Clinical Research

ENT Updates 2015;5(3):113–118
doi:10.2399/jmu.2015003010

ENT updates
www.entupdates.org

Can the devices used to treat obstructive sleep apnoea syndrome increase the tendency to gain weight?

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Abstract

Objective: This study investigated the effects of device treatments on weight changes in obstructive sleep apnoea syndrome (OSAS) patients.

Methods: The study included 256 patients who underwent polysomnography to evaluate snoring and suspected OSAS. They were grouped according to the apnoea hypopnoea index (AHI) and device usage for OSAS as follows: Group 1 included patients who were established with OSAS diagnosis and used device for treatment purpose (n=101); Group 2 included patients who were established with OSAS diagnosis but could not adapt to the devices recommended for medical purposes (n=76); and Group 3 included patients who were established with ordinary snoring diagnosis but did not have OSAS, (n=79). Group 1 used CPAP, Auto CPAP, or BiPap. For all groups, BMI and neck circumference data were obtained from sleep centre records (baseline values) and invited to visit again for follow-up measurements in otolaryngology outpatient clinic (control values).

Results: In Group 1, both BMI and neck circumference were increased at follow-up compared with the baseline measurements ($p<0.05$) while no significant change was detected in the other two groups ($p>0.05$). The BMI and neck circumference did not differ among the devices used in Group 1 (CPAP, Auto CPAP, and BiPap) ($p>0.05$).

Conclusion: Devices used to treat OSAS tend to enhance weight gain. Such patients should be closely monitored and the required measures should be taken in terms of obesity.

Keywords: Auto CPAP, body mass index, BiPap, continuous positive airway pressure (CPAP), neck circumference, obstructive sleep apnoea syndrome (OSAS).

Özet: Uyku apnesi tedavisinde kullanılan cihazlar kilo almaya eğilimi arttırıyor olabilir mi?

Amaç: Bu çalışma ile tıkayıcı uyku apnesi sendromu (TUAS) hastalarının tedavisinde kullanılan cihazların kilo değişiklikleri üzerine etkilerinin araştırılması planlandı.

Yöntem: Çalışmaya horlama ve uyku apnesi şikayetleriyle başvurup polisomnografi (PSG) tetkiki istenen 256 hasta dahil edildi. Hastalar apne hipopne indeksleri (AHI) ve cihaz kullanım durumlarına göre aşağıdaki şekilde gruplandırıldı: Grup 1 TUAS tanısı konularak tedavi amaçlı cihaz kullananlar (n=101), Grup 2 TUAS tanısı konularak tedavi amaçlı önerilen cihaza uyum sağlayamayanlar (n=76) ve Grup 3 PSG ile basit horlama teşhisi konulup TUAS olmayanlar (n=79). Grup 1; CPAP, Auto CPAP veya BiPap kullanan hastalardan oluşmaktadır. Her üç grup hastanın da vücut kitle indeksi (VKİ) ve boyun çevresi (BÇ) ölçümleri kayıtlarına PSG merkezinden ulaşıldı (başlangıç değerleri); bu hastalar tekrar ölçüm ve kontrol için Kulak Burun Boğaz polikliniğine çağırılarak değerlendirildiler (kontrol değerleri).

Bulgular: Grup 1 hastalarında; başlangıç değerleri ile kontrol değerleri karşılaştırıldığında: VKİ ve BÇ istatistiksel olarak anlamlı derecede yüksekti ($p<0.05$), Grup 2 ve 3 için VKİ ve BÇ'de istatistiksel olarak anlamlı bir fark saptanmadı ($p>0.05$). Grup 1 de farklı cihaz türlerini kullanan (CPAP, Auto CPAP veya BiPap) hastalar için VKİ ve BÇ açısından anlamlı farklılık göstermedi ($p>0.05$).

Sonuç: Uyku apnesi hastalarını tedavi etmek için kullanılan cihazlar kilo almaya eğilimi arttırmaktadırlar. Bu hastaların ileride kısır döngüye sebep olmamak için obezite açısından yakın takipleri ve gerekli önlemlerin alınması gerekir.

Anahtar sözcükler: Uyku apnesi, CPAP, Auto CPAP, BiPap, vücut kitle indeksi, boyun çevresi.

