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Comparision of CBCT & Lateral Cephalogram in Potentially Obstructive Sleep Apnea Patients: A Comparative Study

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ABSTRACT

Obstructive Sleep Apnea (OSA) has been considered a major health complication as the underlying medical condition poses independent risk factors such as hypertension, Cardio Vascular Disease (CVD), and diabetes thus resulting in an increased multi-morbidity and mortality rate among individuals. The emergence of diagnostic tools and techniques for exploring OSA has become a primary requisite for the healthcare community to focus on meticulously.

Aim of the study: To determine the morphology of the soft palate among potential OSA patients via performing CBCT and lateral cephalogram studies Objective of the study: To perform a comparative analysis between CBCT and Lateral Cephalogram and to determine the reliability of the radiographic techniques in measuring the upper airway.

Methodology: 30 individuals diagnosed with potential OSA were subjected to Upper Airway measurements through radiographic imaging. Two Examiners carried the study out using standardized diagnostic tools such as the Sirona Dental Systems Lateral cephalogram machine and CS 3D CBCT machine. The variables involved in UA measurements for both radiographic studies involve NPA, VPA, OPA, HPA, SPT and SPL. The collected data were analyzed qualitatively and quantitatively and necessary statistical analysis was carried out using SPSS version 24.

Results: There is no significant difference observed by the examiners on UA measurements from CBCT and lateral cephalogram, except for a few parameters like VPA and OPA.

Conclusion: The study indicates that both CBCT and Lateral cephalogram are effective diagnostic tools for morphological characterization of UA among those individuals who are highly susceptible to exhibiting OSA.

Key words: Obstructive Sleep apnea, Radiographic examination, CBCT, Lateral Cephalogram, Upper Airway

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INTRODUCTION

There are wide arrays of medical disorders, of which sleep-related disorders or in certain cases, referred to, as sleep-disordered breathing have become a major concern. It is characterized by abnormal respiration experienced by patients during their sleep and can be grouped into four categories: Obstructive Sleep Apnea (OSA), Central sleep apnea or sleep-related hypoventilation, and Sleep-related hypoxemia disorder. OSA is the most common disorder commonly found in family medicine, setting them to be increasingly recognized due to the growing epidemic of obesity. OSA prevalence in India was estimated to be over 7.5% of the entire population [1, 2].

One typical feature observed in OSA patients is the snoring habit, which has become a major concern that affects the significant population, as the estimates suggested that adult males and females ranged between 3-7% and 2-5%, respectively [3]. This eventually results in a reduction/pause of breath that might lead to waking up and a loud snort or gasping sound. Overall estimates have suggested that ~80-90% of the total population meeting the criteria appeared to be still undiagnosed [4]. This disorder appears to have a deleterious impact with long-term consequences including symptoms like cardiovascular morbidity, neurocognitive impairment and increased overall mortality [5, 6].

The clinician undertakes a diagnosis primarily based on symptoms associated with the patient and medical history. It can be determined whether the patient is suffering from OSA in the first place and this assessment could be classified as subjective or objective [7, 8]. Nevertheless, in view of taking medical care to a low socioeconomic population, affordability gains primary importance. Regularly, CBCT and Lateral cephalogram are utilized to arrive at a clinical diagnosis. Several other techniques used for evaluating the adenoid tissues and their impact on obstruction of airways, such as nasal endoscopy, lateral cephalogram, CT scan, MRI and acoustic rhinometry, the utilization of lateral cephalogram has been observed to be cost-effective and reproducible and easy to interpret and assess the of adenoidal tissue, based on its size [9- 15].

Since lateral cephalogram is a simple and well-standardized imaging approach that comprises radiograph along with the head and neck region with specific emphasis over the bony as well as soft-tissue structures, if it is comparable to other expensive techniques, it can be used in their place, thereby making diagnosis affordable to more people. This study was performed to compare CBCT and Lateral Cephalogram and to determine the reliability of the radiographic techniques in measuring the upper airway [16-20].

MATERIALS AND METHODS

Institutional the human ethics committee approved this study. It was conducted in Sree Balaji Dental College and Hospital, on outpatients reporting to the Department of Oral Medicine. This study included 30 patients [21].

