Indian J Otolaryngol Head Neck Surg
(July–September 2010) 62(3) (Rhinology):304–309

Original Article

Craniofacial variables in subjects with and without habitual snoring: A cephalometric comparison

Soheila Nikakhlagh · Morteza Tahmasebi · Roshanak Badri · Nader Saki · Fakher Rahim · Shideh Badri

Abstract

Objective The aim of this case control study was to evaluate which cephalometric variables related to craniofacial morphology discriminate between snoring and non-snoring or any other respiratory disease subjects.

Materials and Methods Total 42(21 snoring and 21 non-snoring) cephalometric measurements were determined to study the craniofacial morphology. Non-snoring subjects were matched to snoring subjects by age, sex, and body mass index. Snoring was assessed using a sleep behavior questionnaire administered to the patients. The cephalometric radiographs of the study subjects were traced by a single investigator, and 1 angular measurement and 13 linear measurements of hard and soft tissues were recorded. The paired Student's t test was used to analyze the cephalometric data.

Results Vertical position of the hyoid (MP-H) was significantly longer ($P<0.05$) in snoring subjects (23.44±14.892mm) than non-snoring subjects (12.89±4.540mm). Anterior overbite and anterior overjet of snoring group ((4.81± 3.265 and 5.83±8.59) were significantly higher ($P<0.05$) than non-snoring group (0.67±1.441 and 0.54±1.138). No significant differences of the other [11] cephalometric variables were found within groups.

Conclusion Snoring subjects appear to present craniofacial factors that differ from those of non-snoring subjects, and we suggest obtaining cephalogram for diagnosis and following up of them.

Keywords: cephalometry · snoring · craniofacial morphology

Introduction

Snoring is a sound produced during sleep because of turbulence of air passing through partially obstructed airway. It is by far the most common clinical symptom of obstructive sleep apnea-hypopnea syndrome (OSAHS) [1-3]. The prevalence of snoring is appraised from 24% to 50% for adult males and from 14% to 30% for adult females, respectively [3-8]. It is estimated that as many as 70% of adult with OSAHS snored during childhood. Snoring can be aggravated by anatomical abnormality, alcohol consumption, smoking, and obesity [9-14]. It has been involved in hypertension, ischemic heart disease, cerebrovascular accident, increased morbidity and mortality from car and work-related accidents [15, 16]. Genetic and environmental factors influence snoring, and many studies support an anatomic origin. Palatal flutter has been reported to be the most important cause of snoring. In situations of airway obstruction, the blockage is often located at the level of the soft palate, but has been identified elsewhere within the entire extent of the pharynx.

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Lee SA et al, showed in their study that the risk of carotid atherosclerosis is remarkably augmented by heavy snoring, and this increase does not rely on other risk factors, such as obstructive sleep apnea severity [17]. One prospective study discerned that snoring has effect on developing chronic bronchitis [18].

Several studies have used cephalometrics to examine for anatomic differences in snoring and apneic subjects. The cephalometric datas exhibit both craniofacial and soft tissue arrangements. Lateral cephalogram is very easy to use and more readily available than magnetic resonance imaging (MRI) and computed tomography (CT) scanning methods [19-23]. Most frequently, cephalometric radiographs of adults with apnea were compared with radiographs of non-apneic adults. The tendency was for apneic adults to have an increased hyoid bone to mandibular plane distance, longer soft palates, a diminished sagittal cranial base dimension, and narrower posterior airways [24-25]. A japanese study found that children with apnea had an inferiorly positioned hyoid. An Italian study reported that habitually snoring children with apnea and adenotonsillar hypertrophy had increased craniomandibular intermaxillar. This skeletal architecture causes a decreasing the space available for the airway [26-27]. Moreover, increases in lower face height and maxillo-mandibular planes angle has been reported in the vertical plane [28]. Snoring may have excessive daytime sleepiness and daytime fatigue independent of the apnea-hypopnea frequency, age, obesity, and smoking [9]. In addition, snoring can be a serious problem, for both the patient and their partners. It can cause serious strain in a relationship and also be socially full of distress.

