructive Sleep Apnea Syndrome Patients

Hoang Anh Tien and Nguyen Thi Thanh Duyen

Abstract Sleep apnea syndrome poses many dangers to the cardiovascular, nervous and respiratory systems. Evaluating changes in anatomical features of facial bones on head X-ray was an accessible and helpful tool in assessing the severity of obstructive sleep apnea syndrome. A case–control study of 49 patients (case group: 33, control group: 16) with symptoms of loud snoring and/or evidence of suspected obstructive sleep apnea syndrome (OSAS) admitted to the Hue University of Medicine and Pharmacy's Hospital, from May 2018 to May 2019. Sleep apnea syndrome was measured with StarDust II, Germany. X-ray was performed with Amrad ARM, USA. Average age of the study group: 71.47 ± 11.46 years. The average Epworth score of OSAS group (+) 7.64 ± 3.13 was higher than the OSAS group (−) 5.00 ± 2.13 ($p < 0.05$). High-risk Berlin scores accounted for 82.9% higher proportion in the OSAS group (+) than the OSAS group (−) ($p < 0.05$). SNA, SNB, ANB, MPH and PAS in OSAS group (+) differed from OSAS group (−) with $p < 0.05$. The average value of ANB and PAS were statistically significant, according to AHI with $p < 0.05$. There was a correlation between AHI and Epworth, SNB, ANB, MPH, PAS in the study group ($p < 0.05$). Among OSAS patients (+): Correlated between AHI and SNB, ANB, MPH, PAS was − 0.45 ($p < 0.05$), 0.58 ($p < 0.05$), 0.39 ($p < 0.05$), − 0.46 ($p < 0.05$), respectively. The lateral head X-ray provides SNB, ANB, MPH, PAS values correlated with AHI in obstructive sleep apnea syndrome patients.

Keywords Obstructive sleep apnea syndrome · Lateral cephalometric · X-ray

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1 Background

Sleep apnea syndrome is a common sleep disorder [1] that has a negative impact on health and quality of life [2], which is the cause of drowsiness and fatigue during the day, leading to neurophysiological changes such as memory loss and concentration ability [3], and increase the risk of occupational accidents and traffic accidents [4]. This disease is common in both developed and developing countries. In Asia, the prevalence is about 8.5% [5].

Changes in the anatomical structure of the face affect the structure of the upper airway, thus affecting sleep apnea syndrome in patients with loud snoring and/or evidence of sleep apnea. The relationship between obstructive sleep apnea syndrome and facial bone features on the skull X-ray has been mentioned in many studies [6, 7].

Sleep apnea syndrome is a syndrome causing many dangers to the cardiovascular, nervous and respiratory systems. However, the diagnosis of sleep apnea syndrome is often overlooked, and until it is discovered, sleep apnea syndrome has left serious complications [8]. Assessing changes in facial anatomical features on a tilted skull X-ray is an accessible tool, useful in relation to the severity of obstructive sleep apnea syndrome [7].

2 Subjects and Methods

2.1 Subjects

Forty-nine patients (disease group 33, control group 16) who have been examined and treated at the Department of Internal Cardiology at Hue University of Medicine and Pharmacy have symptoms of loud snoring and/or evidence of suspected obstructive sleep apnea syndrome (OSAS).

2.2 Methods

A case–control study of 49 patients (case group: 33, control group: 16) with symptoms of loud snoring and/or evidence of suspected obstructive sleep apnea syndrome (OSAS) admitted to the Hue University of Medicine and Pharmacy's Hospital, from May 2018 to May 2019. Sleep apnea syndrome was measured with StarDust II, Germany. X-ray was done with Amrad ARM, USA. Data analysis used SPSS 20.0 software. Diagnosis of sleep apnea syndrome according to the American Sleep Association 2017 [9].

