Eur Arch Otorhinolaryngol (2006) 263: 481–486
DOI 10.1007/s00405-005-1018-y

MISCELLANEOUS

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Upper airway surgery: the effect on nasal continuous positive airway pressure titration on obstructive sleep apnea patients

Published online: 1 February 2006

Abstract The objective of this study was to observe the change in CPAP pressure after nasal and/or tonsil surgery in a retrospective study involving 17 patients unable to tolerate CPAP titration. All patients had two polysomnography studies for titration: one before and another subsequent to upper airway surgical treatment. The results showed a mean age of 49 ± 9 years, a body mass index of 30 ± 4 kg/m^2 and an apnea-hypopnea index of 38 ± 19. Surgical procedures were radiofrequency reduction of the inferior turbinate (eight patients), septoplasty (one patient), septoplasty with inferior turbinectomy (two patients), septoplasty with inferior turbinate submucosal diathermy (two patients), septoplasty with tonsillectomy (two patients), septoplasty with inferior turbinate submucosal diathermy and tonsillectomy (one patient) and tonsillectomy (one patient). CPAP titration before and after surgery had respectively a mean pressure of 12.4 ± 2.5 and 10.2 ± 2.2 cmH_2O ($P = 0.001$). Maximum CPAP pressure was 16.4 cmH_2O before and 13 cmH_2O after surgery. A pressure reduction ≥1 cmH_2O occurred in 76.5% of the patients and ≥3 cmH_2O in 41.1%. Upper airway surgical treatment appears to have some benefit by reducing nasal CPAP pressure levels. The effect seems to be greater when the prior pressure was ≥14 cmH_2O.

Keywords Obstructive sleep apnea · Upper airway surgery · CPAP · Radiofrequency · Nasal obstruction

This investigation was conducted at the Sleep Center of the Psychobiology Department and at the Otorhinolaryngology Department, Universidade Federal de São Paulo, São Paulo-SP, Brazil. The authors disclose that they were not the recipients of any form of financial support, nor did they have any involvement with organization(s) with financial interest in the subject matter. This paper was presented in the 17th Annual APSS Meeting, Chicago, IL, 3–8 June 2003.

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Introduction

Obstructive sleep apnea (OSA) has a prevalence of 2% in middle-aged women and 4% in middle-aged men [1]. Clinically, it is associated with a poor quality of sleep and excessive daytime somnolence, which leads to a higher rate of automobile accidents in patients with the syndrome [2, 3]. If left untreated, the cardiovascular complications are associated with significant mortality [4, 5]. In this regard, OSA is considered a public health problem, and as this syndrome is a lifelong condition, it is important to ensure an effective treatment [6].

Nasal CPAP is an efficient therapy, and it is the most appropriate treatment for patients with moderate and severe OSA; however, compliance can be unsatisfactory on account of the dropout rate and its irregular use [7, 8, 9, 10. 11]. Despite relatively good compliance rates, there are some patients who demonstrated a high discomfort rate with CPAP use; 20 to 30% of patients reject CPAP treatment during the first 2 to 4 weeks of use [12]. Also, 8 to 15% of patients refuse CPAP treatment after a single night's use in a laboratory setting [13, 14]. Many of the common complaints with CPAP are pressure related, such as nasal and sinus pressure, air leaks, chest discomfort and flatulence [15, 16]. In addition, nasal side effects are frequently reported by patients during CPAP use, and nasal obstruction is the most common complaint [8, 15, 18, 19, 20]. According to the above-mentioned authors, between 21.9 and 66% of

patients who display CPAP intolerance or discomfort also complain about adverse nasal effects. Some authors have documented the limited efficacy of nasal procedures to improve OSA when a decrease in the apnea-hypopnea index (AHI) is taken into consideration. However, significant improvement in sleep quality and daytime somnolence has been demonstrated after nasal surgical procedures [21, 22, 23, 24, 25]. An improvement in nasal patency can be assured by nasal surgery, despite the fact that it does not necessarily decrease the AHI. Friedman et al. documented some benefit from the decreasing CPAP pressure level after nasal surgery in OSA patients [23].

Many factors can influence CPAP compliance and tolerance. Also, the effective CPAP pressure might be influenced by unsatisfactory nasal permeability, leading to increased upper airway resistance. The objective of the present study was to check the change of CPAP pressure level during polysomnography (PSG) titration after nasal and/or tonsil surgery.