There are few case control studies that discussed about relationship between anatomic abnormalities and snoring, thus the present study was performed to gather additional information from snorers and to compare them with normal individuals matched for age, sex, and BMI.

Materials and Methods

Questionnaire A sleep-related behavior questionnaire including age, gender, height, weight, alcohol consumption, cigarette smoking, using medications such as sedatives, heavy dinner, neuromuscular and/or endocrine disorders, the time between eating dinner and sleeping, and the presence or absence of sleep symptoms in first - degree relatives was designed. There were some questions asking partners about subject's behavior during sleep. Alcohol consumption was estimated in units of alcohol per week, and about smoking if the subject reported it at least one cigarette a day during the previous month.

Subjects Total 42 cephalometric measurements were determined to study the craniofacial morphology. 21 subjects with the diagnosis of snoring referred to Ear Nose and Throat (ENT) clinic of Ahwaz Imam hospital created our Case group. 21 subjects without history of snoring or respiratory disorders, and were matched on a one-to-one basis for age, gender, BMI with each of the 21 snorers, formed our control group. The body mass index was calculated using Height and Weight (BMI=weight in kilograms divided by height in M^2). All participants gave written informed consent for participation, and local ethics committee approval was acquired for this study.

Radiography Standardized lateral cephalograms in the natural head position were taken for evaluation of craniofacial abnormalities of all subjects. When the subject meticulously placed in the cephalostat, was requested to breath in slowly, then exhale, in order to fix hyoid bone in a consistent position, and finally hold the latter position while the film was exposed. All radiographs were achieved at the same magnification by one radiographer proficient with the procedure. A standard lateral cephalogram in an adult contains many landmarks that serve as reference points and lines to measure and analyze the craniofacial skeleton. Analysis of a cephalogram involves comparing the plotted points and angles either with a set of normative data or with a patient's earlier cephalogram [21]. Using Cephalostat is the classic way for analysis of Caphalometric data [32]. In this study we have utilized a personal computer and Photoshop program to obtain subject's skeletal and dental variables. Regarding that each cephalogram is magnified 8-14%, we fixed a standard radio-opaque ruler on Nasion point for obtaining the cephalometric's landmarks from snores and non-snores participants and then we calculated landmarks on the basis of 10 mm of this ruler, after that we measured our cephalometric's data on each cephalogram. This way was less expensive and more valid and simple than using Cephalostat.

Cephalometric analysis A lateral projection of the skull was captured (utilizing an Oralix Ceph unit; Philips Dental Systems; Shelton, Conn) with a method of 68-72 kVp and 12 mA at 1 s exposure time. Film (Kodak T-mat G) was used in combination with rare earth screen. The lateral cephalograms were performed using a film focus distance of 1 meter with the subject's head secured. All cephalograms were recorded in natural head posture with the subject standing and using a mirror eye reference position. A standard lateral cephalogram in an adult contains many landmarks that serve as reference points and lines to measure and analyze the craniofacial skeleton (Fig. 1). Bony structure and soft tissue points were digitalized using the cephalometric software (Quick-Ceph; Orthodontic Processing; Chula Vista, Calif). Tracking the lateral cephalogram may start at the cranial base, which is approached by the pituitary fossa (or sella turcica) and the nasofrontal suture. The cranial base is used as one of two commonly used horizontal reference lines for the positions of the maxilla and mandible. Since patients acquire most of their growth around the cranial base at a proportionately early age, this line is estimated stable.

Statistical analysis Data were analyzed using the Statistical Package for the Social Science (SPSS-PC+ for windows, version 14; Chicago, IL). Means, standard deviations and ranges were calculated for each variable. Paired Student's t-test was used to test for equality of means between snoring and no snoring subjects. The probability value equal to or less than 0.05 was considered to be statistically significant. First-degree relative's correlation of cephalometric variables was assessed by multilevel analysis of variance.

