Section: Dentistry

Original Research Article

EVALUATION OF THE RETROPHARYNGEAL SPACE WITH THE HELP OF CBCT AND ITS EFFECT ON SPIROMETRIC FUNCTIONAL VALUES BEFORE AND AFTER COMPLETE DENTURE REHABILITATION

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Abstract

Background: In the course of oral respiration, oral tissues and existing dentures are the first contacting structures of the air passing through upper airways. In edentulous patients while recording lung function tests without dentures mild but significant decrease in inspiratory airflow rates is observed, this may be suggestive of threat to the patency of upper airway. The aim is to evaluate retropharyngeal space and its effect on spirometric functional values before and after complete denture rehabilitation. **Materials and Methods:** 15 male and female patients, age ranging from 40-70 years with completely edentulous maxillary and mandibular ridge and requiring removable complete denture prosthesis satisfying following conditions were considered for this study. CBCT of the skull and spirometry were recorded and analysed before rehabilitation with complete denture. Complete Dentures were fabricated following standardized techniques. CBCT of skull and spirometry were recorded and analysed after rehabilitation with complete denture. **Result:** Before complete denture rehabilitation mean value of FVC (forced vital capacity) was 2.91(L) and after complete denture rehabilitation was 3.11(L). The difference was found to be statistically non-significant (P=0.165). Before complete denture rehabilitation mean value of FEV1 (forced expiratory value at 1second) was 2.04L and after complete denture rehabilitation was 2.28L. The difference was found to be statistically non significant (P=0.123).Before complete denture rehabilitation mean value of FEV1/FVC was 74.5% and after complete denture rehabilitation was 74.27%. The difference was found to be statistically non significant (P=0.938). Before complete denture rehabilitation the mean value of PIFR (peak inspiratory flow rate) was 2.27L after complete denture rehabilitation was 2.72L. The difference was found to be statistically significant (p=0.031). **Conclusion:** There was statistically significant difference were observed in retropharyngeal space and spirometric functional values before and complete denture rehabilitation.

INTRODUCTION

Edentulism is the absence or complete loss of all natural teeth. In edentulous patients absence of all the teeth lead to loss of vertical dimension of occlusion, reduction of lower facial height and rotation of mandible. These anatomical changes may have influence on the stomatognathic system.[1-3]

Respiration is one of the most vital functions, and it is a process of exchange of gases between the living organism and the atmosphere to meet the metabolic demands of the body. In the course of oral respiration, oral tissues and existing dentures are the first contacting structures of the air passing through upper airways.[4-7]

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In edentulous patients while recording lung function tests without dentures mild but significant decrease in inspiratory airflow rates is observed, this may be suggestive of threat to the patency of upper airway.[8-11]From the very beginning, researchers and clinicians used a multitude of different techniques not only to reveal potential differences in upper airway anatomy to better understand the origin and the pathophysiology of the disease but also to improve patient management and treatment success.[12-15]

Despite the vast amount of research concerning airway anatomy and its influence on craniofacial growth and development, most studies have been 2-dimensional (2D) and have used lateral or frontal cephalograms with limited evaluation of lengths and areas.[16-19]

New 3-dimensional (3D) technology of computed tomography (CT) has expanded diagnostic capacities, making volumetric analysis and accurate visualization of the airway possible. Most 3D studies of the airway used multi-slice CT to evaluate the airway. This has the advantage of high-quality images to discern hard and soft tissue anatomies. However because of the high radiation dose, it is restricted to patients with severe craniofacial deformities and those undergoing orthognathic surgeries.[20-24]

Recently, cone-beam CT (CBCT) systems have been developed specifically for the maxillofacial region. Because a CBCT scan uses a different type of acquisition than traditional multislice CT, radiation is reduced and can be used in a wider range of patients.[25-30]

In this study the role of complete dentures in modifying the position of the jaw, tongue, soft tissues and retropharyngeal space is evaluated, with the help of cone beam computed tomography.

This study also evaluate the effect of use of complete denture prosthesis by edentulous patients on spirometric functional values.

