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CLINICAL RESEARCH

Effects of nocturnal complete denture usage on cardiorespiratory parameters: A pilot study

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ABSTRACT

Statement of problem. Sleeping without conventional complete dentures (CCDs) has been stated by some to induce negative effects on the cardiorespiratory functions of edentulous patients with obstructive sleep apnea (OSA), although others have reported the exact opposite. Therefore, a consensus on nocturnal CCD usage is lacking.

Purpose. The purpose of this clinical study was to assess the effects of nocturnal denture usage on cardiorespiratory stability by using pulse oximetry (PO).

Materials and methods. Thirty CCD wearers were enrolled in the study. The first nocturnal pulse oximetry (FNPO) recordings were made on 3 different nights while the participants were sleeping without dentures (WOD). Oxygen desaturation index (ODI) and other PO parameters of the participants, including total respiratory event (TRE), basal SpO_2 ($BSpO_2$), time$\leq$88 (T88), average low SpO_2 ($ALSpO_2$), total pulse event (TPE), average pulse rate (APR), and heart rate variability index (HRVI), were processed and the obtained data were recorded as WOD condition values. According to the ODI scores, the OSA status of the participants was grouped as normal (ODI<5), mild (5<ODI<15), moderate (15<ODI<30), or severe (ODI>30). Complete dentures were fabricated by an experienced prosthodontist and a dental laboratory technician by following conventional procedures. At the end of the first month of the follow-up period, the second nocturnal PO recordings (SNPO) were made on 3 different nights while the participants slept wearing dentures (WID), and the data obtained were recorded as WID condition values. The comparison of mean PO values obtained from WOD and WID were analyzed with the Wilcoxon signed- rank test (α=.05).

Results. Significant differences were found between WOD and WID values in terms of TRE (P=.01), ODI (P=.001), ALSpO2 (P=.006), TPE (P=.001), and HRVI (P=.001) parameters. The significance of the improvements in the WID condition increased with the severity of OSA.

Conclusions. Improvements were observed in substantial cardiorespiratory parameters such as the ODI and HRVI of the participants wearing dentures nocturnally. (J Prosthet Dent 2021;■:■-■)

Edentulism can be the cause of many sequelae and has detrimental effects on the quality of life.[1-7] By the loss of occlusal vertical dimension, edentulism leads to morphological alterations[8] such as reductions of facial height and upper airway volume.[8-14]

Conventional complete dentures (CCDs) are still the most frequently provided treatment for edentulism.[15] However, CCD wearers are at risk in terms of denture stomatitis, traumatic ulcers, and irritation hyperplasia.[3,7,16] Therefore, removing dentures nocturnally is recommended to prevent continuous usage-associated conditions.[3,7,15,16] However, in some recent polysomnography (PSG) employed studies, rises in the apnea-hypopnea index (AHI) of the participants with obstructive sleep apnea (OSA) who slept without dentures were observed, but the opposite has been reported in other studies.[8,10,17,18] In addition, data on edentulous individuals without OSA are sparse.[8,10,17,18]

OSA is a life-threatening disorder characterized by recurrent apneas and hypopneas caused by narrowing or closing of the upper airway during sleep.[19-22] The prognosis of those diagnosed with OSA may be affected by

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Clinical Implications

Performing overnight PO recordings on edentulous patients helps clinicians determine the appropriate nocturnal denture usage for their patients until a consensus is reached. Until the positive effects of wearing CCD during sleep on cardiorespiratory stability has been verified by further studies, clinicians should decide in which condition their patients should sleep by using PO evaluations.

the volume of the oral cavity and oropharynx.[20-23] The AHI is the key criterion in determining OSA severity and can be monitored by PSG.[20-23] Full-night, technician-attended PSG evaluation is the standard for the diagnosis of OSA.[21-31] Individuals are categorized according to the AHI scores: healthy (5<AHI), mild (5<AHI <15), moderate (15<AHI<30), or severe (AHI >30).[19-21] However, PSG tests are time-consuming, uncomfortable, and costly procedures.[29,31,32] Therefore, interest in home-based sleep evaluations has increased.[33,34]