Some of the landmarks and measurements commonly used in X-ray film analysis [10]:

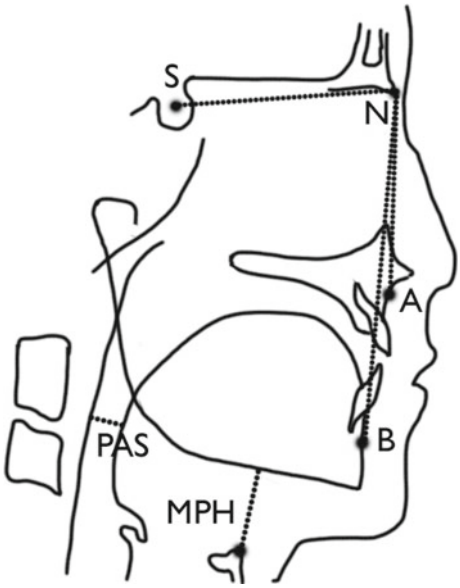

Fig. 1 The SNA, SNB angle and MPH, PAS distance

- Na point (Nasion): the first point on the frontonasal suture along the middle vertical line.
- S point (Sella Turcicca): the middle point of the hypophyseal fossa of alar bone.
- A point (Subspinale): the posterior point of the maxillary bone.
- B point (Submental): the posterior point of the mandibular bone.
- The angle and distance measurement:
- SNA angle: Angle created by straight lines connecting points S, Na and A.
- SNB angle: Angle formed by straight lines connecting point S, Na and B.
- ANB angle: Angle formed by the difference between the SNA angle and the SNB angle.
- MPH distance: The distance from the hyoid bone to the line parallel to the lower edge of the mandibular bone.
- PAS distance: Distance from the bottom of the tongue to the back of the throat (Fig. 1).

3 Results

3.1 Characteristics of the Study Group

Baseline characteristics of the study group

See Table 1.

Table 1 Baseline characteristics

Characteristics	OSAS (+) (n = 33)	OSAS (−) (n = 16)	Total (n = 49)	*p*
Male/female	19/14	9/7	28/21	> 0.05
Neck circumference (cm)	39.94 ± 3.63	37.50 ± 3.45	39.14 ± 3.72	< 0.05
Waist circumference (cm)	92.48 ± 8.5	82.44 ± 10.33	89.20 ± 10.21	< 0.05
BMI (kg/m^2)	23.97 ± 2.95	22.48 ± 2.79	23.42 ± 2.92	> 0.05
Age	71.85 ± 10.78	70.69 ± 13.10	71.47 ± 11.46	> 0.05

Neck circumference and waist circumference in the group OSAS (+) higher than in the group OSAS (−) with p < 0.05
No gender difference between the group OSAS (+) and the group OSAS (−)

Table 2 OR of the risk factors for OSAS

Risk factors	OR	95% CI	*p*
Obesity	7.5	0.874–64.37	0.039
Smoking	0.65	0.195–2.165	0.482
Hypertension	2.417	0.518–11.279	0.253
Diabetes	1.304	0.337–5.048	0.7
Dyslipidemia	1.056	0.316–3.522	0.93
Heart failure	0.774	0.16–3.739	0.749

Obese patients are 7.5 times more likely to have OSAS than those with normal weight with OR = 7.5 (95% confidence, 0.874–64.37, $p = 0.039$)

Odds ratio (OR) of the risk factors for OSAS

See Table 2.

Polysomnography parameters in the group OSAS (+) and group OSAS (−)

See Table 3.

Table 3 Polysomnography parameters

Parameters	OSAS (+) (n = 33)	OSAS (−) (n = 16)	Total	*p*
AHI (event/h)	22.73 ± 10.20	3.5 ± 0.632	16.45 ± 12.35	< 0.05
Maximum apnea duration (s)	24.12 ± 8.05	11.69 ± 3.4	20.06 ± 9.03	< 0.05
Minimum apnea duration (s)	14.64 ± 6.95	8.44 ± 2.68	12.61 ± 6.56	> 0.05
Average of apnea duration (s)	19.64 ± 6.48	9.94 ± 3.13	16.47 ± 7.22	< 0.05

AHI in the group OSAS (+) higher than in the group OSAS (−) $p < 0.05$
Maximum apnea duration and Minimum apnea duration in the OSAS (+) higher than in the group OSAS (−) $p < 0.05$

3.2 *Relationship Between OSAS and Lateral Cephalometric X-Ray Characteristics*

Lateral cephalometric X-ray characteristic and gender

See Table 4.

Lateral cephalometric X-ray characteristics and OSAS

See Table 5.

Lateral cephalometric X-ray characteristic and AHI

See Table 6.