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Received: August 12, 2015; **Accepted:** October 22, 2015

Online available at:
www.entupdates.org
doi:10.2399/jmu.2015003010
QR code:

Obstructive sleep apnoea syndrome (OSAS) is characterized by successive episodes of interrupted or decreased respiration.[1] The diagnosis of OSAS is based on polysomnography (PSG), which consists of monitoring nocturnal sleep in a special laboratory and includes electroencephalographic and respiratory parameters. PSG verifies respiratory airflow cessation, accompanied by loud intermittent snoring, which may be associated with nocturnal awakening and episodes of desaturation, as measured by the apnoea-hypopnoea index (AHI).[2–4]

The main risk factors for OSAS have been shown to be obesity and male sex.[5] An estimated 70% of individuals with OSAS are obese.[6,7] In OSAS patients, a 10% weight gain was associated with an increase of about 32% in the AHI; moreover, a 10% decrease in weight was associated with a 26% reduction of the AHI.[8] In OSAS patients, micrognathia, retrognathia, macroglossia, elongated soft palate, or a large uvula can lead to airway obstruction.[9]

Debate continues on whether OSAS treatment devices cause weight changes. Some authors found that CPAP devices triggered weight loss;[10,11] others reported the opposite.[12,13] We sought to clarify this question. To the best of our knowledge, this is the first work to explore the effects of CPAP, Auto CPAP, and BiPap on body mass index (BMI).

Materials and Methods

This study was performed at Çorlu State Hospital between 2010 and 2013 and followed the guidelines of the Declaration of Helsinki.[14] The study was approved by the Ethics Committee of Bakırköy Dr. Sadi Konuk Training and Research Hospital (Date: 2013, number: 119).

Subjects

This study enrolled 256 patients who were admitted to the ENT outpatient clinics of Çorlu State Hospital and underwent polysomnography for suspected OSAS. Many of them complained of snoring and some had breathing deficits during the night. Patients whose apnoea hypopnoea index (AHI) values were over 5/h were diagnosed with OSAS. The 256 patients were grouped as follows:

1. **Group 1, OSAS+Device users (OSD) (n=101):** These OSAS patients were recommended to use an OSAS device, such as a continuous positive airway pressure (CPAP) device, Auto CPAP, or BiPap. Their AHI values were over 5/h. The mean age of the patients was 52.29±1.05 (range: 30 to 76) years.
2. **Group 2, OSAS+non-Device users (OSnD) (n=76):** These OSAS patients declined to use a device (CPAP, Auto CPAP, or BiPap). The mean age of the patients was 49.98±1.31 (range: 22 to 76) years.
3. **Group 3, Non-OSAS+non-Device users (nOSnD) (n=79):** This group served as the control group as they did not require an OSAS device (CPAP, Auto CPAP, or BiPap). Their AHI values were lower than 5/h. The mean age of the patients was 42.81±1.35 (range: 18 to 68) years.

Exclusion criteria included patients diagnosed with neurological diseases or malignancies, and those who had undergone surgery of the head-and-neck region. Also, those who took weight loss medications and/or who underwent bariatric surgery were excluded.

Device types

In Group 1, three devices were used:

1. **CPAP:** REMstar M Series (Philips Respironics, Murrysville, PA, USA)
2. **Auto CPAP:** REMstar Auto A-Flex (Philips Respironics, Murrysville, PA, USA)
3. **BiPap:** BiPap Plus M Series (Philips Respironics. Murrysville, PA, USA)

Methods

1. All patients underwent polysomnography and their AHI and respiratory disturbance index (RDI) values were recorded.
2. Patients were classified as OSAS or non-OSAS according to the AHI values. Patients with AHI values over 5/h were classified as having OSAS, and those with AHI values less than 5/h were considered the control group.
3. Initial height, weight, and neck circumference were measured, and the body mass index (BMI) calculated, in our sleep center. Patients were invited to visit again for follow-up measurements in otolaryngology outpatient clinic. These were performed on all patients in Groups 1–3 at 23.05±1.01, 23.05±1.01, and 24.44±1.17 months later, respectively. During that time, group 1 patients used a CPAP, Auto CPAP, or BiPap device.
4. The frequency of device usage and pressure of the device (cmH_2O) were also noted for Group 1.