Oxygen desaturation indexes and pulse events can be safely and readily determined by pulse oximetry (PO).[32,34-39] The PO monitor is attached to a finger, and, unlike PSG, additional cables or apparatus are not required. The patient can perform the measurement anywhere without technician assistance. Therefore, it is a user friendly method which does not cause sleep fragmentation or first night effect, which may occur during PSG testing.[30] However, studies that used PO to evaluate the effects of dental procedures on cardiorespiratory stability are sparse.[34,38] The authors are aware of only 1 study that evaluated the cardiopulmonary effects of overnight denture usage.[34] Additionally, in the existing studies, there is no detailed information on whether the neutral zone method was applied or how the posterior palatal seal was shaped.[40]

The purpose of the present study was to assess the effects of nocturnal denture usage on the cardiorespiratory stability of healthy participants and those with OSA by using PO. The null hypothesis was that using CCDs nocturnally has no significant effects on the cardiorespiratory parameters of participants.

MATERIAL AND METHODS

The present study was approved by the Ethical Committee of Gulhane Military Medical Academy and executed in accordance with the Helsinki Declaration of 1964 as revised in 2013 in Fortaleza, Brazil. All volunteers provided written informed consent before participation. The study was executed in 5 stages: selection of the participants, execution of the first nocturnal PO (FNPO) recordings, fabrication of the CCDs, execution of the second nocturnal PO (SNPO) recordings, and statistical analysis.

A total of 30 participants who referred to the Department of Prosthodontics for the replacement of their complete dentures were enrolled in this study. The inclusion criteria were the absence of systemic disease, not using any medication that affected sleep integrity, and the absence of nasal septum deviation. The findings of a physical examination which included height, weight, and body mass index (BMI) were recorded. All recordings were executed using the same pulse oximeter (Beurer P30; Beurer GmbH), and FNOP recordings were performed while the participants were sleeping without dentures (WOD).

All CCDs were fabricated by using conventional procedures.[4] Because of the proximity of posterior borders of the maxillary complete dentures to the oropharyngeal region, strict attention was paid to define and transfer the posterior palatal seal correctly. The nonfluid wax addition technique was used for making the definitive maxillary impressions.[5] Denture bases complied with the neutral zone process, and the procedure was accomplished using a tissue conditioning material (Viscogel; Dentsply Sirona).[5,6]

The SNPO recordings were performed while the participants were sleeping with dentures (WID). An experienced chest physician evaluated the NPO data, and a decrease in arterial blood oxygen saturation (SpO_2) by at least 4% for a minimum of 10 seconds was accepted as a respiratory event. The total number of respiratory events per hour was recorded as oxygen desaturation index (ODI). Participants were categorized according to the ODI scores as normal (OSA-0) below 5, mild (OSA-1) between 5 and 15, moderate (OSA-2) between 15 and 30, or severe (OSA-3) over 30.[21,34] Changes in heart rate by at least 6 bpm for a minimum duration of 8 seconds were accepted as pulse events, and the total number of pulse events per hour was recorded as heart rate variability index (HRVI). In addition, the other NPO parameters such as total respiratory event (TRE), basal SpO_2 ($BSpO_2$), time $\leq$ 88 (T88), average low SpO_2 ($ALSpO_2$), total pulse event (TPE), and average pulse rate (APR) of each participant was determined and recorded.[34,38]

The obtained data were analyzed with a statistical software program (IBM SPSS Statistics, v20.0; IBM Corp). Demographic structure of the participants was determined, and the average values of the NPO parameters obtained for 3 nights under WOD and WID conditions were calculated. Obtained data were subjected to descriptive analysis, and the effects of WOD and WID conditions on NPO parameters were analyzed using the Wilcoxon signed-rank test. The effects of BMI and age

were evaluated with the Spearman rank correlation coefficient (α=.05).

RESULTS

The demographic profile of the 30 participants that completed the study is given in Table 1. Descriptive analysis of the NPO data obtained from the WOD and WID conditions are given in Table 2. The effects of the WOD and WID conditions on TRE, ODI, BSpO2, T88, ALSpO2, TPE, HRVI, and APR parameters, as evaluated by using the Wilcoxon signed-rank test, are given in Table 3. The results of descriptive analyses related to the OSA-0, OSA-1, OSA-2, and OSA-3 groups are shown in Table 4. The statistical significance as determined by the Wilcoxon signed-rank test is given in Table 5. Table 6 shows the increase and decrease of ODI scores of 4 different OSA groups under WID condition. The correlation between the ODI scores of WOD and WID and the ages of the participants and BMI scores was analyzed with the Spearman rank correlation coefficient analysis. As can be seen in Table 7, a positive correlation was found between WOD ODI scores and ages of the participants (r_s=0.430).

