The Effect of Nasal CPAP on Nocturnal Reflux in Patients With Aperistaltic Esophagus*

J. Patrick Shoenut; Paul Kerr, M.D.; Allan B. Micflikier, M.D.; Yoshihiro Yamashiro, M.D.; and Meir H. Kryger, M.D., F.C.C.P.

It has been shown that nasal continuous positive airway pressure (nasal CPAP) significantly reduces nocturnal reflux both in patients with sleep apnea and in patients without sleep apnea but consistent abnormal nocturnal reflux. The mechanism by which CPAP is thought to reduce reflux includes the elevation of the resting lower esophageal sphincter (LES) pressure. In this study, we tested the effect of nasal CPAP in two groups of patients with aperistaltic esophagus but with different resting LES pressure. Seven patients with scleroderma esophagus and six patients treated for achalasia were tested over a 48-h period. On the first night, the patients were untreated; on the second night, both groups received applied nasal CPAP at 8 cm H2O pressure. The percentage of time the pH <4.0, the number of reflux events >5 min, and the length of the longest reflux event were all significantly reduced in the patients with achalasia (p<0.03), but not in the scleroderma group (p>0.20). These results suggest that a residual resting LES pressure greater than that demonstrated by patients with scleroderma (>10 mm Hg) may be necessary for nasal CPAP to affect nocturnal reflux.

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Nasal continuous positive airway pressure (CPAP) has been shown to reduce nocturnal gastroesophageal reflux (GER) in both patients with obstructive sleep apnea syndrome (OSAS) and patients without OSAS but abnormal nocturnal GER. The etiology for the GER in these two groups is different and multifactorial; however, both groups of patients had essentially normal esophageal function and normal resting lower esophageal sphincter (LES) pressures.

Patients with scleroderma esophagus and patients who have been treated for achalasia are known to demonstrate abnormal reflux patterns. In this study, we performed 48 h of continuous esophageal pH monitoring and polysomnography on 13 consecutive patients with classical esophageal aperistalsis, 7 with scleroderma esophagus, and 6 patients with achalasia. To be included in the study, patients had to demonstrate reflux on the first night. On the second night, all patients were treated with 8 cm H2O pressure of nasal CPAP. The efficacy of CPAP in reducing nocturnal reflux in these patients was evaluated.

METHODS

The study group was composed of 13 patients. Seven patients had known scleroderma esophagus and six patients had been treated for achalasia by either transthoracic limited myotomy without fundoplication or pneumatic dilatation. The study protocol has been reported previously and consisted of esophageal manometry followed by 48 h of continuous esophageal pH monitoring. The pH studies were conducted using a Synectics Mark II digitrapper (Carsen Co, Toronto, Canada). The end of the antimony pH catheter was placed 5 cm above the manometrically determined proximal border of the LES. The position of the catheter was checked fluoroscopically in each case. Patients spent both nights in a sleep laboratory where polysomnography was performed. On the second night, 8 cm H2O pressure was delivered by nasal CPAP. All patients tolerated the procedure well and there were no test failures, although some patients did complain that the pressure was not pleasant.

Patients With Scleroderma

Seven female patients with known, manometrically proved scleroderma esophagus were studied. All patients had Raynaud's phenomenon and ranged in age from 35 to 81 years (mean, 59 years). None of these patients had had chest or upper gastrointestinal tract surgery. Although two of these patients had complained of heartburn, no medication was being taken by any patient that would affect the results of the manometry or pH tests.

Patients With Achalasia

Six patients with achalasia who had been treated by pneumatic dilatation (n=3) or transthoracic limited myotomy without fundoplication (n=3) were studied. These were consecutive patients selected by a previous abnormal nocturnal pH study. These patients ranged in age from 32 to 71 years (mean, 46 years). The follow-up time since treatment was 3.1 ±1.1 months.

