

CASE REPORT

Open Access



Low carbohydrate diet-based intervention for obstructive sleep apnea and primary hypothyroidism in an obese Japanese man

Yoshio Tokuchi^{1*} , Yayoi Nakamura¹, Yusuke Munekata² and Fumio Tokuchi¹

Abstract

Background: Obesity is a major risk factor for obstructive sleep apnea (OSA), and weight loss is necessary in the overall management of obese patients with OSA. However, primary care physicians can provide only limited weight loss with lifestyle interventions, usually reducing a patient's body weight by only 2.5 kg or less after 6–18 months.

Case presentation: A 45-year-old Japanese man was referred to our clinic owing to obesity, daytime sleepiness, and snoring during sleep. His weight was 130.7 kg and his body mass index (BMI) was 41.0 kg/m². He underwent polysomnography, which revealed OSA with an apnea–hypopnea index of 71.2 events/h (normal, <5 events/h). His laboratory results were as follows: thyroid stimulating hormone, >500 µIU/mL; free triiodothyronine, 1.4 pg/mL; free thyroxine, <0.15 ng/dL; thyroid peroxidase antibody, 10 IU/mL; thyroglobulin antibody, >4000 IU/mL; total cholesterol (TC), 335 mg/dL; high-density lipoprotein cholesterol, 45 mg/dL; triglycerides (TGs), 211 mg/dL; low-density lipoprotein cholesterol, 248 mg/dL; fasting blood sugar, 86 mg/dL; and glycated hemoglobin (HbA1c), 6.1 %. These results showed that he also had primary hypothyroidism (Hashimoto's disease). Continuous positive airway pressure (CPAP), levothyroxine replacement, and a low-carbohydrate diet (LCD) were initiated. CPAP use and a euthyroid condition induced by 175 µg/day levothyroxine allowed the patient to proactively reduce his body weight. After 18 months, the patient achieved a weight reduction of 32.4 kg (25 % of his initial weight) and a BMI reduction of 10.2 kg/m², as well as improved laboratory results, including an HbA1c level of 5.3 %, TC level of 194 mg/dL, and TG level of 89 mg/dL.

Conclusion: An LCD may be an effective intervention for weight loss in obese Japanese patients with OSA. Further studies are needed to investigate the weight loss effect of an LCD compared with a conventional calorie-restricted diet. Hopefully, this case report will help to improve the management of obese Asian patients with OSA who typically consume a higher amount of carbohydrates.

Keywords: Obstructive sleep apnea, Continuous positive airway pressure, Low-carbohydrate diet, Obesity, Hypothyroidism, Levothyroxine replacement

Background

Obesity is a major risk factor for obstructive sleep apnea (OSA) [1], and weight loss is necessary in the overall management of obese patients with OSA. However, primary care physicians can provide only limited

weight loss by medical therapy alone. Previous trials, in which primary care physicians offered lifestyle counseling, achieved a weight loss of only 2.5 kg or less after 6–18 months [2, 3]. In addition, intensive medical therapy or enhanced weight loss counseling for patients with obesity has been shown to achieve a mean weight loss of 4.3–5.1 kg after 2–3 years [1, 2, 4]. In contrast, continuous positive airway pressure (CPAP)—the standard treatment for OSA—may actually increase the body weight of

*Correspondence: yoshio-tokuchi@hokkaido.med.or.jp

¹ Tokuchi Naika Clinic, 3-6, Iwamizawa, Hokkaido 068-0023, Japan
Full list of author information is available at the end of the article

patients [5]. On the other hand, hypothyroidism can be associated with OSA [6], and some symptoms, such as daytime sleepiness, fatigue, and lethargy, overlap for both diseases.

Here, we describe an obese Japanese man with OSA and primary hypothyroidism who was treated with CPAP, levothyroxine replacement, and a low-carbohydrate diet (LCD) and achieved a weight reduction of 32.4 kg (25 % of his initial weight) and a body mass index (BMI) reduction of 10.2 kg/m² after 18 months.