The correlation between AHI, Epworth scale, BMI and SNA, SNB, ANB, MPH, PAS in the group OSAS (+)

See Table 7.

Table 4
Lateral cephalometric X-ray characteristic and gender

Parameters	Male (n = 19)	Female (n = 14)	*p*
SNA (°)	78.26 ± 3.53	77.64 ± 3.69	> 0.05
SNB (°)	71.26 ± 4.67	70.71 ± 3.95	> 0.05
ANB (°)	7.21 ± 1.72	7.14 ± 2.38	> 0.05
MPH (mm)	24.71 ± 4.12	20.39 ± 3.86	< 0.05
PAS (mm)	11.93 ± 2.05	13.42 ± 3.51	> 0.05

In the group OSAS (+), MPH in male higher than MPH in female $p < 0.05$

Table 5
Lateral cephalometric X-ray characteristics in the group OSAS (+) and group OSAS (−)

Parameters	OSAS (+) (n = 29)	OSAS (−) (n = 11)	*p*
SNA (°)	78 ± 3.55	81.69 ± 4.22	< 0.05
SNB (°)	71.03 ± 4.33	77.94 ± 4.28	< 0.05
ANB (°)	7.18 ± 1.99	4.06 ± 2.08	< 0.05
MPH (mm)	22.88 ± 4.5	16.53 ± 3.86	< 0.05
PAS (mm)	12.56 ± 2.82	16.87 ± 3.78	< 0.05

SNA, SNB, PAS in the group OSAS (+) lower than in the group OSAS (−), $p < 0.05$
ANB, MPH in the group OSAS (+) higher than in the group OSAS (−), $p < 0.05$

Table 6 Lateral cephalometric X-ray characteristic and AHI

Parameters	AHI (event/h)			*p*
	5–15 (n = 8)	16–30 (n = 16)	> 30 (n = 9)	
SNA (°)	78.75 ± 3.85	78.19 ± 3.66	77 ± 3.28	> 0.05
SNB (°)	73.25 ± 3.62	71.38 ± 4.47	68.44 ± 3.64	> 0.05
ANB (°)	5.5 ± 2.07	7.19 ± 1.68	8.67 ± 1.23	< 0.05
MPH (mm)	20.35 ± 3.35	23.06 ± 4.2	24.84 ± 5.23	> 0.05
PAS (mm)	13.43 ± 2.62	13.25 ± 3.17	10.57 ± 0.83	< 0.05

ANB and PAS had a significant difference between the AHI classification $p < 0.05$

Table 7 The correlation between AHI, Epworth scale, BMI and SNA, SNB, ANB, MPH, PAS in the group OSAS (+)

		AHI	Epworth	BMI	SNA	SNB	ANB	MPH	PAS
AHI	r	1.00	0.650	− 0.06	− 0.23	− 0.452	0.575	0.392	− 0.459
	p		*0.001*	0.75	0.19	*0.01*	*0.001*	*0.02*	*0.01*
Epworth	r	0.650	1.00	− 0.04	− 0.15	− 0.30	0.32	0.21	− 0.491
	p	0.00		0.80	0.41	0.09	0.07	0.24	*0.001*
BMI	r	− 0.06	− 0.04	1.00	− 0.26	− 0.11	− 0.15	0.12	0.10
	p	0.75	0.80		0.14	0.54	0.40	0.52	0.57
SNA	r	− 0.23	− 0.15	− 0.26	1.00	0.894	− 0.15	− 0.06	− 0.21
	p	0.19	0.41	0.14		*0.001*	0.40	0.76	0.23
SNB	r	− 0.452	− 0.30	− 0.11	0.894	1.00	− 0.527	− 0.19	− 0.10
	p	*0.01*	0.09	0.54	*0.001*		*0.001*	0.29	0.58
ANB	r	0.575	0.32	− 0.15	− 0.15	− 0.527	1.00	0.397	− 0.28
	p	*0.001*	0.07	0.40	0.40	*0.001*		*0.02*	0.12
MPH	r	0.392	0.21	0.12	− 0.06	− 0.19	0.397	1.00	− 0.545
	p	*0.02*	0.24	0.52	0.76	0.29	*0.02*		*0.001*
PAS	r	− 0.459	− 0.491	0.10	− 0.21	− 0.10	− 0.28	− 0.545	1.00
	p	*0.01*	*0.001*	0.57	0.23	0.58	0.12	*0.001*	

There was a correlation between AHI and Epworth, SNB, ANB, MPH, PAS $p < 0.05$

4 Discussion

4.1 Characteristics of Age, Gender, Neck Circumference

There was no statistically significant difference in age between the two groups OSAS (+) and OSAS (−). The proportion of patients > 60 years in the OSAS group (+) accounts for the majority with 87.9%.