Inclusion criteria

18 and 65 years of age

Symptoms of snoring

Higher frequency of daytime sleepiness

BMI>30

Hypertension

The patient and their relatives completed the Berlin Questionnaire. Patients with a complaint of sleep a respiratory disorder associated with signs and symptoms such as snoring, daytime sleepiness, witnessed apnea, choking during sleep and hypertension, and 2 or 3 positive scores from the three categories of Berlin questionnaires are included [22].

Exclusion Criteria

The patient with morbid obesity (BMI>40), craniofacial abnormalities (e.g., cleft lip or palate), gross ear-nose-throat problems, larynx or pharynx paralysis or upper airway surgery, history of cerebrovascular, kidney, lung disease or cancer, and temporomandibular disorder were excluded from the study [23].

In the case of lateral cephalogram, the radiographs were obtained with CS 8000(Kodak) 60 kv, 2-14 mA 0.1-32 s, and the patients stood with the Frankfort horizontal line parallel to the floor with their teeth in maximum intercuspation, with lips relaxed, head in natural head position and, dorsum of the tongue as well as a pharyngeal airway. The same investigator traced all the radiographs thrice [24].

CBCT images were obtained by CARESTREAM (Kodak) 9000 3D operating at 90 kV 10 mA 10.80 s 18×21 mm FOV and 0.2 slice thickness. To observe the airway in the same CBCT data set in the 18×21 mm FOV, the patient was asked to stand with a Frankfort horizontal line parallel to the floor with their teeth in maximum intercuspal position without using a bite block [25]. Any CBCT scans with artefacts distorting the airway borders have been excluded from this study. Both CBCT and lateral cephalogram were performed on each patient, and they were employed for radiographic examination via two examiners at different variables namely: NPA, VPA, OPA, HPA, SPL, and SPT (The radiographic variables and their definitions shown in Table 1. Statistical analysis was done using IBM SPSS (Version 24.0) statistical software. The scores were compared with paired t-test and inter-observer agreement was analyzed using Pearson's r correlation analysis and Kendal's tau, $P < 0.05$ was considered significant [26].

RESULTS

The mean values for each of the variables by both examiners in CBCT were 22.74 for NPA; 8.79 for VPA; 11.00 for OPA; 7.28 for HPA; 35.13 for SPL; 9.80 for SPT by Examiner I; and 22.78 for NPA; 8.81 for VPA;10.95for OPA; 7.29 for HPA; 35.10 for SPL; 9.8 for SPT by Examiner II. The mean values for each of the variables by

Table 1: Radiographic variables and their definitions.

Variable	Name	Definition
NPA	Nasopharyngeal airway space	Distance from the PNS to the posterior pharyngeal wall along an extension of the basal plane
VPA	Velopharyngeal airway space	Distance from U to the posterior pharyngeal wall
OPA	Oropharyngeal airway space	Distance 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
HPA	Hypopharyngeal airway space	Distance from V to the posterior pharyngeal wall
SPT	Soft palate thickness	The maximal thickness of the soft palate measured perpendicular to PNS to U
SPL	Soft palate length	Distance from PNS to U

both examiners in the Lateral Cephalogram were 22.66 for NPA; 8.85 for VPA; 11.47 for OPA; 7.36 for HPA; 35.22 for SPL, 9.72 for SPT by Examiner I and 22.64 for NPA; 8.86 for VPA; 11.12 for OPA; 7.20 for HPA; 35.37 for SPL; 9.64 for SPT by Examiner II. Pearson's r analysis clearly shows that there is an agreement difference between the observers when they scored the CBCT and lateral cephalogram [27].

There were no significant differences between the observers scoring CBCT and lateral cephalogram. (The interrater agreement was good.) Comparing the agreement between CBCT and Lateral cephalogram for every parameter measured showed no significant difference, except in VPA and OPA. Table 1 provide a detailed comparative analysis using a paired-sample t-test showing that mean NPA values remain the same in the two radiographic examinations, viz, CBCT and lateral cephalogram since the P-value is >0.05.

DISCUSSION

The diagnosis of OSA in upper airway measurements is one of the prime factors that facilitate the exploration of unexplored enigmas regarding OSA pathology. The structural narrowing in the upper airway along with a combination of the inadequate compensation for a decrease in upper airway neuromuscular tone is an important factor in the pathogenesis of Obstructive Sleep Apnea Syndrome (OSAS). Lateral Cephalogram tends to suffer certain limitations as the inherent errors could be witnessed in the 2D representation of the 3D structures with regards to its distorted structure, variations in its magnifications, and the superimpositions in its bilateral craniofacial structure. Additionally, it has also been reported that it exhibits lower reproducibility due to difficulty in identifying landmarks. One of the major drawbacks of lateral cephalograms is their lack of information on the cross-sectional area and volume.