Statistical analysis

The statistical calculations were performed using SPSS 16.0 (SPSS, Chicago, IL, USA). The Kruskal-Wallis variance analysis, Mann-Whitney U-test with Bonferroni adjustment, Wilcoxon signed-rank test, and Spearman's

rank correlation coefficient test were used. A p-value less than 0.05 was defined as statistically significant. When the Bonferroni adjustment was performed, an adjusted p-value less than 0.0175 was defined as statistically significant.

Results

The patient characteristics, including BMI and neck circumference, are shown in Table 1. In Group 1, the AHI and RDI were 59.59±2.67 and 61.25±2.64 per hour, respectively. Their symptom duration was 33.89±2.75 months. In Group 2, the AHI and RDI were 44.76±2.29 and 45.57±2.27 per hour, respectively. Their symptom duration was 23.05±1.01 months. In the control group (Group 3), the AHI and RDI were 2.89±1.44 and 3.65±2.11 per hour, respectively. Their symptom duration (snoring) was 24.44±1.17 months.

Fig. 1 shows baseline and follow-up BMI values and neck circumferences, for all groups (Group 1 used a device and Groups 2 and 3 did not).

For each group, the difference in BMI and neck circumference between the baseline and follow-up values was analyzed with the Wilcoxon signed-rank test. In Group 1, both the BMI and neck circumference had increased at follow-up ($p<0.05$) (Table 1). For the other groups (Groups 2 and 3), no significant difference was detected ($p>0.05$).

The difference between the initial and follow-up BMI and neck circumference of Groups 1–3 was analyzed using the Kruskal-Wallis test; the difference was significant for all items ($p<0.05$) (Table 1).

To identify the value responsible for the difference, the Mann-Whitney U-test with Bonferroni adjustment was performed and $p_{adjusted}<0.0175$ was defined as indicative of statistical significance.

For Group 1, the difference between the baseline and follow-up BMI and neck circumference for all three OSAS devices was not significant (Kruskal-Wallis variance analysis, $p>0.05$).

For all three groups, Spearman's rank correlation coefficient test showed a positive correlation between the baseline and follow-up BMI and neck circumference.

Discussion

We found that both BMI and neck circumference increased after approximately two years of sleep apnoea devise use, whereas no significant change was detected in either untreated sleep apnoea patients or controls. BMI