Patients and methods

Methods

We carried out a retrospective case series involving OSA adult patients referred for CPAP titration to the Sleep Institute and the Otorhinolaryngology Clinic of the Universidade Federal de São Paulo. Medical charts and ORL surgery databases were used to identify patients unable to tolerate CPAP titration due to the amount of pressure and/or symptoms of nasal obstruction and who also had undergone nasal and/or tonsil surgical treatment. According to the routine of our practice at the university, all patients with OSA are also seen at the Otorhinolaryngology Department, where physical examination accessing the facial profile, oral cavity, oropharynx characteristics and anterior rhinoscopy is performed. This database was used to address the anatomical alterations during the examination of each patient (septal deviation, turbinate hypertrophy and enlarged tonsils). Seventeen patients who submitted to one or to combined surgical procedures were studied (for example, only nasal surgery or nasal and tonsil surgery at the same time). In this group of patients, the surgical procedures were septoplasty, inferior turbinectomy, inferior turbinate submucosal diathermy, radiofrequency volumetric reduction of inferior turbinate and tonsillectomy.

Patients

All patients had two PSG studies for CPAP titration, one before and another after the surgical treatment. The PSG were performed with a 13-channel SAC Oxford system including an electrocardiogram, oculogram, submental and anterior-tibialis electromyogram, nasal and oral airflow (measured with a thermistor and/or nasal canula), thoracic and abdominal movements, body position and oxygen saturation measured by pulse oximetry. As the health system in our country does not cover the cost of using a CPAP device, many patients in the public day care unit do not use it or take too long to start using it. For this reason, we are unable to address CPAP compliance for this group of patients.

Statistical analysis

Basic descriptive statistics were performed for all variables, including the mean, standard deviation, and minimum and maximum values. The Wilcoxon matched pairs test was used to compare PSG parameters before and after surgical treatment. The level of significance was set for $P \leq 0.05$. The data were analyzed by means of the software Statistica for Windows (Statsoft Inc., 1997).

Results

The 17 patients (16 men and 1 woman) had a mean age of 49 ± 9 years (range: 30–62), a body mass index of 30 ± 4 kg/m^2 (range: 24–39) and apnea-hypopnea index of 38 ± 19 events/h (range: 12.2–79). The upper airway surgical procedures were radiofrequency volumetric reduction of the inferior turbinate in eight patients, septoplasty in one patient, septoplasty with inferior turbinectomy in two patients, septoplasty with inferior turbinate submucosal diathermy in two patients, septoplasty with tonsillectomy in two patients, septoplasty with inferior turbinate submucosal diathermy and tonsillectomy in one patient and just tonsillectomy in one patient. Table 1 summarizes the surgical procedures and CPAP pressure levels before and after surgery for each patient. Pre- and postoperative PSG studies for CPAP titration reveled, respectively, optimal CPAP pressure levels of 12.4 ± 2.5 cmH_2O (range: 7–16) and 10.2 ± 2.2 cmH_2O (range: 7–13) ($P = 0.001$) (Fig. 1). PSG parameters did not change between the first and second titration: the residual apnea-hypopnea index was 10.9 ± 8 cmH_2O (range: 0.7–29) and 5.7 ± 3.9 cmH_2O (range: 1.5–13), the minimum oxygen saturation was $82.2 \pm 9.8\%$ (range: 61–93) and $80 \pm 11\%$ (range: 61–94), the percentage of delta sleep was $19 \pm 9.7\%$ (range: 1.5–33) and $20.1 \pm 10.6\%$ (range: 0.7–43) and the percentage of REM sleep was $20.9 \pm 13.2\%$ (range: 0.7–52) and $20.9 \pm 9.2\%$ (range: 8–44). Considering the whole group, the maximum CPAP pressure level was 16.4 cmH_2O before and 13 cmH_2O after surgery. A fall in CPAP pressure was considered to be just when the variation was ≥1 cmH_2O. According to this, in 23.5% of the patients (4 of 17 patients) the pressure did not decrease; in one patient pressure did not change after the surgical

Table 1 Performed upper airway surgical treatment for the 17 individual patients with CPAP pressure levels before and after surgery

