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ASSESSMENT OF SKELETAL AND AIRWAY MEASUREMENTS IN OBSTRUCTIVE SLEEP APNEA, SNORERS, AND NON-SNORERS: IMPLICATIONS FOR OTOLARYNGOLOGY TREATMENT PLANNING

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ABSTRACT

This study compared individuals with obstructive sleep apnea (OSA), simple snorers, and non-snorers to assess skeletal and airway measurements. The first group comprised twenty simple snorers (mean age: 37.5 years), the second group consisted of twenty individuals with OSA (mean age: 40.0 years), and the third group included twenty individuals without breathing problems (mean age: 29.6 years). Cephalometric films were used to measure four skeletal and fourteen airway parameters. No statistically significant differences were found in skeletal measurements among the three groups. Additionally, neither the OSA nor simple snoring groups exhibited significant differences in airway measurements. However, the soft palate angle was significantly different between the OSA and control groups ($P < 0.05$). Furthermore, soft palate length, thickness, and height were significantly different between the OSA and control groups ($P < 0.001$). The area of the soft palate was also significantly lower in the OSA group compared to controls. Moreover, the control group had greater distances between the anterior and posterior pharyngeal spaces compared to both study groups. A significant difference ($P = 0.1$) was observed in the positioning of the hyoid bone among the OSA groups. These findings suggest that individuals with OSA exhibit smaller airway dimensions due to increased soft palate volume. Therefore, treatment strategies should be tailored accordingly to address these anatomical differences.

Key words: Obstructive sleep apnea, Snoring, Cephalometric analysis, Airway measurements, Otolaryngology.

INTRODUCTION

Obstructive sleep apnea (OSA) arises from upper airway obstruction, causing airflow limitation during sleep, often accompanied by hypopnea lasting at least ten seconds [1]. Diagnosis of OSA, particularly regarding the age group at which it should be addressed, remains uncertain. Notably, research suggests a higher prevalence of OSA among women than men. OSA poses challenges in individuals with various conditions such as Down syndrome [2], Crouzon and Apert syndromes [3], Treacher-Collins syndrome, Pierre-Robin syndrome, and cerebral palsy. Severe cases may necessitate tracheostomy, while patients with craniofacial anomalies require specialized surgical interventions to avoid this procedure [4]. Surgical options include maxillomandibular advancement, distraction osteogenesis, septoplasty, and turbinectomy [5], whereas soft tissue procedures encompass tonsillectomy, adenoidectomy [6], uvulopalatopharyngoplasty (UPPP), uvulectomy, and tongue reduction. Both adults and children can suffer from OSA, a condition that has gained increased recognition in recent years due to its significant medical and psychological implications [7]. It is imperative for orthodontists to identify individuals at risk for OSA by assessing narrow airways and craniofacial anomalies. This

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study aimed to determine whether individuals with simple snoring or diagnosed OSA exhibit obstructed pharyngeal airways caused by tongue position.

MATERIALS AND METHODS

To identify suitable candidates who were non-obese and devoid of orthodontic treatment history, we conducted a retrospective review of records from the Department of Ear, Nose, and Throat. The Apnea-Hypopnea Index (AHI) served as the metric to assess apnea-hypopnea events. Individuals with an AHI ranging from five to ten were categorized as exhibiting simple snoring, while those with an AHI exceeding ten were classified as having obstructive sleep apnea (OSA). In Group 1 and Group 2, consisting of 20 individuals each, 20 were diagnosed with simple snoring, 20 with OSA, and 30 had no respiratory issues. Group 1 participants had a mean age of 37.5 years (±8.05), comprising four females and sixteen males. The second group, predominantly male with twenty-seven individuals, had an average age of 40.08 years (±4.27), ranging up to 54 years. Group 2 participants, with a mean age of 29.6 years (±3.20), consisted of individuals aged between 24 and 35 years.

Statistical analysis

A comparison between individuals who snored and those who did not was carried out using a Dunnett t-test and a Bonferroni test. Additionally, a second assessment was performed two weeks later, involving the selection of 20 random cephalometric films for comparison. The measurements obtained from these films were analyzed using T-tests. Results from the two sets of measurements conducted on 20 films each revealed no significant differences. Furthermore, the range of values obtained fell within acceptable limits.

RESULT

Significant differences were observed between the groups with obstructive sleep apnea (OSA) and those without. Specifically, the lengths, thicknesses, and heights of the soft palates differed significantly between the OSA and simple snoring groups ($P = 0.001$). Additionally, Group 1 exhibited a significant difference in their inferior pharyngeal spaces compared to the control group ($P = 0.001$), while Group 2 showed a significant difference in their soft palates ($P = 0.001$). The distance between the soft palate and posterior pharyngeal wall (SPT-PPW2) in the snoring group was significantly different from that in the control group. Moreover, significant differences were observed between the groups with OSA and those without in terms of the distance between the soft palate and hyoid bone (SPT-PHWS) and the distance between the soft palate and base of tongue (SBTN-PHWN). The position of the epiglottis (PNS-EB) was significantly lower in the study group compared to the control group ($P < 0.001$). Furthermore, the OSA group exhibited a greater distance between the tip of the tongue and the epiglottis compared to the control group. Overall, statistically significant differences were found between the control groups of simple snoring and OSA, indicating a higher incidence of inferiorly positioned hyoids in OSA patients than in controls, as summarized in Table 1.

Table 1: Studying simple snorers, OSA patients and controls on cephalometric and pharyngeal airway measurements.