Table 1. Distribution of participants according to numbers, age, body mass index

Number of Participants	Female	Male	Total
–	12	18	30
Age	67.2	67.7	67.5
BMI	28.0	26.8	27.3

BMI, body mass index.

DISCUSSION

As nocturnal CCD usage affected the cardiorespiratory parameters, the null hypothesis was rejected. The results of the present study revealed substantial improvements gained by nocturnal denture usage in the cardiorespiratory stability of the participants. ODI scores of the 22 individuals in the present study decreased under WID condition, whereas 1 remained the same, and increases were seen for 7 participants. In the OSA-0 group, the mean value of ODI dropped from 3.6 to 2.9 in nocturnal denture-wearing individuals. However, the difference was not statistically significant (P=.726), possibly because of the narrow range of values (0 to 5). Additionally, the OSA-0 group was composed of healthy participants whose hourly oxygen saturation changes were in a range from 0 to 4. This situation was also seen in the TRE, T88, TPE, HRVI parameters, which showed limited improvements in the OSA-0 group. However, in the OSA-1 group, the ODI score range was set at 5 to 15, and the number of the participants was sufficient for a valid evaluation. Therefore, the OSA-1 was considered the most suitable group for the assessment of all the parameters. Statistically significant changes were detected between the ODI, TRE, ALSpO2, TPE, and HRVI values recorded under WOD and WID conditions. These changes indicated significant respiratory and cardiac improvements for nocturnal denture wear in individuals with mild OSA. Significant differences were also observed in the ODI, TPE, and HRVI scores of the OSA-2 group. In the OSA-3 group, which was composed of individuals with severe OSA, all the parameters that were evaluated with the described method showed improvements. However, a statistical analysis could not be performed because of the small sample size.

These findings were consistent with those of both Bucca et al[10] and Arisaka et al.[8] Bucca et al[10] assessed 20 of 48 participants with PSG and the rest with ambulatory PSG and reported that AHI dropped from 17.4 to 11 with nocturnal denture wear. Arisaka et al[8] also reported decreases in AHI of most of the individuals who slept wearing dentures by using a portable sleep monitor. The results of the present study and of Arisaki et al and Bucca et al are consistent with recently reported radiological findings for 17 edentulous participants with OSA by Tripathi et al,[14] stating that total upper airway volume increased by wearing complete dentures. This was the first volumetric research supporting the results of 2-dimensional cephalometric studies that shared the same conclusion; reduced upper airway volume increases with complete denture wearing. However, Almeida et al[18] reported significant increases in AHI of the nocturnal denture wearers in a study including 23 participants with an average age of 69.6 years and an average BMI of 26.7. The reason for conflicting results in similar studies is thought to be methodological.

The present study differed critically in methodology compared with previous studies,[10,14,18] especially the method used to evaluate cardiorespiratory stability. Whereas all the previous studies used PSG, we used high-resolution PO instruments for this evaluation. Also, previous studies did not cite the importance of shaping the posterior palatal seal, the use of the neutral zone technique for the mandibular dentures, or evaluation for nasal obstruction.[10,17,18] There is strong evidence for the relationship between OSA and nasal obstruction.[22] Thus, individuals diagnosed with nasal obstruction or congestion were excluded from the present study.

Increased BMI was found to have adverse effects on cardiopulmonary parameters such as $BSpO_2$ and $ALSpO_2$ in the present study. In the WID group, these effects seemed reduced. However, a positive correlation (r_s=0.430) was found between age and the ODI scores in WOD, and no correlation was seen under the WID

Table 2. Descriptive analysis of NPO data under WOD and WID conditions

Condition	Descriptive Parameters	TRE	ODI	BSpO2	T88	ALSpO2	TPE	HRVI	APR
WOD	Mean	82.7	12.1	92.1	28	89.1	86.7	12.8	64.2
	Median	57	8.4	93.1	2	89.8	77.4	12.8	65.3
	Standard deviation	80.2	10.2	3.4	79.9	3.6	61	7.7	7.8
	Minimum	10	1.4	76.60	0.15	72.6	5.3	0.8	49.4
	Maximum	330	44.7	96.0	384.4	92.6	267	32.5	84
WID	Mean	56.1	8.5	92.4	22.7	88.8	68.6	10.7	53.8
	Median	35.4	6.0	93.0	1.1	90.3	58.3	11.2	54.4
	Standard deviation	55.6	7.6	2.4	70.1	5.5	50.6	6.3	5.2
	Minimum	3.0	0.90	83.70	0.00	64.5	4.5	0.7	39.8
	Maximum	217	25.3	94.90	293.4	93.1	201.3	27.9	70.6