Results

The ages of the snoring and control groups were well adjusted and equal (mean=41, standard deviation (SD) =13.63). The youngest subject was 18 years old whilst the oldest one was 64 years old. Among 21 snorers 42.9% (n= 9) were females and 57.1% (n= 12) were males. In control group there were 42.9 % (n= 9) females and 57.1% (n=12) males). BMI for the snoring and non-snoring subjects were also well matched (mean=26.2 and SD= ±2.93). The lowest BMI was 20 and the highest was 33 (Table 1). In this study, normal time between eating dinner and sleeping was considered over and/or equal to three hours. This time was almost below three hours in snorers (95.2%), and it was statistically significant (P<0.05). All of the other demographic variables of the snoring and non-snoring subjects are presented in Table 2.

Table 1 Demographic measures for Each Group: Mean (SD) and Range

Women	Men	Measure
Age, yr	40.08(16.00) 18-64	42.22(10.48) 22-52
BMI, kg/m²	25.76(2.7) 20-30	26.79(3.23) 23-30

Table 2 Quantitative variables in subjects with and without snoring

Variable	control Percent (n=21)		snorer Percent (n=21)		Paired Samples Test
	Within	Without	Within	Without	
Sedative Drugs	50%	50%	50%	50%	1.000
Cigarette	50%	50%	50%	50%	1.000
Alcohol	9.5%	90.5%	19%	81%	0.428
Neuromuscular D	38.1%	61.9%	23.8%	76.2%	0.329
Endocrine D.	14.3%	85.7%	9.5%	90.5%	0.666
Heavy Dinner	4.8%	95.2%	66.7%	33.3%	0.000***
Time of Sleep	0%	100%	95.2%	4.8%	0.000***
Familiar correlation	0%	100%	95.2%	4.8%	0.000***

Significance: *P<0.05, **P<0.01, ***P<0.0001

Table 3 Comparison between facial dimensions for control, snoring patients: skeletal and dental measurements.

Variable	control mean (SD) (n=21)	control range	snorer mean (SD) (n=21)	snorer range	Paired Samples Test
PNS-P (mm)	38.47 (4.708)	27-52	41.66 (10.159)	29-66	0.000***
MP-H (mm)	12.89 (4.540)	4-24	23.44 (14.892)	4-57	0.005**
PAS (mm)	10.06 (3.000)	5-17	10.91 (3.501)	4-17	0.385
ANB (º)	3.81 (1.167)	3-7	5.05 (2.617)	2-9	0.080
SNA (º)	84.86 (5.180)	78-97	83.33 (3.526)	77-89	0.326
SNB (º)	80.57 (4.728)	73-90	78.86 (4.840)	72-90	0.338
SN-MP (º)	28.33 (6.159)	17-37	31.33 (8.064)	14-46	0.217
N-ANS (mm)	47.37 (6.154)	30-55	54.45 (13.435)	38-89	0.060
ANS-Gn (mm)	66.20 (7.711)	39-76	73.73 (20.726)	56-132	0.125
Maxillary incisor inclination (º)	16.52 (5.636)	6-28	15.81 (9.443)	7-43	0.756
Over-jet (mm)	0.54 (1.138)	0-3	5.83 (8.590)	0-41	0.012*
Over-bite (mm)	0.67 (1.441)	0-4	4.81 (3.265)	0-10	0.000***
Superior airway space (mm)	37.00 (6.108)	20-52	38.00 (10.751)	22-65	0.734
Soft plate width (mm)	9.24 (2.168)	6-15	10.63 (3.871)	4-19	0.092

Significance:*P<0.05, **P<0.01, ***P<0.0001.

Comparison of means and SDs for the 14 cephalometric Variables between the snoring and non-snoring subjects is exhibited in Table 3. Few statistically significant differences were discovered between the cephalometric measurements for the snoring and control groups. Vertical position of the hyoid (MP-H) was significantly longer in snoring subjects (23.44±14.892mm) than non-snoring subjects (12.89±4.540mm; P <0.05). Among snoring group, anterior overbite which is defined as distance between the tips of the upper and lower incisors measured perpendicular to the occlusal plane, was significantly greater (4.81± 3.265) than non-snoring group (0.67±1.441 ;P<0.05). Anterior over-jet, distance between the tips of the upper and lower incisors measured along the occlusal plane, was also significantly different in snoring subjects (5.83±8.59) versus control group (0.54±1.138; P<0.05). No significant differences of other cephalometric variables were found within groups, as illustrated in Table 3.