Polysomnography

Polysomnography was done to exclude sleep apnea and consis-

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gram, electro-oculogram, electromyogram, electrocardiogram, and recording of the heart rate. Arterial oxygen saturation was recorded with a pulse oximeter (Biox 3700; Ohmeda Incorporated, Boulder, Colo) set on its fastest response. Respiratory effort was measured using respiratory inductance plethysmography (SARA Unit, Vitalog Inc, Redwood, Calif) and airflow inferred from expired CO₂ (Datex 223 CO Analyzer, Datex Instrumentarium, Finland). All patients were videotaped to monitor position. A polygraph (model 78E; Grass Instruments, Quincy, Mass) was used to record data on both paper and floppy disk via a personal computer data acquisition system (IBM compatible).

The complete polygraphic record was scored manually for sleep stage, arousal, and movement according to established criteria. Apneas and hypopneas were identified and quantified by computer-based analysis of oxygen saturation. The number of apneas and hypopneas per hour of sleep is called the apnea/hypopnea index (normal <5).

Statistics
A two-tailed t test was used to test the statistical differences in the data throughout the study. Numbers are reported as mean ± SD.

RESULTS
No esophageal peristalsis was demonstrated by either group of patients. Simultaneous contractions in the body of the esophagus in the patients with achalasia ranged from 5 to 20 mm Hg (average=13 mm Hg). Mean resting LES pressure of the patients with achalasia ranged from 10 to 25 mm Hg (mean=17.1 ± 5.8 mm Hg); for patients with scleroderma, the range was 0 to 4 mm Hg (mean, 2.4 ± 1.3). The difference in LES resting pressure was significant (p<0.01). There was no sleep apnea demonstrated by any patient in either group.

Reflux Status: Patients With Achalasia
The percentage of time the pH was less than 4.0 on night 1 ranged from 11.7 to 57.6 percent (38.5 ± 20.6 percent); on night 2, 0.0 to 14.3 percent (2.9 ± 5.6 percent) (p=0.014). The number of reflux episodes on night 1 ranged from 1 to 17 (6.5 ± 6.5); on CPAP, the range was 0 to 5 (1.8 ± 1.9) (p=0.05). The number of reflux episodes longer than 5 min on night 1 ranged from 1 to 6 (2.7 ± 2.1); on night 2, the range was 0 to 2 (0.5 ± 0.8) (p=0.03). The length of the longest reflux episode ranged from 49 to 272 min on night 1 (134.0 ± 104 min); on CPAP, the range was 0 to 46 min (10.1 ± 18.7 min) (p=0.04).

Reflux Status: Patients With Scleroderma
The percentage of time the pH was less than 4.0 on night 1 ranged from 2.5 to 86.9 percent (33.9 ± 26.5 percent); on CPAP, 0.2 to 67.7 percent (23.2 ± 23.7 percent) (p=0.4). The number of reflux episodes on night 1 ranged from 1 to 32 (11.1 ± 12.6); on CPAP, the range was from 2 to 8 (4.4 ± 2.3) (p=0.19). The number of reflux episodes longer than 5 min on night 1 ranged from 0 to 5.8 (2.6 ± 2.0); on CPAP, 0 to 5.1 (1.7 ± 1.7) (p=0.4). The length of the longest reflux episode on night 1 ranged from 6 to 430 min (130 ± 148 min); on CPAP, 1 to 15.6 min (68 ± 60 min) (p=0.2).

The individual responses to CPAP for both groups of patients are found in Figure 1. Typical patient 24-h monitoring for a patient with achalasia with CPAP intervention in the second night is found in Figure 2; for a patient with scleroderma, Figure 3.

DISCUSSION
Nocturnal GER is an important element in the pathogenesis of esophageal disease. Anecdotal reports in patients with OSAS have suggested that nasal CPAP reduced symptoms of nocturnal reflux in these patients; however, Kerr et al. were the first to show that nasal CPAP significantly reduced the percentage of time the pH <4.0, the number of reflux events, and the length of the longest reflux events in

![Graphs](image-url)
patients with OSAS. In that report, nocturnal reflux was associated with movement, arousal, and swallowing.