Patient	Upper airway surgical intervention	CPAP pressure (Pre-treatment)	CPAP pressure (Post-treatment)
1	Tonsilectomy	13	12
2	Septoplasty	10	8
3	Septoplasty + tonsilectomy	12	7.5
4	Septoplasty + tonsilectomy	15	11
9	Septoplasty + tonsilectomy + turbinate diathermy	15	11
5	Septoplasty + turbinate diathermy	11	10
7	Septoplasty + turbinate diathermy	12	10
8	Septoplasty + inferior turbinectomy	12.2	13
6	Septoplasty + inferior turbinectomy	10.6	8
10	Radiofrequency of inferior turbinate	7	7
11	Radiofrequency of inferior turbinate	9	8.5
12	Radiofrequency of inferior turbinate	11	10
13	Radiofrequency of inferior turbinate	12	13
14	Radiofrequency of inferior turbinate	14	11
15	Radiofrequency of inferior turbinate	14	7
16	Radiofrequency of inferior turbinate	16	13
17	Radiofrequency of inferior turbinate	16.4	12.4

procedure (7 cmH_2O); in another, the pressure had a small change (9 to 8.5 cmH_2O), and in two patients, there was a small increase in the pressure (12 versus 13 cmH_2O). A reduction of at least 1 cmH_2O was observed in 76.5% of the patients (13 of 17 patients); ≥2 cmH_2O was observed in 58.8% of the patients (10 of 17 patients) and ≥3 cmH_2O in 41.1% of the patients (8 of 17 patients) (Fig. 2).

The patients of the follow-up database did not present any major complications, such as bleeding or infection after surgery. Mucosa adhesion after nasal surgery occurred in one patient who had been submitted to septoplasty and inferior turbinectomy; it was removed by a new surgical procedure. This specific patient became ill after surgery (he came down with dengue fever), and since he was living in another city, he just came back for the nasal surgery follow-up more than 1 month later, justifying the formation of mucosa adhesion.

Discussion

Nasal symptoms and pressure-related complaints are very common during CPAP therapy, so it seems likely that for good compliance, the absence of preexisting nasal disorders is essential. The CPAP pressure level is also a constant concern in sleep centers, where many strategies have been followed to minimize pressure-related complaints, such as titrating the lowest pressure necessary to overcome upper airway obstruction during sleep. Many factors may contribute as determinants of the CPAP pressure level in OSA patients, but they are