In the current study, the mean variables of the upper airway measurements when compared by both CBCT and Lateral Cephalogram appeared to exhibit similar results without showing any significant differences, therefore, it can be considered that both radiographic techniques exhibit good reproducibility of upper airway measurements. Radiographs have been taken from potential OSA patients so it can be suggested that radiographic measurements of the upper airway could act as an effective predictor for determining the risk factors of OSA susceptibility. Besides, both the measurements about the radiographic landmarks of the key variables were found to showcase similar measurements for both CBCT as well as Lateral Cephalogram. This indicates that a Lateral Cephalogram could serve as a potent, reliable, and cost-effective diagnostic procedure, which could be utilized for the diagnosis of OSA.

There are conflicting results derived from the radiographic analysis of the available literature sources, there exists a significant difference among OSA patients in its sagittal and vertical planes. This particular characteristic exhibited among OSA patients from several studies indicated that there are no ideal or standardized tools for analyzing the skeletal differences as there is much debate on this subject, especially on the mandibular position as well as the positioning of the hyoid bone and the soft palate's length. From the currently available literature on the diagnosis of obstructive sleep apnea, it is known that there is no single universal tool that assesses the risk of bias for different studies.

Table 2: Interrater agreement among CBCT and lateral cephalogram.

Variables	CBCT	LATERALCEPH	CBCT	LATERALCEPH
	Pearson r		Kendall Tau	
NPA	0.994**	0.995**	0.947**	0.945**
VPA	0.988**	0.993**	0.931**	0.937**
OPA	0.995**	0.991**	0.961**	0.942**
HPA	0.988**	0.934**	0.918**	0.846**
SPL	0.997**	0.996**	0.949**	0.934**
SPT	0.983**	0.980**	0.873**	0.873**

NOTE; ** indicates P value is less than 0.001 (i.e., P < 0.001)

Table 3: Inter-technique agreement among CBCT and lateral cephalogram.

Variables	PEARSON'S 'r'		KENDALL'S TAU	
	r	P Value	Tau	P Value
NPA	-0.121	0.524	-0.026	0.844
VPA	0.498	0.005	0.353	0.007
OPA	0.45	0.013	0.351	0.007
HPA	0.17	0.369	0.101	0.442
SPL	-0.071	0.708	0.051	0.695
SPT	-0.024	0.9	0.016	0.9

The assessment by t-test has shown that on average there was no difference between the scores given by observers, scoring or evaluating the Lateral cephalogram and CBCT scans. On deeper examination using Pearson's correlation, every parameter has been properly rated in both cephalogram and CBCT (Table 2).

However, the question to be answered here is whether what is seen in CBCT tallies with lateral cephalogram or otherwise. This is answered by Pearson's r and Kendall's T value calculated assuming all four values are from the same technique (Table 3). VPA and OPA are differently rated between lateral cephalogram and CBCT. Other parameters are statistically similar. Hence, while using lateral cephalograms in place of CBCT, when doubts arise about these parameters, the clinician should not hesitate to make CBCT arrive at a proper conclusion [28].

CONCLUSION

Obstructive sleep apnea is one such complication that has raised concerns in recent times. With the advent of radiographic screening, it has become an effective tool for understanding the morphology and anatomical features of upper airway space. Hence, determining individuals who are exhibiting OSAS is being studied intensively.

Lateral Cephalogram and CBCT are regarded as effective diagnostic tools that facilitate the understanding of upper airway anatomy among normal individuals and those with OSAS. This study involved a comparative analysis of CBCT and lateral cephalogram among potential OSA individuals. From this study, we inferred that both radiographic examinations showed no significant difference in the measurements of the mean variable, thus clearly indicating that both tools are suitable and effective for the diagnosis of potential OSA patients. Since both the radiographic assessments showed a similar result, we could conclude that for the initial screening of individuals with OSA lateral cephalogram, it can be used as a diagnostic radiograph, which is more cost-effective, and easily available when compared to CBCT. However, care must be taken when interpreting OPA and VPA.

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