Nasal CPAP was shown to reduce nocturnal GER in nonapneic patients. In six patients, Kerr et al showed that 8 cm H2O pressure delivered by nasal CPAP significantly reduced the percentage of time the pH < 4.0 from 27.7 ± 10.0 percent to 5.8 ± 2.6 percent (p = 0.004), the duration from 2.1 ± 0.6 min to 0.9 ± 0.5 min (p < 0.03), and length from 84.3 ± 32.6

Figure 2. Effect of 8 cm H2O nasal CPAP in a treated (pneumatically dilated) patient with achalasia. A, basal; B, CPAP application during study period.

Figure 3. Effect of 8 cm H2O nasal CPAP in a patient with scleroderma esophagus. A, basal; B, CPAP application during study period.
min to 13.8 ± 6.9 min (p<0.01) of reflux events.²

This reduction of reflux was demonstrated without altering the patient's arousal frequency. No change was seen in the amount of daytime reflux, day 1 to day 2. In the same study, the mechanism of this phenomenon was investigated in six volunteers with normal esophageal function. A routine esophageal motility examination was conducted and 8 cm H₂O pressure of nasal CPAP was then applied during the course of another complete esophageal motility test. Resting LES pressure and the intraesophageal resting pressure were both found to be significantly (p<0.05) increased following the application of CPAP. Wave velocity, amplitude, and duration were unchanged.

In the present study, 8 cm H₂O CPAP was found to reduce nocturnal reflux in treated patients with achalasia. No consistent effect was found in patients with scleroderma esophagus. It is unknown whether using a higher pressure may have been effective in the patients with scleroderma. This may indicate that an important factor involved in the reduction of nocturnal reflux was the residual resting pressure of the LES in the patients with achalasia. The mean resting LES pressure in the patient groups in two other studies in which CPAP was successful in reducing nocturnal reflux was 14.1 and 14.6 mm Hg; this was comparable to the resting LES pressure in the group of patients with achalasia described herein (17.1 ± 5.8 mg), and significantly greater (p<0.01) than was found in the patients with scleroderma (2.4 ± 1.3 mm Hg).

Both of these patient groups are known to develop complications secondary to reflux.⁸⁻¹¹ In patients with scleroderma esophagus, several surgical procedures have been proposed to reduce reflux,¹²⁻¹³ including colonic transposition as an initial intervention.¹⁴ Omeprazole has been shown to reduce acid exposure effectively. The dosage to relieve reflux in patients with scleroderma is in the 20- to 80-mg range.³⁻⁴ Patients with achalasia following palliation by either transthoracic limited myotomy or pneumatic dilatation are also known to demonstrate substantial GER. In some centers, fundoplication is added routinely to prevent reflux.

We believe that nasal CPAP may have a place in the treatment of medically and surgically resistant nocturnal reflux. Thousands of patients with OSAS use home CPAP and long-term compliance is about 70 percent. The long-term use of omeprazole would be expensive, even if toxicity trials ultimately prove it safe. A 20-mg daily dose would cost $4,800 (US) a year.¹⁵ Patients with achalasia are generally young when their conditions are diagnosed and treated and have a 40- to 50-year life expectancy. In view of the medication costs, nasal CPAP is not, perhaps, an unreasonable alternative. At the time of this report, three of the patients with achalasia from this study are using home nasal CPAP.

In conclusion, we believe that nasal CPAP reduces nocturnal reflux in patients who have residual LES pressure in excess of that found in patients with scleroderma esophagus (those >10 mm Hg). In studies of patients with resting LES pressure of 14.1, 14.6, and 17.1 mm Hg, nasal CPAP was found to reduce nocturnal reflux significantly. It is not known at present whether long-term CPAP use will prevent reflux-associated complications in patients with achalasia who demonstrate nocturnal reflux. However, further study of nasal CPAP on nocturnal reflux appears warranted.

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REFERENCES