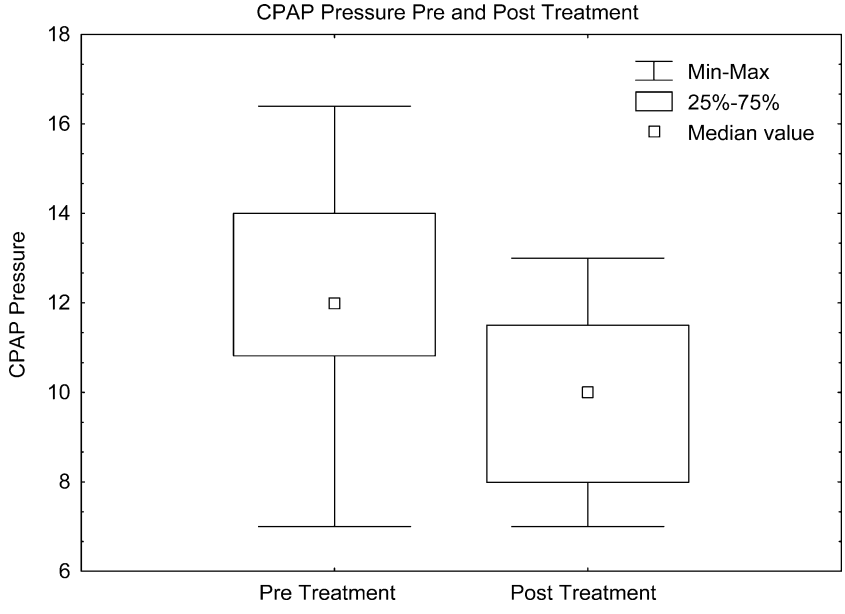

Fig. 1 Average CPAP pressure level before and after surgical treatment

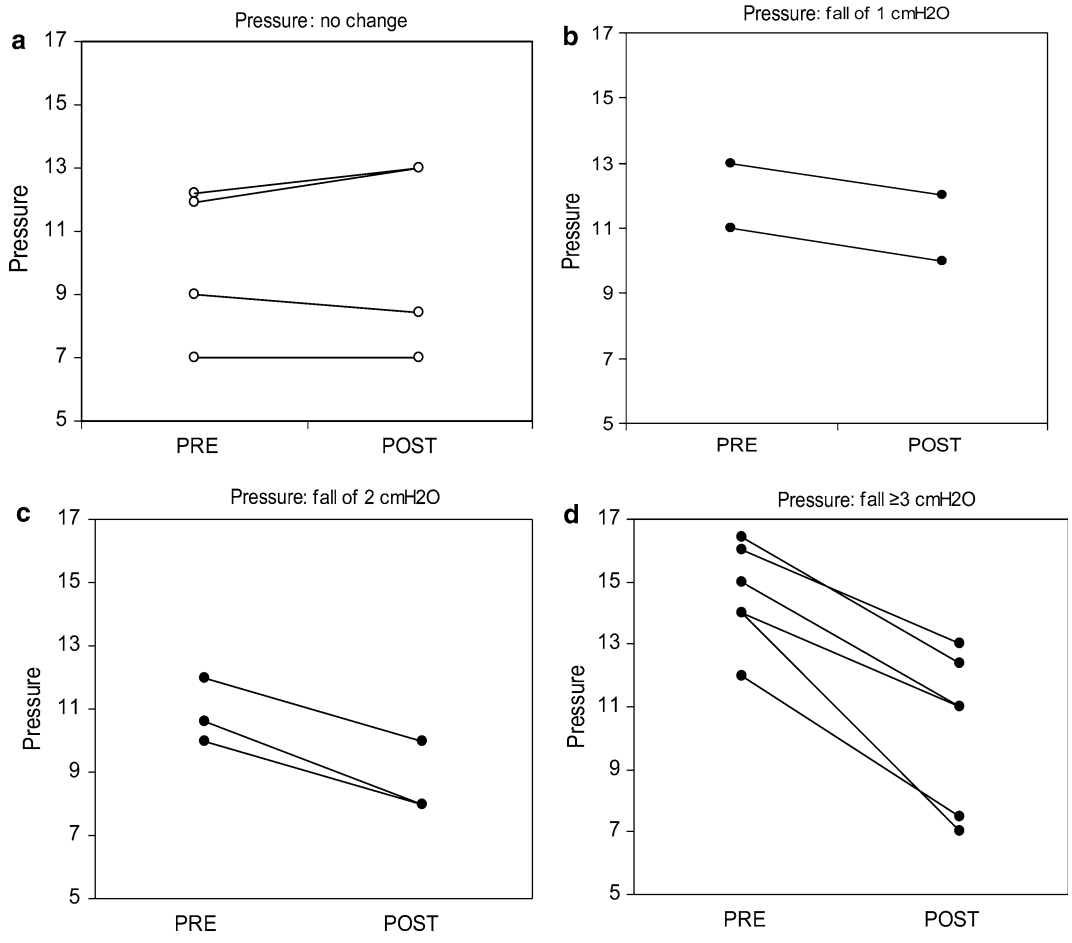

Fig. 2 CPAP pressure change before (pre) and after (post) surgical treatment. **A** Patients without significant fall; **B** patients with a fall of at least 1 cmH_2O; **C** patients with a fall of at least 2 cmH_2O; **D** patients with a fall of 3 cmH_2O or more

not yet well understood. Miljeteig and Hoffstein [26] demonstrated that the variability in CPAP pressures required to abolish sleep apnea is related primarily to obesity and the severity of OSA.