MATERIALS AND METHODS

The present study was carried out in the Govt. College of Dentistry. All the patients were informed about the nature of study and the level of cooperation needed from them. After obtaining written consent, they were included in this study. The approval from Institutional Ethical Committee was obtained before the commencement of this study. The study was performed as follows:

Selection of Subject

Inclusion Criteria

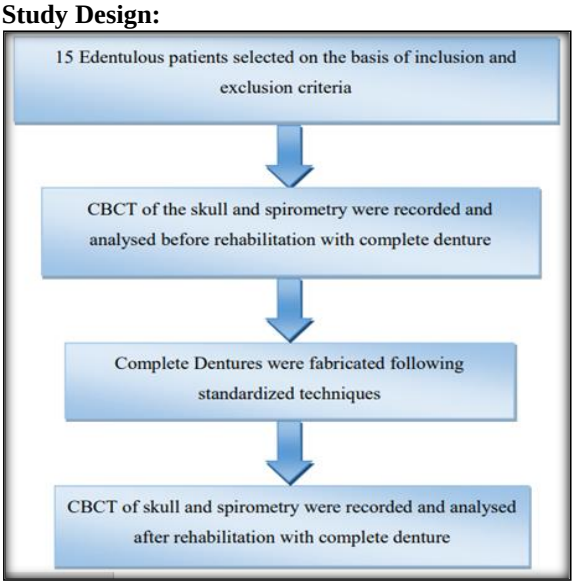
- 15 male and female patients, age ranging from 40-70 years with completely edentulous maxillary and mandibular ridge and requiring removable complete denture prosthesis satisfying following conditions were considered for this study.
- Subjects who were completely edentulous for atleast 6 months.
- Well-formed/average ridge
- Subject who have not worn any denture previously
- Good general health

Exclusion criteria

- Any patient who exhibited joint noises, muscle soreness, restricted opening and movements
- Systemic involvement specially respiratory diseases
- Deep Neck Infections

Unable or unwilling to give informed consent

Study Design:



Methodology: The radiographic examination was made with CBCT, before prosthetic rehabilitation and after prosthetic rehabilitation. Before prosthetic rehabilitation, with the maxillary and mandibular residual ridges approximated. And after prosthetic rehabilitation with maxillary and mandibular complete denture in centric occlusion. Then radiographic examination of the retropharyngeal space, airway space was done with CBCT and analysed.

Spirometric technique and analysis: The spirometry (pulmonary function test) was recorded before and after complete denture rehabilitation while patient was seated in upright position and clip was placed on nose to keep both nostrils close, and patient was instructed to breath normally and then take a deep breath and hold for few seconds and finally exhale as hard as possible into the breathing mask. Acceptability criteria included spirogram having good starts with extrapolated volume<5% of FVC or 0.15lt and satisfactory exhalation of 6 seconds or a plateau in volume-time curve. After 3 acceptable spirograms were recorded, reproducibility criteria were applied. The two largest FVC values within 0.2lt of each other and two largest FEV1 values within 0.2lt of each other were taken, when both of these criteria were met the session was concluded.

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Following spirometric variables were taken into consideration:

- FVC— Maximal volume of air exhaled with maximally forced effort from a position of maximal inspiration
- FEV1—The volume of air exhaled in specified time during the performance of the FVC (volume of the air exhaled during the first second of FVC).
- FEV1/FVC—Ratio is an invaluable indicator of respiratory disease and allows separation of ventilatory abnormalities into―restrictive‖ or―obstructive‖ patterns.
- PIFR—It stands for peak inspiratory flow rate during inspiration and represents extrathoracic airways.

Cone beam computed tomography scan:

The scan was taken before complete denture rehabilitation, with the patient standing in an upright position using a cephalostat using CBCT machine [Carestream CS 93003D Rochester, USA with the FOV(Field of View) of 13.5×17 cm] The patient position was standardised in such a way, that the Frankfort plane (a line passing horizontally from the superior border of external auditory meatus to the inferior border of the orbital rim) was kept parallel to the horizontal plane on the lateral view, with their head within the circular gantry housing of the X-ray tube in order to obtain a consistent orientation of sagittal images. Accurate positioning of the head was facilitated by the use of two light-beam markers. The vertical positioning light must be aligned with the mid-sagittal line of the patient, which helps to keep the head of the patient centred with respect to the rotational axis. The X-ray tube detectors system performed a 180 degree rotation around the head of the patient and the scanning time was 20 seconds. The scanner operated with a maximum output of 90 kV and 12 mAs, with 0.9 mm Al-equivalent filtration and a standard 14 degree cone beam angle, 17cm × 13.5cm field of view, 0.18mm voxel size. CS9300 Software program was used for analysis. The measurement of distances were made using Carestream software with the original selected images.

