Cervical Positional Effects on Snoring and Apneas

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We examined the effects of cervical position on the Obstructive Sleep Apnea Syndrome (OSAS) through the use of a custom-designed cervical pillow which promoted neck extension. Twelve subjects with OSAS were recruited from a tertiary sleep disorder clinic population. Of the twelve subjects, three had mild cases of OSAS, four had moderate cases, and the remaining five had severe cases. The subjects used their usual pillows during two consecutive recorded baseline nights in our laboratory. The subjects then used the cervical pillow for five days at home, and returned for two consecutive recorded nights at our laboratory while using the cervical pillow. During the nights in our laboratory, the subjects completed questionnaires, were videotaped to record head and body position, and had their breathing parameters recorded during sleep. Subjects with mild OSAS cases had a non-significant improvement in the severity of their snoring and a significant improvement in their respiratory disturbance index with the cervical pillow, while subjects with moderate OSAS cases showed no improvement in these parameters. Subjects with severe OSAS cases showed slight improvement in some measures of their abnormal respiratory events during the experimental period.

CURRENT CLAIM: Subjects with mild cases of the Obstructive Sleep Apnea Syndrome showed improvement in the severity of their snoring and sleep-disordered breathing using a custom-designed pillow which promoted neck extension.

The cervical pillow was designed to reduce the severity of snoring and sleep-disordered breathing in individuals with the Obstructive Sleep Apnea Syndrome (OSAS). Snoring, sleep-related breathing pauses, and excessive daytime sleepiness characterize this sleep disorder. The OSAS diagnosis is confirmed by a respiratory disturbance index (RDI, apnea-hypopnea index) ≥5 events/hr during polysomnography (sleep study) which includes monitoring of respiratory parameters. This disorder carries significant morbidity, including an increased risk for hypertension, cardiac dysrhythmias and failure, myocardial infarction, stroke, and sleepiness-related industrial and motor vehicle accidents.

The cervical pillow was designed to extend the head in a posture similar to that used in cardiopulmonary resuscitation (CPR) to create an open airway in an unconscious victim. Similarly, studies have documented better visualization and patency of the upper airway for intubation of children and adults with the head extended (Westhorpe, 1987; Shorten et al., 1995a; 1995b). Prior investigators have observed that head position modifies upper airway resistance, with less resistance noted when the subjects’ heads were extended (Liistro et al., 1988; Jan et al., 1994). A 20-degree head extension resulted in a significant increase in the cross-sectional dimension of the pharyngeal airway as shown by lateral skull radiographs (Hellsing, 1989). Although these studies evaluated conscious subjects, similar changes in upper airway resistance or cross-sectional area would be expected with head position in sleeping subjects. However, asleep subjects, particularly those with OSAS, would be expected to have overall higher upper airway resistances due to relaxation of the upper airway musculature during sleep. Interestingly, similar findings were observed in dogs (Odeh et al., 1995), where head extension resulted in a more negative pressure at which upper airway collapse occurred and increased maximal flow compared to head flexion.

The cervical pillow used in the present study (Figure 1) consists of a urethane foam foundation, an overlying NASA "memory foam" supporting the head and neck, a stretch terry-cloth cover, and a cotton pillowcase. The pillow was custom-fitted to each subject by three simple measurements of the head and neck. The objective of the present study was to test whether the neck posture enforced by this pillow would be adequate to reduce the severity of the snoring and sleep-disordered breathing in OSAS subjects.

METHODS

Fifteen subjects with OSAS who were otherwise healthy were recruited. Since the subjects were recruited from the clinic population at our tertiary sleep disorders clinic, each subject had a physical examination and evaluation by a board-certified sleep specialist and had confirmation of a diagnosis of OSAS by polysomnography prior to enrollment in the study. The subjects were recruited consecutively into the study following their OSAS diagnosis.