APR, average pulse rate; HRVI, heart rate variability index; NPO, nocturnal pulse oximetry; ODI, oxygen desaturation index; TPE, total pulse event; TRE, total respiratory event; WID, with denture; WOD, without denture.

Table 3. Wilcoxon signed-rank test results of comparison of WOD and WID values of 30 participants

Significance Value	TRE (WOD/WID)	ODI (WOD/WID)	BSpO2 (WOD/WID)	T88 (WOD/WID)	ALSpO2 (WOD/WID)	TPE (WOD/WID)	HRVI (WOD/WID)	APR (WOD/WID)
P	.01	.001	.344	.139	.006	.001	.001	.05

APR, average pulse rate; HRVI, heart rate variability index; NPO, nocturnal pulse oximetry; ODI, oxygen desaturation index; TPE, total pulse event; TRE, total respiratory event; WID, with denture; WOD, without denture.

Table 4. Descriptive analysis of NPO scores according to OSA severity

Condition	Severity	Descriptive Parameters	TRE	ODI	BSpO2	T88	ALSpO2	TPE	HRVI	APR
WOD	OSA-0	Mean	22.7	3.6	93.2	1.6	90.6	68.3	10.8	63.6
		Standard deviation	6.8	1.1	1.3	1.1	1.5	34.1	5.8	6.9
	OSA-1	Mean	56.8	9.1	92.9	4.3	89.8	99.3	15	63.6
		Standard deviation	24.8	2.9	1.3	5.7	1.2	72	8.1	10.5
	OSA-2	Mean	148.9	20.6	92.1	34.3	88.7	80.2	10.7	64.8
		Standard deviation	4.3	4.6	2.5	70.4	2	47.2	5.8	3.8
	OSA-3	Mean	311.1	39.1	82.8	267.7	78.9	115.8	15.5	68.6
		Standard deviation	6.6	7.9	8.8	165	8.9	145.9	19.8	6.1
WID	OSA-0	Mean	20.5	2.9	93.4	0.9	88	58.2	9.5	63.5
		Standard deviation	14.1	2.1	1.1	0.9	8.9	32.5	4.6	7.1
	OSA-1	Mean	36.2	5.8	93.1	2.4	90.6	81.4	12.9	62.8
		Standard deviation	24	3.1	1.4	4.2	1.1	66.2	7.6	8.9
	OSA-2	Mean	108.3	13.5	91.5	44.1	90.9	67.3	9.7	66.2
		Standard deviation	68.4	8.2	2.7	97.1	1.8	41.9	5.3	5.4
	OSA-3	Mean	152.5	24	87.1	167.3	81.7	43.5	6.5	62.9
		Standard deviation	2.1	1.7	4.8	178.3	6.5	51.6	7.5	0.8

APR, average pulse rate; HRVI, heart rate variability index; NPO, nocturnal pulse oximetry; ODI, oxygen desaturation index; OSA, obstructive sleep apnea; TPE, total pulse event; TRE, total respiratory event; WID, with denture; WOD, without denture.

condition. The importance of the methodology will be revealed after further studies test the effect of the inclusion criteria, the denture manufacturing procedures, and the evaluation methods.

When complete dentures are fabricated improperly, their bulk may constrict the oral cavity and position the tongue posteriorly.[40] However, the use of the neutral zone technique secures adequate space for the tongue.[13] The denture acts as an oral appliance and helps to preserve the vertical dimension of occlusion (VDO) and pharyngeal muscle tone.[27] When an edentulous individual sleeps without dentures, with the loss of vertical dimension of occlusion, the mandible rotates, and the tongue repositions posteriorly causing the upper airway to constrict.[34] With poor pharyngeal muscle tone added, cardiorespiratory parameters may deteriorate. The possible reasons for the improvement in PO values with nocturnal CCD usage are conservation of the VDO, prevention of the posterior mandibular rotation, and preservation of the tone of the superior pharyngeal constrictor muscle.