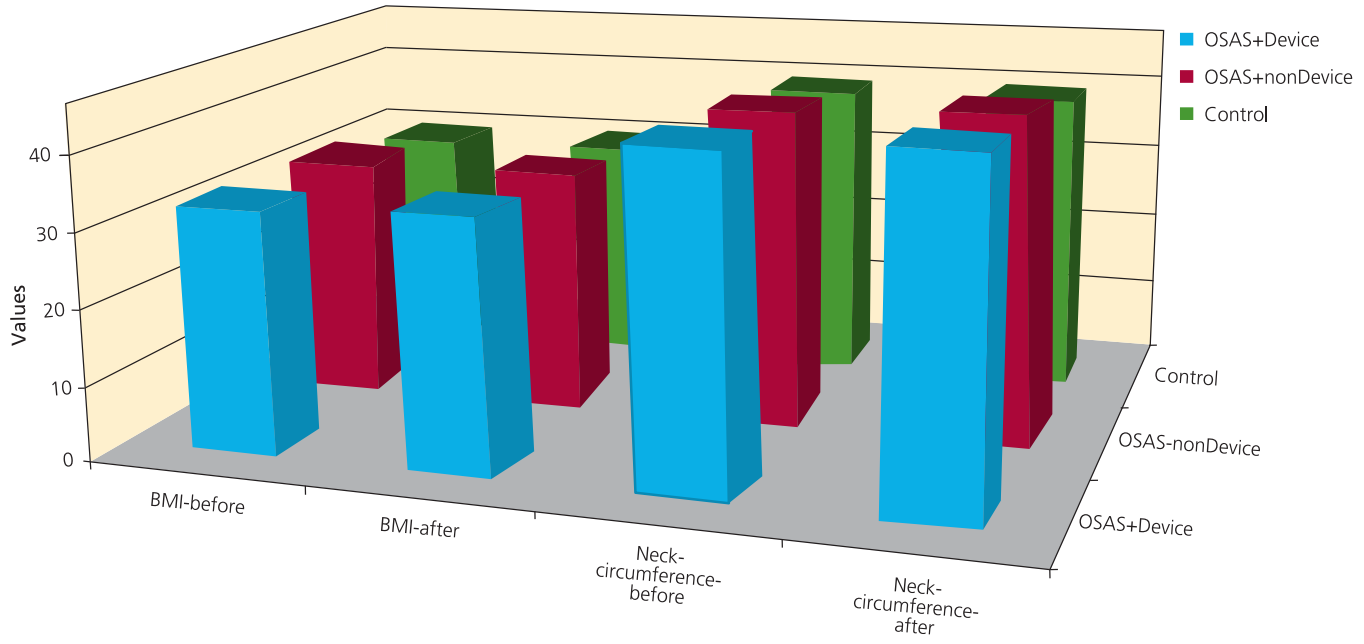

Fig. 1. BMI and neck circumference values (Body mass index in kg/m² and neck circumference in cm).

Table 1. Characteristics of the patients and BMI and neck circumference values of Groups 1–3.

	Group 1 (OSAS+Device user) (OSD) (n=101)				Group 2 (OSAS+non-Device user) (OSnD) (n=76)				Group 3 (Non-OSAS+non-Device user) (nOSnD) (n=79)				p*	$p_{adjusted}$ <0.0175†
	Mean± Std. Dev.	Median	Min.	Max.	Mean± Std. Dev.	Median	Min.	Max.	Mean± Std. Dev.	Median	Min.	Max.		
Age	52.29±1.05	53.00	30.00	76.00	49.98±1.31	48.50	22.00	76.00	42.81±1.35	44.00	18.00	68.00	0.000	Groups 1–3 Groups 2–3
AHI	59.59±2.67	56.00	17.00	167.00	44.76±2.29	39.00	17.00	117.00	2.89±1.44	3.00	.00	5.00	0.000	Groups 1–2 Groups 1–3 Groups 2–3
RDI	61.25±2.64	58.00	17.00	167.00	45.57±2.27	38.00	20.00	117.00	3.65±2.11	3.00	.00	10.00	0.000	Groups 1–2 Groups 1–3 Groups 2–3
Symptom duration (months)	33.89±2.75	22.00	8.00	120.00	23.05±1.01	23.00	2.00	50.00	24.44±1.17	25.00	1.00	43.00	0.386	Groups 1–3 Groups 2–3
Baseline														
BMI (kg/m²)	32.21±5.24	31.39	21.16	53.33	32.21±6.05	31.99	18.56	48.67	29.781±5.09	29.68	19.72	45.79	0.006	Groups 1–3 Groups 2–3
Neck circumference (cm)	43.08±3.38	43.00	36.00	54.00	42.03±3.87	42.00	35.00	54.00	39.45±3.27	39.00	33.00	48.00	0.000	Groups 1–3 Groups 2–3
Follow-up														
BMI (kg/m²)	33.25±5.34	33.20	21.97	48.15	32.01±6.28	31.86	18.56	48.99	29.87±5.13	29.62	20.20	45.79	0.000	Groups 1–3
Neck circumference (cm)	44.40±5.51	44.00	27.00	84.00	42.98±9.21	42.00	35.00	115.00	39.56±3.29	39.00	33.00	48.00	0.000	Groups1–2 Groups 1–3 Groups 2–3
p_{BMI}‡	p=0.000, z=-4.965				p=0.568, z=-0.571				p=0.217, z=-1.234					
$p_{Neck\_circumference}$‡	p=0.000, z=-5.209				p=0.336, z=-0.961				p=0.168, z=-1.378					

*p-value shows the results of Kruskal-Wallis variance analysis. †$p_{adjusted}$ shows the results of the Mann-Whitney U-test with Bonferroni adjustment. ‡p-value shows the results of the Wilcoxon signed-rank test.

and neck circumference values did not differ among the three devices (CPAP, Auto CPAP, and BiPap).