Case presentation

In January 2014, a 45-year-old Japanese man was referred to our clinic owing to obesity, daytime sleepiness, and snoring during sleep. His Epworth Sleepiness Scale score was 10 points. He underwent overnight diagnostic polysomnography in February 2014. Upon admission, his height was 178.6 cm, weight was 130.7 kg, abdominal circumference was 122 cm, and BMI was 41.0 kg/m². Physical examination showed that the thyroid gland was not palpable. His serum levels of creatine kinase and creatinine were elevated at 1581 U/L and 1.46 mg/dL, respectively, while his other laboratory results were as follows: aspartate aminotransferase, 57 U/L; alanine aminotransferase, 49 U/L; lactate dehydrogenase, 353 U/L; total cholesterol (TC), 335 mg/dL; high-density lipoprotein cholesterol, 45 mg/dL; triglycerides (TGs), 211 mg/dL; low-density lipoprotein cholesterol, 248 mg/dL; fasting blood sugar, 86 mg/dL; glycated hemoglobin (HbA1c), 6.1 %; thyroid-stimulating hormone (TSH), >500 μIU/mL; free triiodothyronine, 1.4 pg/mL; free thyroxine, <0.15 ng/dL; thyroid peroxidase antibody, 10 IU/mL; and thyroglobulin antibody, >4000 IU/mL (Table 1). Blood samples were evaluated using routine methods at Sapporo Clinical Laboratory Inc. (Sapporo, Hokkaido, Japan). Based on these results, indicating hypothyroidism and thyroglobulin antibody positivity, the patient was diagnosed with severe primary hypothyroidism (Hashimoto's thyroiditis). His dyslipidemia and impaired glucose tolerance were considered as secondary changes due to primary hypothyroidism and obesity. Because polysomnography showed an apnea–hypopnea index (AHI) of 71.2 events/h (normal, <5 events/h) and a minimal SpO₂ of 60 %, he also was diagnosed with severe OSA associated with autoimmune hypothyroidism. Therefore, in the beginning of March 2014, nasal CPAP (ICON+Auto, auto-adjusting CPAP; Fisher & Paykel Healthcare Limited, Auckland, New Zealand; minimal pressure, 4.0 cmH₂O; maximal pressure, 18.0 cmH₂O) and low-dose levothyroxine (12.5 μg/day) were initiated. Upon initiation of the CPAP therapy, the patient was informed that he would have to continue with the CPAP therapy unless his body weight decreased sufficiently.

Table 1 Laboratory results of blood samples on admission

CBC	
WBCs	5500 × 10 ³ /μL
RBCs	452 × 10 ⁴ /μL
Hgb	14.1 g/dL
PLTs	25.6 × 10 ⁴ /μL
Glucose	
FBS	86 mg/dL
HbA1c	6.1 %
Lipids	
TC	335 mg/dL
HDL-C	45 mg/dL
TGs	211 mg/dL
LDL-C	248 mg/dL
Thyroid	
TSH	>500 μIU/mL
ft4	<0.15 ng/dL
ft3	1.4 pg/mL
Tg antibody	>4000 IU/mL
TPO antibody	10 IU/mL
Biochemistry	
TP	6.9 g/dL
TB	0.8 mg/dL
AST	57 U/L
ALT	49 U/L
LDH	353 U/L
ALP	209 U/L
γGTP	75 U/L
CK	1581 U/L
Cr	1.46 mg/dL
UA	6.9 mg/dL
BUN	11.4 mg/dL
Na	139 mEq/L
K	4.1 mEq/L
Cl	98 mEq/L
CRP	0.17 mg/dL

Abnormal findings are italicized

ALP alkaline phosphatase, ALT alanine aminotransferase, AST aspartate aminotransferase, BUN blood urea nitrogen, CBC complete blood count, CK creatine kinase, Cl chloride, Cr creatinine, CRP C-reactive protein, FBS fasting blood sugar, ft3 free triiodothyronine, ft4 free thyroxine, γGTP gamma-glutamyl transferase, HbA1c glycated hemoglobin, HDL-C high-density lipoprotein cholesterol, Hgb hemoglobin, K potassium, LDH lactate dehydrogenase, LDL-C low-density lipoprotein cholesterol, Na sodium, PLTs platelets, RBCs red blood cells, TB total bilirubin, TC total cholesterol, Tg thyroglobulin, TGs triglycerides, TP total protein, TPO thyroperoxidase, TSH thyroid-stimulating hormone, UA uric acid, WBCs white blood cells

In April 2014, the patient's body weight had decreased to 125.2 kg, and post-CPAP polysomnography indicated improved OSA (AHI, 2.8 events/h; minimal SpO₂, 88 %). A monthly follow-up visit was scheduled to check his body weight and adherence to CPAP. The memory stick of the CPAP machine showed that he used CPAP for

an average of 6 h per night, 6 days a week, and that he had an AHI of approximately 2.0 events/h. In the course of gradually increasing the dose of levothyroxine, the patient reportedly felt better and had recovered from his fatigue and lethargy.

To address his weight loss as a priority, an LCD was initiated in July 2014 [7]. Yamada et al. [8] reported the benefits of a non-calorie-restricted LCD with the amount of carbohydrates limited to 70–130 g/day for Japanese patients with type 2 diabetes. The patient consumed 50 g of white rice per meal in addition to vegetables, fish, eggs, and meat in the morning and at noon; however, he did not eat rice, noodles, or other carbohydrates at night. In February 2015, the dose of 175 µg/day levothyroxine appeared to maintain a euthyroid state (TSH, 0.75 µIU/mL), and his other laboratory results were within normal limits, including an HbA1c level of 5.3 %, TC level of 194 mg/dL, and TG level of 89 mg/dL.