Discussion

Snoring can be a serious problem, for both the patient and their bed partner. It can cause serious strain in a relationship and also be socially troublesome. Many of these patients will present to the otolaryngologist for treatment of this problem. It is therefore prudent for the otolaryngologist to be aware of the diagnosis options that are available. Snoring has been linked to palatal flutter and vibration of upper airway tissues as a result of turbulent air flow. There have been many attempts to correct this process, including pharmacological agents, mechanical devices, and surgical interventions [30-31]. For surgical interventions, it is needed to perform thorough diagnosis via a simple and valid diagnostic test. This study demonstrated cephalometric values differences of adult subjects with and without habitual snoring, considering variables explicitly related to this problem.

The methods for identifying the obstructive sites of obstructive sleep apnea syndrome (OSAS) are physical examination, cephalometry, fiberoptic nasopharyngoscopy, computed tomography (CT), cine CT, dynamic MRI and multipoint pressure measurements of the pharynx and esophagus [33]. It is an advantage of cephalometry that the cost is relatively low and the equipment is widely available. The disadvantages of the method are that it allows only two-dimensional static images and studies must be performed during wakefulness. It is an advantage of the MRI method that it is noninvasive. Radiation is avoided and thus far no harmful effects of MRI have been reported. It is a disadvantage of the MRI technique that long data acquisition time is required, possibly resulting in motion artifacts due to breathing and swallowing. It is not possible to document sleep stages because the strong magnetic field prevents the use of electroencephalogram, electro-occulogram, and electromyogram electrodes. Very obese patients cannot be studied because of the size limitations of most MRI scanners. MRI cannot be performed in patients with pacemakers, claustrophobia and anxiety. Loud noise during imaging and the unfamiliar and uncomfortable surroundings are some of the problems which may influence the subject's sleep during MRI. The MRI method is furthermore restricted by its ability to document only a limited number of events. The cost of MRI studies is relatively high [33].

One prospective study analyzed the upright lateral cephalometric radiographs of 46 male with simple snoring and 45 subjects with proven obstructive sleep apnoea (OSA), and they found that whilst the dento-skeletal patterns of snores resembled those of subjects with OSA, some differences in soft tissue and hyoid orientation were obvious, but there was not a identifiable transition in stages of airway's size and its surrounding structures from snoring to OSA subjects [9]. In another six-month period study, 157 OSAS patients seen consecutively in clinic had standardized cephalometric roentgenograms, and cephalometric landmarks were statistically analyzed. Long mandibular plane to hyoid bone (MP-H) distance and width of the posterior airway space (PAS) (space behind the base of the tongue) were statistically significant, thus they concluded that standardized cephalometric roentgenograms can be useful in determining the appropriate treatment for OSAS patients [34].

We chose 14 cephalometric variables based on their importance as reported in the literature [24]. In comparing the means of these measurements, three variables exhibited statistical significance. MP-H distance was significantly longer in snoring group. The normative means and SDs for MP- H distance in normal healthy adult with no sleep problems is 19.5 (7.1) mm in men and 15.15.8 (4.1) mm in women [32]. We showed that the snorers, regardless of gender, had a larger vertical distance 23.4 (14.9) mm than the normal values. The normal means and SDs for anterior overbite distance in adults is 2.5 (2.2) mm for men and 1.7 (1.6) mm for women [32]. In our study this variable was significantly greater in snoring group (4.81± 3.27 mm) . Anterior overjet distance in normal male adult is 3.4 (1.5) mm and for female adult 3.5 (1.1) mm [32]. We demonstrated that it was also significantly greater in snoring adults (5.83±8.59 mm). In a study conducted by Kulins et al [35], on 12 cephalometric measurements, three variables (H-MP, N-PAS, and S-PAS) showed statistical significant. Our study also showed three variables (H-MP, Over-jet, and Over-bite) with statistical significant results. This finding may help to understand there is difference between populations among cephalometric variables.