In obstructive sleep apnoea (OSA) patients, sleep-related airway obstructions lead to apnoea. These events provoke arousals and cause oxygen desaturation and heightened sympathetic activity during sleep and waking hours[15] that may contribute to insulin resistance.[16] Sleep apnoea syndrome, for which obesity is a major risk factor, is typically treated with CPAP therapy.[17,18] A relationship between the severity of OSAS and body mass index (BMI) and visceral fat has been reported.[19] Adipocytes express many genes that encode secretory proteins. Obese individuals have low plasma levels of adiponectin, a secretory protein encoded by the gene most abundant in adipocytes.[20,21] Nakagawa et al. found nocturnal reductions in serum adiponectin levels in patients with severe OSAS.[22] These decreases were ameliorated by one-night CPAP treatment. Zamarron et al. reported that, after 12 months of CPAP treatment, significant decreases in plasma intercellular cell adhesion molecule-1 (ICAM-1) levels were evident.[23] An increased plasma ICAM-1 level is a risk factor for cardiovascular events.[24] and adiponectin exerts an anti-atherosclerotic effect by suppressing tumor necrosis factor (TNF).[25] Furthermore, reduced plasma adiponectin levels are associated with coronary artery disease.[26] We do not seek to refute the positive biochemical effects of CPAP device use evidenced in the above-mentioned studies. We also accept that the gold standard for OSA treatment is CPAP application. We rather wish to add only that if the necessary measures are not taken, the use of such devices may establish a vicious cycle causing weight gain.

Quan et al.[13] assessed 1,105 participants with an AHIs≥10 events/hour. Of 812 participants, body weight was measured at baseline and after 6 months. Participants were randomized to the CPAP group or the Sham CPAP group. Participants randomized to the CPAP group gained 0.35±5.01 kg, whereas those in the Sham CPAP group lost 0.70±4.03 kg (mean±SD, p=0.001). The amount of weight gain in the CPAP group was related to hours of device adherence, with each hour per night of use predicting a 0.42 kg increase in weight. This association was not noted in the Sham CPAP group. CPAP participants who used their device ≥4 h per night on ≥70% of nights gained more weight over 6 months in comparison to non-adherent CPAP participants (1.0±5.3 vs. -0.3±5.0 kg, p=0.014). The study concluded that OSA patients using CPAP might gain a modest amount of weight compared to the greatest weight gain observed in those most compliant with CPAP. Redenius et al.[12] reported results similar to those of Quan et al.[13] Garcia et al.[27] assayed insulin and appetite-regulating hormones in 20 obese subjects with OSA before and after 6 months of CPAP use. Forty percent of patients gained significant amounts of weight. They reported that CPAP effectively improved hypoxia. However, subjects had increased insulin and insulin resistance (IR). Their results showed that ghrelin decreased significantly while leptin, adiponectin, and resistin remained unchanged. They concluded that weight change, rather than elimination of hypoxia, modulated alterations in insulin resistance in obese patients with OSA during the first 6 months of CPAP therapy. Our results thus support those of Quan et al.,[13] Redenius et al.,[12] and Garcia et al.[27] Moreover, we found that the extent of weight gain did not vary among devices.

Conversely, Loube et al.[10] found that, of 21 CPAP-treated OSA patients and 11 who were non-compliant, those who self-reported good adherence were more likely to exhibit a weight loss of over 4.5 kg compared to those who were non-adherent. Our data do not support those of Leube et al.[10] as we did not find that CPAP treatment of OSA caused weight loss. Our study population (256) is considerably larger than these earlier studies. Moreover, to the best of our knowledge, we provided the longest-term data published to date (roughly two years from baseline to follow-up measurements).

Treatment with CPAP, Auto CPAP, or BiPap is valid for all degrees of OSAS,[28] and has been shown to reduce sleep problems and related disorders.[29] Several studies have examined the effect of sleep apnoea treatment on depressive symptoms.[28] OSAS may cause depression depending on sleep disruption and cognitive changes induced by intermittent hypoxemia based on sleep loss.[29] Harris et al. reported that the rate of depression coexisting with OSAS ranges from 21–41%.[30] Our results may indicate that the incidence of depressive symptoms was reduced, consequently leading to better appetite and eating habits. The next step in our study will be to determine which depression symptoms are improved and compare the results with the devices used for OSAS treatment.

Our study had certain limitations. First, all initial data were collected in our sleep centre and our population was small. A large prospective study is required to verify our results.

Conclusion

We found that both BMI and neck circumference increased in OSAS patients using respiratory devices. Various devices were associated with similar weight gains.

Conflict of Interest: No conflicts declared.

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Please cite this article as: Ulusoy S, Yavuz N, Dinç ME, Acar M. Can the devices used to treat obstructive sleep apnoea syndrome increase the tendency to gain weight? ENT Updates 2015;5(3):113–118.