The inclusion criteria for the study were as follows: (1) men and women between the ages of 18 and 80 years; (2) characteristic symptoms of OSAS (e.g., snoring, witnessed breathing pauses, excessive daytime sleepiness); (3) an Epworth Sleepiness Scale Score≥10; and (4) polysomnographic

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confirmation of OSAS, with an RDI>5. Exclusion criteria were complex or serious medical or psychiatric conditions; co-existing sleep disorders; mental or sensory impairment which prevented the subjects from understanding or completing the requirements of the study; alcoholism or substance abuse; use of benzodiazepines, barbiturates, protriptyline, or other respiratory stimulants or depressants; and use of medications known to affect sleep (e.g., antitussives, antihistamines, analgesics, sedatives, tranquilizers, hypnotics, or amphetamines).

The subjects were studied using the following protocol: (1) Two consecutive baseline nights in our laboratory, during which the subjects used their own low, regular pillow and respiratory data were recorded. (2) Five adaptation nights in which the subjects adapted to the cervical pillow at home. (3) Two consecutive experimental nights in our laboratory, during which the subjects used the cervical pillow and their respiratory data were once again recorded. The subjects completed medical and sleep disorder screening questionnaires, and bedtime and morning questionnaires. The body weight of each subject was measured upon recruitment, and self-reported body weights were obtained on each recording night at the laboratory. An Edentrace II® System was used to provide data on the subject’s oronasal airflow, chest wall movement, heart rate, body position, snoring and oxygen saturation during sleep. The recorded data were printed out, and each record was evaluated for abnormal respiratory events independently by two investigators. A computer simultaneously analyzed these data, and any discrepancies between the computerized and handscored data were rectified. The subjects were also recorded during each laboratory night by videotape. Every change in head and body position for each subject was documented, and the number of abnormal respiratory events with every possible head and body position during sleep were calculated. All data were statistically analyzed using SYSTAT® 7.0 for Windows®. Paired t-tests were used to compare baseline and experimental conditions for each parameter studied. Statistical significance was defined as alpha≤0.05.

**RESULTS**

A total of 15 subjects were eventually studied. One subject had improvement in OSAS after her initial sleep study at the clinic, but prior to her baseline nights, so that the severity of her sleep-disordered breathing was below the OSAS respiratory disturbance index of 5. A second subject did not return for her second baseline night. A third subject did not sleep well during her baseline period, obtaining less than 5 hours on her second baseline night, and withdrew from the study.

Twelve subjects remained in the study: there were nine men and three women, between the ages of 24 and 67 years. No significant self-reported body weight fluctuations were reported for any of the subjects. Of these 12 subjects, their baseline OSAS was as follows: three (all men) of the subjects had mild cases (RDI=5-20), four (2 men, 2 women) had moderate cases (RDI=20.1-40), and the remaining five (4 men, 1 woman) had severe cases (RDI>40.1). The results are summarized in Table 1.

| Table 1 |
|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
|                                | Mild OSAS (3 Subjects)          | Moderate OSAS (4 Subjects)      | Severe OSAS (5 Subjects)        |
|                                | Baseline | Experimental | Sig level | Baseline | Experimental | Sig level | Baseline | Experimental | Sig level |
| # Hypopneas                    | 105.2    | 78           | 0.02      | 222.9    | 243          | n.s.      | 335      | 310.7        | n.s.      |
| # Apneas                       | 5.2      | 3.2          | n.s.      | 13.2     | 50.8         | n.s.      | 91.7     | 84.9          | n.s.      |
| Events Duration (Min)          | 30.4     | 26           | n.s.      | 89.8     | 110.5        | n.s.      | 200.4    | 180.4         | n.s.      |
| RDI                            | 14.7     | 10.5         | 0.02      | 30.1     | 37           | n.s.      | 56.9     | 56.5          | n.s.      |
| Minimum O2 sat                 | 95.2     | 96.5         | n.s.      | 89.2     | 85.2         | <0.01     | 74.5     | 72.7          | n.s.      |
| Average O2 sat                 | 98       | 98.5         | n.s.      | 97.2     | 96.6         | n.s.      | 95.1     | 93.6          | n.s.      |
| % Snoring                      | 5.2      | 0.8          | n.s.      | 12.4     | 13.9         | n.s.      | 13.4     | 20.3          | n.s.      |
| Snoring Duration (Min)         | 23.4     | 3.9          | n.s.      | 63.5     | 66.1         | n.s.      | 59.4     | 86.2          | n.s.      |
saturations were significantly lower during the experimental condition, there was a non-significant decrease in the number of abnormal respiratory events in the former condition (Figure 2). For mild versus moderate and severe OSAS subjects.