The surgical procedure for the treatment of an obstructed upper airway was initially thought to be an effective treatment to the majority of patients with OSA. Nasal surgery was first reported as a possible treatment for sleep apnea in 1977 by Simmons and co-workers who treated four patients without significant improvement of the obstructive respiratory events after surgery [27]. Subsequently, papers relating the treatment of OSA by nasal surgery also reported partial and limited results [21, 23, 24, 25, 28, 29]. Previous reports have shown that nasal obstruction in normal individuals may lead to an increased nasal resistance causing, as a consequence, sleep disorder breathing events, including snoring, apnea and hypopnea events [30, 31, 32, 33]. An alternative approach, i.e., relieving UAW resistance, may be useful in patients who complain of CPAP discomfort, and also, tolerance to CPAP therapy seems to improve after nasal surgical treatment [21, 22, 23]. Friedman et al. [23] reported that nasal surgery alone may contribute to a decrease in the CPAP level and that the benefit depends on the severity of OSA. An opposite result was recently presented by Masdon et al. [22] in a series of 35 patients who had been treated by uvulopalatopharyngoplasty alone or in combination with nasal surgery, with CPAP titration before and after surgery. They observed that CPAP pressures were decreased in 51.4% of patients, unchanged in 28.6% and increased in 20%. The conclusion was that upper airway surgery does not reduce postoperative CPAP pressure levels. However, the authors did not discuss the fact that their results, with a very limited change in CPAP pressure, could be related to a mouth air leak due to the classical uvulopalatopharyngoplasty [34], and thus, extra pressure could be necessary to maintain the pharyngeal opening.

Nasal septum and inferior turbinectomy surgeries are usually done in OSA patients to improve the nasal patency. The benefit derived from nasal surgery may be as a co-adjuvant therapy, sometimes to facilitate CPAP use. Tonsillectomy is usually done as a curative treatment for patients with OSA, but not for better compliance on CPAP in cases of enlarged tonsils. We believe that any anatomic factors in the nose, such as a deviated septum or enlarged turbinate, can create a blockade of the nasal passage and that an enlarged tonsil can also

increase oropharynx resistance. Both situations may increase airflow resistance during CPAP use. In our results, 76.5% of the patients had a reduction of at least 1 cmH_2O in the CPAP pressure level following surgery. The difference of 2.2 cmH_2O (from 12.4 to 10.2 cmH_2O) observed between the mean pressure before and after the surgical procedure may signify a small reduction, but 41% of the patients had at least a fall of 3 cmH_2O in CPAP pressure, representing a significant reduction. Looking more closely at this group of patients with better benefits, the majority of them had a prior pressure of ≥14 cmH_2O (Fig. 2). We can infer that the higher the initial pressure, the higher the decrease in the pressure level after surgical treatment. One key point is to query how great a fall in pressure is really necessary to make CPAP use more comfortable. According to the literature data, this question remains unanswered. Is a 2 to 3 cmH_2O drop in CPAP pressure important to make CPAP use more comfortable? If not, perhaps that more than 3 or 4 cmH_2O may be. Since we performed different surgical procedures in a small group of patients, we could not establish the statistical correlation between a specific procedure and the degree of change in the CPAP pressure level. In the group without benefit (23%, 4/17 patients), three patients were treated with a radiofrequency volumetric reduction procedure of the inferior turbinate. At the same time, four patients treated by the same procedure had a significant decrease in the CPAP pressure level (14 to 7 cmH_2O, 16.4 to 12.4 cmH_2O, 16 to 13 cmH_2O and 14 to 11 cmH_2O).

Many questions about the correlation of the side effects and pressure level remain unanswered. We studied a small group of patients, limiting the determination of conclusions with statistical significance. We believe that surgical procedures to address nasal and/or pharyngeal anatomical abnormalities, such as a deviated septum, hypertrophied turbinate and enlarged tonsil, may decrease the CPAP titration level and may alleviate CPAP use. Some patients appear to have a limited fall in pressure, while others appear to benefit much more by having a more significant reduction in the pressure; according to the present study, these patients are the ones with prior pressure at 14 cmH_2O.

Conclusions

Upper airway surgical treatment to correct nasal or pharyngeal anatomical abnormalities (deviated septum, hypertrophied turbinate and enlarged tonsil) appears to have a beneficial effect in reducing nasal CPAP pressure levels. The benefit seems to be limited to patients with a prior pressure that is not too high, but it seems to be more beneficial in patients with at least 14 cmH_2O of prior pressure. Understanding the relationship between CPAP compliance and upper airway patency to make CPAP treatment more comfortable and compliance better is still something to be investigated extensively. Studies involving surgical and clinical treatment to reduce upper airway resistance are still needed and must be encouraged, principally involving patients with a high CPAP pressure setting (14 cmH_2O or more).

Acknowledgments The authors would like to thank to Terri E. Weaver, PhD, RN, CS, FAAN, for her valuable support.

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