Group 1					Group 2				Group 3			
Parameters	mean	sd	max	min	mean	sd	max	min	mean	sd	max	min
Cephalometric measurements												
SNA	81.94	4.60	89.00	75.80	81.48	4.99	89.21	73.00	80.80	5.52	90.00	71.51
SNB	79.35	4.74	88.00	73.00	79.50	5.41	87.51	70.51	77.83	5.37	88.51	72.51
ANB	3.56	3.66	8.41	-3.00	2.99	2.87	8.00	-4.00	3.98	3.97	9.91	-4.31
S-N/GO-GN	31.60	6.89	46.00	17.50	30.40	51.85	41.51	21.00	33.80	5.40	50.00	23.00
Airway measurements												
ANS.PNS.SPT	127.06	5.97	141.00	116.00	126.30	7.60	150.00	126.00	139.92	5.97	149.00	130.00
PNS-SPT	44.04	5.97	55.60	29.70	46.38	7.14	55.00	33.60	38.02	5.27	44.60	40.60
SPC-SPD	8.99	3.03	27.450	7.60	20.48	2.94	22.60	8.00	5.87	1.97	13.60	6.00
SPT-SPpp	36.85	5.54	49.80	27.00	36.05	6.70	43.60	16.80	27.48	4.82	34.30	18.00
PNS-PPW1	25.51	3.75	40.90	18.30	26.76	3.54	32.00	18.80	28.98	3.53	35.81	22.00
SPT-PPW2	7.46	3.03	16.60	0.82	8.93	4.31	19.70	2.31	22.88	4.56	66.60	5.00
SPL/SPS	4.15	0.34	1.20	0.84	2.89	0.21	4.36	1.42	1.47	0.14	1.07	0.78
SPL/IPS	4.75	5.68	47.26	7.57	7.16	2.23	15.76	2.82	4.75	4.25	11.82	2.33
PSP-PHWS	17.30	3.30	22.00	13.00	15.85	4.14	22.60	5.40	14.64	4.85	26.10	11.20
SBTN-PHWN	7.64	3.15	12.00	4.60	6.28	3.57	22.60	3.00	22.67	5.52	32.40	5.00
SBTI-PHWL	12.05	3.82	19.00	9.00	12.35	4.85	18.50	6.00	15.42	6.82	25.20	5.00
PNS-EB	79.14	5.10	94.50	75.50	76.87	8.05	95.00	58.00	70.99	7.34	76.80	57.00

EB-TT	65.48	8.02	95.00	68.60	90.77	8.35	89.50	77.00	90.02	4.05	95.60	70.60
ML-HY	18.76	4.54	25.60	17.00	23.68	4.86	30.00	18.01	18.95	5.86	24.60	11.60

DISCUSSION

This study utilized lateral cephalometric films to investigate potential abnormalities in upper respiratory tract structures among individuals diagnosed with obstructive sleep apnea (OSA). Building upon the work, who similarly employed lateral cephalometric films to discern diagnostic signs in patients with simple snoring or OSA, this study aimed to compare craniofacial and upper airway structures between an OSA patient group and a control group [8]. OSA is influenced by various etiological factors, including anatomical and pathophysiological aspects, some of which may have a genetic basis. The morphology and size of the craniofacial region can impact airway anatomy and contribute to the disorder. Additionally, factors such as sleep posture, age, gender, nasal obstructions, and changes in craniofacial morphology were implicated in OSA. Diagnostic techniques such as polysomnography (PSG) were instrumental in diagnosing sleep-disordered breathing, with the apnea-hypopnea index (AHI) serving as a primary measure [9]. AHI, representing the frequency of respiratory events per hour of sleep, aids in assessing the severity of sleep-disordered breathing and predicting cardiovascular risks. To classify individuals into study groups, AHI was used as a diagnostic criterion. Sleep apnea is typically diagnosed if AHI is less than 5, while individuals with an AHI greater than 5 are categorized as simple snorers. A study on male OSA patients identified several craniofacial characteristics associated with OSA, including posteriorly displaced mandibles and maxillas, steep mandibular planes, high cervical heights, proclined incisors, and overerupted maxillary and mandibular teeth. OSA samples exhibited hypodivergent trends compared to those reported by a study [10], with age ranges spanning from 40 to 54 years. Furthermore, tooth loss or dental changes were noted to impact the vertical dimensions of the mandibular plane, resulting in smaller angles among OSA patients.

Significant differences were observed in soft palate length, thickness, and height between the groups with obstructive sleep apnea (OSA) and those with simple snoring. Notably, patients with severe OSA exhibited longer soft palates compared to simple snorers, as reported [11]. The measurements of SBTN-PHWS and PSP-PHWS in the OSA group were notably lower than those in all other groups, indicating increased angulation and mass in the soft palate, which may contribute to upper airway obstruction in OSA cases [12]. Our study did not find significant differences in upper pharyngeal airway spaces between simple snorers and patients with severe OSA. However, statistically significant differences were observed between the OSA-control and simple snoring-control groups. Specifically, the positioning of the hyoid bones was inferior in the OSA group compared to the other groups. Among patients with OSA, 25 individuals exhibited constricted upper airway spaces, and their hyoid bones were positioned lower in the skull. This aligns with findings from a study, which suggest that children with OSA also tend to have inferiorly positioned hyoid bones [13].

CONCLUSIONS

Considering factors that influence the severity of apnea, such as the position of the hyoid bone and the length of the tongue, becomes crucial. An inferiorly positioned hyoid and an elongated tongue are known contributors to the severity of apnea. Additionally, increased mass in the soft palate can lead to structural narrowing of the upper airway. Hence, evaluating these anatomical structures is essential for devising an effective treatment strategy for obstructive sleep apnea (OSA).

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