Consequences related to CCDs have been well documented. CCD wearing has been associated with oral mucosal lesions such as denture stomatitis, irritation

Table 5. Wilcoxon signed-rank test results of NPO values of participants distributed according to OSA severity

OSA Severity	TRE (WOD/WID)	ODI (WOD/WID)	BSpO2 (WOD/WID)	T88 (WOD/WID)	ALSpO2 (WOD/WID)	TPE (WOD/WID)	HRVI (WOD/WID)	APR (WOD/WID)
OSA-0	0.515	0.03	0.440	0.139	0.259	0.021	0.086	0.574
OSA-1	0.008	0.010	0.533	0.239	0.005	0.040	0.045	0.875
OSA-2	0.091	0.043	0.499	0.398	0.005	0.043	0.040	0.090
OSA-3	-	-	-	-	-	-	-	-

APR, average pulse rate; HRVI, heart rate variability index; NPO, nocturnal pulse oximetry; ODI, oxygen desaturation index; OSA, obstructive sleep apnea; TPE, total pulse event; TRE, total respiratory event; WID, with denture; WOD, without denture.

Table 6. Effects of WID condition on ODI scores

OSA Severity	n	Decrease in ODI	Increase in ODI	No Change in ODI
OSA-0	9	5	3	1
OSA-1	12	10	2	0
OSA-2	7	6	1	0
OSA-3	2	2	0	0
Total	30	22	7	1

ODI, oxygen desaturation index; OSA, obstructive sleep apnea; WID, with denture.

Table 7. Results of Spearman rank correlation coefficient analysis

Variables	TRE-WOD	ODI-WOD	BSpO2-WOD	T88-WOD	ALSpO2-WOD	TPE-WOD	HRVI-WOD	APR-WOD
Age	0.337	0.430	-0.221	0.208	-0.352	-0.202	-0.281	-0.011
BMI	0.205	0.209	-0.748	0.311	-0.500	-0.046	-0.006	-0.001
–	TRE-WID	ODI-WID	BSpO2-WID	T88-WID	ALSpO2-WID	TPE-WID	HRVI-WID	APR-WID
Age	0.073	0.070	-0.386	0.038	-0.276	-0.304	-0.409	-0.143
BMI	0.198	0.213	-0.554	0.408	-0.461	-0.216	-0.172	-0.221

APR, average pulse rate; BMI, body mass index; HRVI, heart rate variability index; NPO, nocturnal pulse oximetry; ODI, oxygen desaturation index; TPE, total pulse event; TRE, total respiratory event; WID, with denture; WOD, without denture.

hyperplasia, flabby ridges, and traumatic ulcers.[1,3,7] Removable dentures also cause resorption of the residual ridges, taste disorders, and burning mouth syndrome.[3] Therefore, continuous CCD wearing is not recommended.[1] It is essential to inform patients about the necessity of removing dentures daily for a certain period.[1,3,7]

Limitations of the present study included that although, PO has been reported to be an accurate and precise instrument for sleep evaluation studies, PSG evaluation is the standard for sleep studies.[29-31] Additionally, PO data were not obtained to evaluate the long-term cardiorespiratory condition. Periodically performed PO assessments will enhance the accuracy of the information and make it possible to observe the stability of the cardiorespiratory improvements gained by nocturnal CCD usage. Thus, denture wearers who do not benefit from nocturnal use and those with negative changes in cardiorespiratory parameters can be detected. In addition, the effects of using single dentures on PO values were not examined. However, in a previous study, statistically significant differences were found between the spirometric parameters of wearing a single denture and wearing both dentures.[40]

The sample size in the study was relatively low. Further studies with larger groups of participants with homogenous distribution will provide more reliable results.

CONCLUSIONS

Based on the findings of the present clinical study, the following conclusions were drawn:

1. PO parameters improved significantly under the WID condition.
2. Additional improvements were observed for the WOD condition in the patients with ODI scores over 5.
3. Adverse effects of the increase in the BMI parameters seemed to be reduced for the WID condition.
4. Until further studies with broader numbers of participants are presented and a consensus is reached, clinicians can use PO to establish a regimen for the nocturnal usage of dentures.

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