Finally, in July 2015, the patient's body weight reached 98.3 kg, a reduction of 32.4 kg (25 % of his initial body weight), while his BMI decreased from 41.0 to 30.8 kg/m². Figure 1 shows changes in his body weight and TSH level over time. The patient felt motivated by the prospect of discontinuing the CPAP therapy, and was encouraged by the consistent weight loss at the monthly clinical visits. He also wanted to continue with the LCD because he did not find it difficult.

Discussion

The course of this patient provided two important clinical suggestions. First, this obese Japanese man with OSA achieved a weight loss of 32.4 kg (25 % of his initial body weight) by medical therapy alone. Second, an LCD may be an effective intervention for obese Japanese patients with OSA.

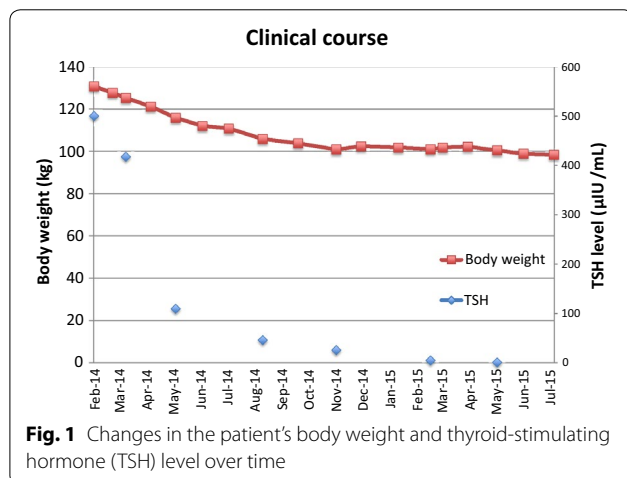
There are three potential mechanisms for this patient's successful weight loss. First, CPAP was able to control

his sleepiness effectively. Second, his primary hypothyroidism was corrected to a euthyroid state with 175 µg/day levothyroxine. Third, an LCD was initiated as dietary therapy. Therefore, both OSA and primary hypothyroidism were treated simultaneously in this patient. He recovered from his fatigue and lethargy, thus enabling him to reduce his body weight more proactively. In developed Western countries, bariatric surgery can be performed for weight loss in patients with obesity [1, 4]. Such surgeries have been shown to achieve a weight loss of 24.5–27.8 kg (20.6–24.5 % of initial body weight) after 2–3 years [1, 4]. Therefore, the weight loss of this patient after 2 years was similar to that observed in those who have undergone bariatric surgery.

An LCD is an effective intervention for weight loss in patients with obesity [7]. Japanese individuals typically consume a higher amount of carbohydrates compared with Western populations, obtaining approximately 60 % of their total energy intake from carbohydrates [9]. Therefore, an LCD may have a superior weight loss effect in obese Japanese patients. As far as we know, this is the first case in which an LCD was initiated in an obese Japanese patient with OSA. An LCD was introduced in this case in July 2014. His weight loss from June to July was 1.4 kg, whereas, from July to August, his weight loss was 5.1 kg. Thus, the LCD seemed to accelerate his weight loss. His glucose and lipid metabolism also improved without diabetes or hyperlipidemia medication. In a previous large long-term observational study in Japan, a usual LCD was found to be significantly inversely associated with cardiovascular and total mortality [9]. Therefore, an LCD could allow Japanese primary care physicians to achieve clinically meaningful weight loss in their obese patients, which they might not be able to accomplish otherwise. However, because CPAP may increase the body weight of obese patients with OSA [5, 10], additional therapy for weight loss is required. Furthermore, weight loss after levothyroxine replacement for hypothyroidism does not always occur [11, 12]. In a previous study, levothyroxine achieved a weight loss of only 4.3 kg (from an average of 83.7–79.4 kg) after 1 year [13]. Moreover, such weight loss occurred due to decrease in lean body mass, whereas fat mass did not decline [13]. This suggests that the weight loss after levothyroxine replacement was due to loss of excess body water associated with untreated myxedema [13]. Thus, levothyroxine replacement alone may not achieve an adequate weight loss in patients with hypothyroidism.

Conclusion

We described an obese Japanese man with OSA and primary hypothyroidism who achieved a weight loss of 32.4 kg (25 % of his initial body weight) by medical



therapy alone. We further demonstrated that an LCD may be an effective intervention for weight loss in obese Japanese patients with OSA. Further studies are needed to investigate the weight loss effect of an LCD compared with a conventional calorie-restricted diet. Hopefully, this case report will help to improve the management of obese Asian patients with OSA who typically consume a higher amount of carbohydrates.