Image selection & measurements:CBCT was used for this study. Two tomographs were recorded for a patient. The first tomograph of the skull was taken before prosthetic rehabilitation. The second tomograph was taken after prosthetic rehabilitation.

Distance between anterior to posterior wall of oropharynx (Retropharyngeal space) at the level c2 vertebrae was measured along the line extending from the point C2 to posterior wall of oropharynx to anterior wall of oropharynx using the CS3D software by the measuring tool on sagittal view.(as mentioned in previous study).[1,3]

Standard procedure of CD fabrication: Standardized procedures were performed for the fabrication of the maxillary and mandibular complete dentures. After clinical examination, diagnostic impressions and casts of the maxillary and mandibular arches were made. Routine steps were performed till final impression to get the master casts. Record bases and occlusion rims were fabricated on the casts and transferred to a semi-adjustable articulator with the aid of a face-bow transfer. A record made with the patient in the centric relation position at established vertical dimension of occlusion. The protrusive bite record was taken by guiding the patient to close the mouth in 6 mm protrusive position. The articulator was then programmed according to values derived from the patients protrusive bite record. The condylar guidance was adjusted until the protrusive record was completely seated. The Bennett angle was calculated using the Hanau formula L=H/8 +12.

Anatomic teeth were selected and arranged in the bilateral balanced occlusion. After trial insertion and confirmation of teeth arrangement, the prosthesis was processed and finished in the usual manner. The processed maxillary and mandibular complete denture were remounted on the articulator, and occlusal adjustments were then made as needed before insertion of the prosthesis.

After insertion of prosthesis, a CBCT of the skull was taken, with the patient in an upright position using a cephalostat using CBCT machine (Carestream CS 93003D Roshester, USA with the FOV (Field of View) of 13.5×17 cm). The patient position was standardised in such away, that the Frankfort plane (a line passing horizontally from the superior border of external auditory meatus to the inferior border of the orbital rim) was kept parallel to the horizontal plane.

After insertion of the denture tomograph of skull and spirometry were recorded and analysed.

Statistical Analysis: The data obtained for all the patients was subjected to statistical analysis using SPSS (Statistical package for social sciences) version 15 statistical analysis software. Mean value and SD Of all the sample was calculated.

Figure 1: material used in the study

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Figure 2:equipment used in the study

Figure 3:denture at restored vertical dimension of occlusion

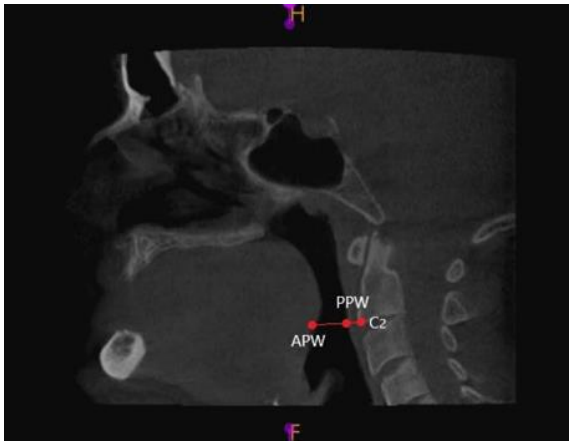
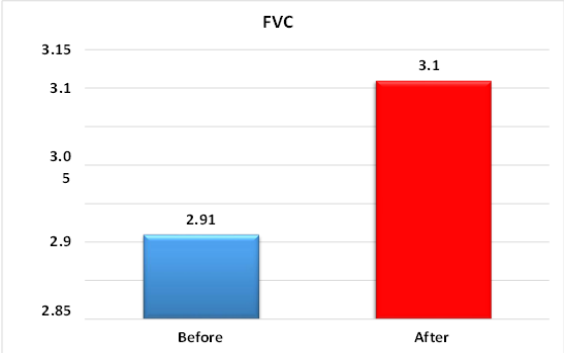