For the four moderate OSAS cases, the mean number of apneas and hypopneas showed a non-significant decrease between baseline and experimental conditions. The mean RDI showed a significant decrease between baseline and experimental conditions, while the mean number of hypopneas significantly decreased. The mean RDI showed a significant decrease between baseline and experimental conditions. The mean duration of the apneas and hypopneas showed a non-significant decrease between baseline and experimental conditions. The mean oxygen saturation and the minimum oxygen saturation were both reduced in the experimental compared to the baseline condition. Although non-significant, mean percentage of snoring during the study and mean snoring duration were both reduced in the experimental compared to the baseline condition. Interestingly, although the subjects spent an average of more time in the body supine, head supine position, there was a non-significant decrease in the number of abnormal respiratory events in the experimental compared to the baseline condition (Figure 2) for mild versus moderate and severe OSAS subjects.

For the four moderate OSAS cases, the minimum oxygen saturations were significantly lower during the experimental compared to the baseline condition. The subjects showed either no change or non-significant worsening of their snoring or obstructive sleep apnea parameters during the experimental versus the baseline condition.

For the five severe OSAS cases, there was a non-significant reduction in the mean number of apneas and hypopneas in the experimental compared to the baseline condition, as well as a non-significant reduction in the mean duration of the abnormal respiratory events in the experimental compared to the baseline condition. However, the mean RDI and minimum and average oxygen saturations did not show parallel changes. There were no additional improvements in any of the other snoring or obstructive sleep apnea parameters studied.

For all OSAS cases, the subjects reported non-significant improvement in their sleep, in terms of the depth and restfulness of their sleep, in the experimental compared to the baseline condition.

**DISCUSSION**

The mild OSAS cases showed improvement in their snoring and abnormal respiratory events while using the cervical pillow compared to their baseline nights when they used their usual pillow. However, there was no improvement in either snoring or abnormal respiratory events for the moderate cases in their experimental versus baseline nights. Paradoxically, for the severe OSAS cases, there was non-significant improvement in the mean number of apneas and hypopneas as well as in the mean duration of the abnormal respiratory events in the experimental compared to the baseline condition. The mild, moderate, and severe cases all reported a non-significant subjective improvement in the depth and restfulness of their sleep. This study is limited in several respects: (1) Since the sample sizes are very small, the terms "significance" and "non-significance" should be taken with caution; the limited sample sizes may also explain the discrepancies in findings between the mild, moderate, and severe cases. (2) Total sleep times for our subjects were not obtained since our sleep studies measured respiratory parameters without EEG data; this could be a source of error in calculation of the RDI. (3) The subjective improvement in depth and restfulness of the subjects’ sleep may reflect an order effect or laboratory adaptation bias.

In conclusion, based on our very limited study, subjects with mild cases of OSAS may show improvement in the severity of their snoring and sleep-disordered breathing using the cervical pillow evaluated in this study. The mechanism by which the cervical pillow improves snoring and sleep-disordered breathing in subjects with mild cases of OSAS is unknown, but is probably due to the increased cross-sectional area associated with head extension. Moderate and severe cases of OSAS are less likely to benefit from this pillow; however, larger sample sizes in all three OSAS categories would be desirable.

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