Abbreviations

AHI: apnea-hypopnea index; BMI: body mass index; CPAP: continuous positive airway pressure; HbA1c: glycated hemoglobin; LCD: low-carbohydrate diet; OSA: obstructive sleep apnea; TC: total cholesterol; TGs: triglycerides.

Authors' contributions

YT managed the patient and drafted the manuscript. YN performed the thyroid ultrasonography and advised the management of the patient. YM analyzed the sleep studies and managed the CPAP at the patient's home. FT supervised both the management of the patient and the drafting of the manuscript. All authors read and approved the final manuscript.

Author details

¹ Tokuchi Naika Clinic, 3-6, Iwamizawa, Hokkaido 068-0023, Japan. ² Hokkaido Air Water Inc., Kikusui 5-2-3-12, Shiroishi-ku, Sapporo, Hokkaido 003-0805, Japan.

Acknowledgements

The authors wish to thank Drs. K. Ebe (Takao Hospital) and J. Kanaya (Sapporo Masui Clinic) for their helpful advice and discussion. They also wish to thank Editage (www.editage.jp) for providing its English language editing service.

Competing interests

The authors declare that they have no competing interests.

Availability of data and materials

The datasets supporting the conclusions of this article are included within the article and its additional files.

Consent for publication

Written informed consent was obtained from the patient for publication of this case report and any accompanying images.

Received: 9 June 2016 Accepted: 29 July 2016

Published online: 05 August 2016

References

- Dixon JB, Schachter LM, O'Brien PE, Jones K, Grima M, Lambert G, et al. Surgical vs conventional therapy for weight loss treatment of obstructive sleep apnea: a randomized controlled trial. *JAMA*. 2012;308:1142–9.
- Wadden TA, Volger S, Sarwer DB, Vetter ML, Tsai AG, Berkowitz RI, et al. A two-year randomized trial of obesity treatment in primary care practice. *N Engl J Med*. 2011;365:1969–79.
- Kanke S, Kawai T, Takasawa N, Mashiyama Y, Ishii A, Kassai R. Interventions for body weight reduction in obese patients during short consultations: an open-label randomized controlled trial in the Japanese primary care setting. *Asia Pac Fam Med*. 2015;14:5.
- Schauer PR, Bhatt DL, Kirwan JP, Wolski K, Brethauer SA, Navaneethan SD, et al. Bariatric surgery versus intensive medical therapy for diabetes—3-year outcomes. *N Engl J Med*. 2014;370:2002–13.
- Drager LF, Brunoni AR, Jenner R, Lorenzi-Filho G, Benseñor IM, Lotufo PA. Effects of CPAP on body weight in patients with obstructive sleep apnoea: a meta-analysis of randomised trials. *Thorax*. 2015;70:258–64.
- Attal P, Chanson P. Endocrine aspects of obstructive sleep apnea. *J Clin Endocrinol Metab*. 2010;95:483–95.
- Shai I, Schwarzfuchs D, Henkin Y, Shahar DR, Witkow S, Greenberg I, et al. Weight loss with a low-carbohydrate, Mediterranean, or low-fat diet. *N Engl J Med*. 2008;359:229–41.
- Yamada Y, Uchida J, Izumi H, Tsukamoto Y, Inoue G, Watanabe Y, et al. A non-calorie-restricted low-carbohydrate diet is effective as an alternative therapy for patients with type 2 diabetes. *Intern Med*. 2014;53:13–9.
- Nakamura Y, Okuda N, Okamura T, Kadota A, Miyagawa N, Hayakawa T, et al. Low-carbohydrate diets and cardiovascular and total mortality in Japanese: a 29-year follow-up of NIPPON DATA80. *Br J Nutr*. 2014;112:916–24.
- Tachikawa R, Ikeda K, Minami T, Matsumoto T, Hamada S, Murase K, et al. Changes in energy metabolism after continuous positive airway pressure for obstructive sleep apnea. *Am J Respir Crit Care Med*. 2016 Mar 1. [Epub ahead of print].
- Lee SY, Braverman LE, Pearce EN. Changes in body weight after treatment of primary hypothyroidism with levothyroxine. *Endocr Pract*. 2014;20:1122–8.
- Skjoldt NM, Atkar R, Easton PA. Screening for hypothyroidism in sleep apnea. *Am J Respir Crit Care Med*. 1999;160:732–5.
- Karmisholt J, Andersen S, Laurberg P. Weight loss after therapy of hypothyroidism is mainly caused by excretion of excess body water associated with myxoedema. *J Clin Endocrinol Metab*. 2011;96:E99–103.

Submit your next manuscript to BioMed Central and we will help you at every step:

- We accept pre-submission inquiries
- Our selector tool helps you to find the most relevant journal
- We provide round the clock customer support
- Convenient online submission
- Thorough peer review
- Inclusion in PubMed and all major indexing services
- Maximum visibility for your research

Submit your manuscript at
www.biomedcentral.com/submit