Figure 4: Landmark Used For Retropharyngeal Space Measurement

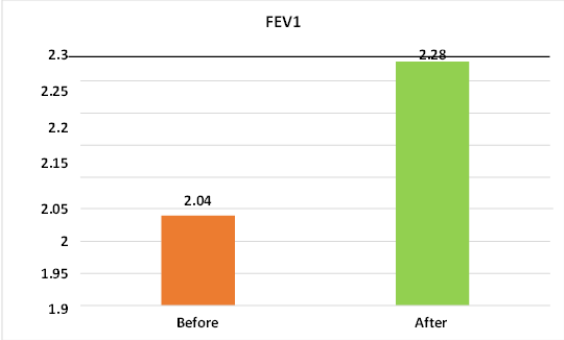
RESULTS

The study included 15 edentulous patients and measure retropharyngeal space before and after complete denture rehabilitation and also measured spirometric functional values. Before complete denture rehabilitation, mean value of retropharyngeal space was 9.18 mm and after complete denture rehabilitation was 10.20 mm. The difference was found to be statistically significant (P=0.001). Before complete denture rehabilitation mean value of FVC (forced vital capacity) was 2.91(L) and after complete denture rehabilitation was 3.11(L). The difference was found to be statistically non significant (P=0.165). Before complete denture rehabilitation mean value of FEV1 (forced expiratory value at 1second) was 2.04L and after complete denture rehabilitation was 2.28L. The difference was found to be statistically non significant (P=0.123). [Table 1-3, Graph 1-3]

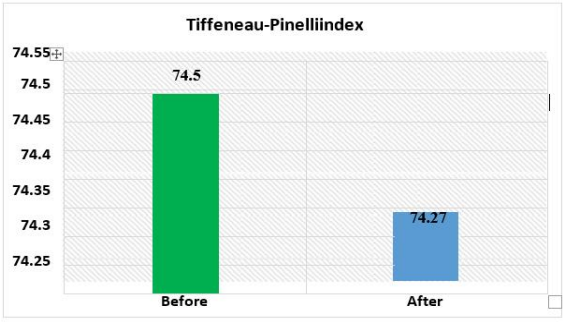
Before complete denture rehabilitation mean value of FEV1/FVC was 74.5% and after complete denture rehabilitation was 74.27%. The difference was found to be statistically non significant (P=0.938). Before complete denture rehabilitation the mean value of PIFR (peak inspiratory flow rate) was 2.27L after complete denture rehabilitation was 2.72L. The difference was found to be statistically significant (p=0.031) Thus there was statistically significant difference were observed in retropharyngeal space and spirometric functional values before and complete denture rehabilitation so null hypothesis was rejected and alternative hypothesis was accepted. [Table 1-3 and Graph 1-4]



Graph1: Forced Vital Capacity before and after denture



Graph 2: ForcedExpiratory Volume before and after denture



Graph 3. Tiffeneau-Pinelli index (FEV1/FVC %) before and after denture

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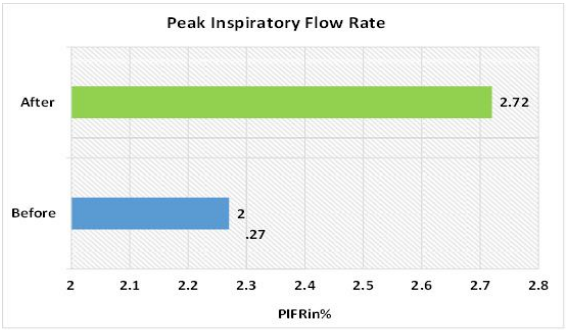

Graph 4: Peak Inspiratory Flow Rate before and after denture

Table 1: Spirometric functional values before and after complete denture

S.No.	Before complete denture rehabilitation				After complete denture rehabilition			
	FVC(L)	FEV1(L)	FEV1/FVC(%)	PIFR(%)	FVC(L)	FEV1(L)	FEV1/FVC(%)	PIFR(%)
1	3.05	2.65	78.09	2.17	3.31	1.62	49.07	2.93
2	2.89	2.03	72.06	2.63	2.98	2.17	74.15	3.05
3	2.39	1.93	80.84	2.53	2.39	1.98	89.85	2.93
4	3.61	1.67	46.34	1.72	3.82	2.62	49.07	2.72
5	2.62	2.06	78..02	2.78	3.89	2.65	80.84	3.02
6	3.22	2.5	74.05	2.15	2.93	2.78	78.65	2.25
7	2.44	1.95	80.89	1.75	3.65	2.18	80.12	2.68
8	2.82	1.82	76.3	2.39	3.05	1.98	84.05	2.90
9	3.75	2.05	72.5	2.63	2.14	2.93	77.4	3.04
10	2.82	1.61	78.09	2.032	3.25	2.62	79.05	2.17
11	2.89	2.03	72.03	2.63	3.31	1.62	49.07	2.95
12	2.39	1.93	80.84	2.53	2.98	2.17	74.15	3.19
13	2.62	2.5	74.05	2.15	3.65	218	80.12	2.68
14	3.22	1.95	80.89	1.75	2.39	1.98	89.85	2.15
15	2.82	2.05	72.5	2.032	2.93	2.78	78.65	2.25