This result was consistent with the study of Prasanthi Ratnakumar [11], the frequency of OSAS increases with age, the proportion of OSAS (+) in patients over 65 years was 3 times higher than patients 30–64 years of age. This was the result of age-related adipose tissue deposits, especially the oropharyngeal adipose tissue, along with structural weakness and elasticity of pharyngeal muscle tissue over time [11].

The incidence of obstructive sleep apnea syndrome was higher in men than in women. This might be due to differences in anatomical characteristics, upper respiratory tract function, hyperventilation response during sleep, and a high concentration of fat in the oropharynx area. In our research results, men predominated in both patient groups (Table 1).

4.2 Relationship Between OSAS and Lateral Cephalometric X-Ray Characteristics

Our research results show that there was a statistically significant difference: SNA, SNB, PAS values in OSAS group (+) were smaller than OSAS group (−), ANB and MPH values in OSAS group (+) were greater than in the OSAS group (−) with $p < 0.05$. The average value in OSAS (+) group of SNA, SNB, ANB, MPH, PAS were $78 \pm 3.55°$, $71.03 \pm 4.33°$, $7.18 \pm 1.99°$, 22.88 ± 4.5 mm, 12.56 ± 2.82 mm.

Neelapu et al. [12] concluded that the SNB angle measure in the OSAS group (+) was 1.45° lower than the control group. The study also showed that there was a lower downward movement of the basal bone compared to the anterior layer and a decrease in the post-pharyngeal air space in OSAS (+) patients compared to the control group [12].

The study by Ahsan et al. [13] concluded that the measurement of SNA angle, SNB angle of Japanese patients was smaller than European patients at the same severity level of OSAS with statistical significance with $p < 0.01$. This result suggests that there was a backward reduction in the lower jaw bone in Asians compared to Europeans in facial bone anatomy [13].

4.3 Correlation Between AHI and SNB and ANB Values

In our study, there was a negative correlation between AHI and SNB values in OSAS patients (+), $r = -0.45$, $p < 0.05$. The smaller the SNB angle, the worse the severity of the disease, suggesting that the patients with lower jaw bone backward relative to the skull base, the higher the severity of the disease. This result was different from that of Paulo et al. [2] in 102 patients diagnosed with OSAS determination, no correlation between SNB value and AHI ($p > 0.05$) [2].

Our study results on the correlation between AHI and ANB values showed a relatively positive correlation between AHI and ANB values in OSAS (+) patients with $r = 0.58$, $p < 0.05$. The larger the ANB angle, the greater the AHI, which suggests that the larger the ANB angle, the more severe the degree of pathology. Therefore, patients who are still young, are in the age of growth, if the lower jaw bone back, it is advisable to treat early, stimulate the lower jaw to develop first to reduce the risk of disease correlation between AHI and MPH and PAS values.

In our study, there was a moderate positive correlation between AHI and MPH values in OSAS (+) patients. The regression equation $y = 0.89\ x + 2.42$, $r = 0.39$ with $p < 0.05$. This result is quite similar to that of Paulo et al. (2014), there is a positive correlation between AHI and MPH values with $r = 0.251$, $p = 0.011$ [2].

Our results show a moderately inverse correlation between AHI and PAS values among OSAS (+) patients. The regression equation $y = -1.66x + 43.61$, $r = -0.46$ with $p < 0.05$. This result is different from that of Paulo et al. (2014), there is no correlation between AHI and PAS value with $p > 0.05$ [2].

5 Conclusion

The lateral head X-ray provides SNB, ANB, MPH, PAS values correlated with AHI in obstructive sleep apnea syndrome patients. Lateral cephalometric by X-ray (SNA, SNB, ANB, MPH, PAS) can be used to evaluate the severity of obstructive sleep apnea syndrome.

Conflicts of Interest The authors have no conflict of interest to declare.

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