In one study, there was a strong association between habitual snoring and family history of snoring among grandparents, parents, siblings, and children. Odds ratios were from 2.4 to 4.2, and all associations were significant

($p<0.05$). Among habitual snorers, two genetic markers and age were the only factors that separated men who had their own bedroom due to snoring from others. The results of this study indicate that snoring; to some extent is hereditary [32]. We found overall strong relationship between habitual snoring and family history of snoring ($P<0.001$).

In conclusion, the value of the cephalometric radiograph in the study of the head and neck and associated pathologies is unsurpassed. It is widely accessible and relatively inexpensive in comparison to alternative imaging procedures. Information obtained from cephalometric assessment has been invaluable in a great number of studies in airway pathology; including snoring. Our data indicate that there are craniofacial differences between snoring and non-snoring adults. Longitudinal studies of habitually snoring adult without apnea could demonstrate whether craniofacial modification is an effect of airway obstruction or genetically determined, and whether these subjects do eventually develop OSA in the ensuing years.

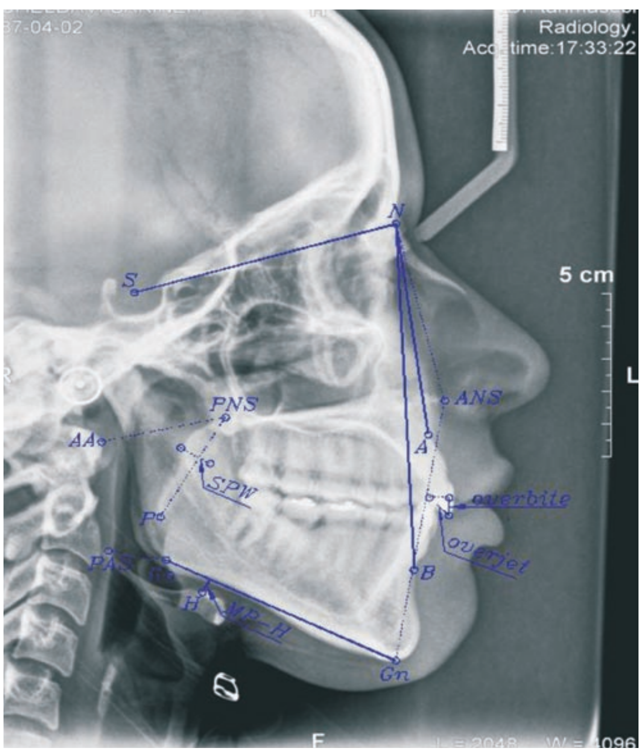

Fig. 1 Graphic description, definitions, and measures of cephalometric parameters as listed in text : S=sella ;N= nasion; H=hyoid bone; A=A point; PNS=posterior nasal spine; ANS=anterior nasal spine; PNS-P=soft palate length; MP-H=hyoid to mandibular plane distance; PAS=posterior airway space (linear distance [mm] between a point on the base of the tongue and another point on the posterior pharyngeal wall both determined by an extension of a line from point B through Go); ANB=A point to nasion to B point angle; SNA=sella to nasion to A point angle; SNB=sella to nasion to B point angle; SN-MP=sella to nasion to Go-Gn angle; N-ANS=nasion to ANS (mm); ANS-GN=anterior nasal spine to Gn (mm); maxillary incisor inclination=an acute angle formed by measuring the midline ofthe upper incisor to the line NA to determine the relative angulation of the incisor to the maxilla; mandibular incisor inclination=an acute angle formed by measuring the midline of the upper incisor to the line NB to determine the relative angulation of the incisor to the mandible; anterior overbite=distance between the incisor tips of the upper and lower incisors measured perpendicular to the occlusal plane; anterior overjet=distance between the tips of the upper and lower incisors measured along the occlusal plane; PNS (mm); soft palate width=soft palate thickness (mm) in midsagittal plane.

Acknowledgments

The authors would like to thank all those colleagues who volunteered to be radiographed to perform the control group for this study. Thanks are also due to Dr Azadi for their assistance with this project.

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