Table 2: Descriptive statistics of the spirometric functional values

Parameter	Timeline	Mean	SD	SEM
FVC	Before	2.91	.413	0.106
	After	3.11	.526	0.135
FEV1	Before	2.04	.293	0.075
	After	2.28	.420	0.108
FEV1/FVC	Before	74.5	8.52	2.20
	After	74.27	13.80	3.56
PIFR	Before	2.27	.352	0.091
	After	2.72	.321	0.083

Table 3: Wilcoxon-signed rank test to compare the difference in mean values before and after Denture rehabilitation:

Parameters	SD	SEM	95% Confidence Interval of the Difference		'z'statistic	P value
			Lower	Upper		
Retropharyngeal space(After-before)	0.548	0.14158	0.72301	1.3303	3.412	.001
FVC (After-Before)	0.528	0.13643	-0.49262	.09262	-1.287	0.165
FEV1(After-Before)	0.555	0.14336	-0.5428	.0721	-1.59	0.123
FEV1/FVC(After-Before)	11.267	2.9092	-6.4682	6.0109	-1.13	0.938
PIFR(After-Before)	0.271	0.0704	0.3001	0.6007	2.87	.031

DISCUSSION

The present study was aimed at evaluation of retropharyngeal space and its effect on spirometric functional values before and after complete denture rehabilitation by cone beam computed tomography.

Edentulism affects up to 42% of individual worldwide and it has been estimated that 40% of edentulous individual suffer from sleep breathing disorder.[12]

Edentulism results in craniofacial changes such as loss of the vertical dimension of occlusion that leads to change in position of the hyoid bone and mandible, all of which may influence the size and function of the upper airway.[2,3]

Rehabilitation of edentulous patients with complete denture is an integral part of prosthodontic treatment modality. Denture not only provides aesthetics and improves the phonetics but also restores the desired function of mastication. It also provides adequate support to the orofacial structure by restoring altered vertical dimension and also improve the conditions like Obstructive Sleep Apnoea/hypopnoea.[16] Thus the present study was undertaken to evaluate the effect of complete denture on retropharyngeal space, upper airway and ultimately altering the functional capacity of airway tract. Further in the present study spirometric functional values were assessed by spirometry before and after complete denture rehabilitation. The mean of spirometric functional values before complete denture rehabilitation PIFR (peak inspiratory flow rate) was 2.27 and after

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complete denture rehabilitation PIFR was 2.72. It was observed that peak inspiratory flow rate were increased significantly with denture at restored vertical dimension, compared with the values in edentulous patients without denture.

This result can be explained by the fact that wearing denture with acceptable vertical dimension of occlusion has significant effect on extrathoracic airways including retropharyngeal space. The increase in mean PIFR might be due to the increase in the retropharyngeal space after wearing complete dentures. This is in agreement with the finding of previous study done by Singhal et al where they were found that in edentulous subjects without denture PIFR was 2.39 and after complete denture it was 2.93. In the present study however no significant changes were observed in forced vital capacity (FVC=maximal volume of air exhaled with maximally forced efforts from a position of maximal inspiration), forced expiratory flow rate (FEV1=volume of air exhaled during the first second of FVC) and FEV1/FVC ratio with complete denture in comparison to edentulous subjects.The advantage of using denture in edentulous patient during sleep is that it help in reducing apnoea-hypopnoea events in edentulous obstructive sleep apnoea patients. This occurs due to the fact that wearing denture induces modifications in the position of the jaw, tongue, soft tissue, and pharyngeal airway space. That may be contributing in the reduction of apnoea events.[30]

The disadvantage of wearing denture during sleep is that it is associated with chronic inflammatory changes, leading to irritation and alveolar bone resorption in denture–supporting area.[3]

Every study had its own limitation with further scope. In the present study the sample size was small, and thus the result may not truly represent the population. Further more advanced longitudinal investigations involving more parameter are required to better understand the short and long term biological implications associated with the use of complete denture as an oral appliance in OSA edentulous patient.

CONCLUSION

There was statistically significant difference were observed in retropharyngeal space and spirometric functional values before and complete denture rehabilitation so null hypothesis was rejected and alternative hypothesis was accepted.

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