Effect of Prone Position on Apnea Severity in Obstructive Sleep Apnea

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We describe a patient with obstructive sleep apnea (OSA) whose apnea-hypopnea index (AHI) improved remarkably in the prone position accompanied by an improved sleep quality, despite a higher AHI in the supine position and even in the lateral position. Magnetic resonance imaging revealed the most dilated upper airway in the prone position, which suggests the role of anatomical narrowing of the upper airway as an important component in the pathophysiology of positional apnea patients. Further studies are needed to determine the therapeutic efficacy of a prone sleeping position in patients with OSA.

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Key words: sleep position, magnetic resonance imaging, apnea-hypopnea index, upper airway

Introduction

It is well known that the supine posture exacerbates obstructive sleep apnea (OSA). Most investigators have found that the apnea-hypopnea index (AHI) decreases significantly by changing from the supine to the lateral decubitus or the upright position (1-5). However, the effect of the prone position on this index has not been previously studied.

This report describes a patient with OSA whose disordered breathing disappeared in the prone position, despite a slight decrease in AHI even in the lateral position. Magnetic resonance imaging (MRI) obtained in the supine, lateral, and prone positions revealed that the upper airway was the widest while prone, but the most narrow while supine. The results support the hypothesis that the anatomical narrowing of the upper airway is an important factor contributing to positional apnea.

Case Report

A 45-year-old man who had experienced excessive daytime hypersomnolence for one year was admitted to our hospital. He had a long history of heavy snoring after adolescence. His weight was 60 kg at age 20, and it gradually increased to 74 kg by age 42. His admission weight was 70 kg (128% of ideal weight). Physical findings were essentially normal except for the blood pressure which was 146/102 mmHg. Otolaryngological examination revealed chronic rhinitis, enlarged bilateral palatine tonsils, and adenoid vegetation. Results of laboratory studies (hematological examination, blood chemistry test, endocrine function test, chest roentgenogram, and electrocardiogram) were within normal limits. Pulmonary function tests showed no obvious expiratory airflow obstruction except for a "saw-tooth" pattern on inspiratory limb of flow-volume loop. Ventilatory responses to isocapnic hypoxia and hyperoxic hypercapnia were both within normal range (-1.04 l/min/% SaO2, 2.07 l/min/Torr, respectively).

Overnight polysomnography was performed using standard techniques to record electroencephalogram, electro-oculogram, chin electromyogram, arterial oxygen saturation (SaO2) by finger-oximetry (Pulsox-7, Minolta, Osaka, Japan), nose and oral airflow by using thermistors, chest and abdominal impedance (AI-600G, Nihon Kohden, Tokyo, Japan), and electrocardiogram. No position was enforced; the patient was free to move around in bed during sleep. Each change in sleep position was recorded directly on the polygraphic record by an observer.

Results of the polysomnography are summarized in Table 1. The patient slept mostly in the lateral and in the supine position (76.3%, and 21.3%, respectively), although for a period of time, he spent 11 min (2.3%) contiguously in the prone position with his head turned slightly to the left side. As a whole, polysomnograph revealed 186 obstructive and 25 mixed apneas, and 297 hypopneas per night (AHI = 65.0/h), with decrement in mean nadir SaO2 of 83.5±8.5% (SD). In the lateral position, compared to supine, apnea index (AI) decreased remarkably...
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Table 1. Results of Overnight Polysomnography Obtained in Three Different Positions in This Patient

<table>
<thead>
<tr>
<th></th>
<th>Total sleep (REM, NREM)</th>
<th>Apnea (evt/night)</th>
<th>Hypopnea (evt/night)</th>
<th>AI</th>
<th>HI</th>
<th>AHI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supine</td>
<td>100 (31, 69)</td>
<td>103</td>
<td>27</td>
<td>61.8</td>
<td>16.2</td>
<td>78.0</td>
</tr>
<tr>
<td>Lateral</td>
<td>358 (25, 333)</td>
<td>108</td>
<td>270</td>
<td>18.1</td>
<td>45.3</td>
<td>63.4</td>
</tr>
<tr>
<td>Prone</td>
<td>11 (0, 11)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>469 (56, 413)</td>
<td>211</td>
<td>297</td>
<td>27.0</td>
<td>38.0</td>
<td>65.0</td>
</tr>
</tbody>
</table>


from 61.8/h to 18.1/h, although the number of hypopnea increased from 27 to 270 per night, resulting in a slight decrease in AHI (from 78.0/h to 63.4/h). This postural change in AHI was observed both in rapid eye movement (REM) sleep and in non-REM sleep.

On the other hand, surprisingly, there was no apnea or hypopnea in the prone position (Table 1). Of the 11 minutes during the prone position, time spent in each sleep stage was 5 minutes in stage 2 and 6 minutes in stage 3+4. An analysis of sleep characteristics showed that the percentage of slow wave sleep (stage 3+4) spent in non-REM sleep in each position was 0% while supine (0 min/69 minutes), 2.1% while lateral (7/326), and 53.5% (6/11) while prone. Sleep quality was thus improved in the prone position.

For a better understanding of this postural change in AHI, MRI of the upper airway was performed in these three positions. While the patient was awake, images were obtained with a 1.5-Tesla superconductive imaging unit (Signa, GE Medical Systems, Milwaukee, WI) (TR/TE = 600/200 msec). For technical reasons, images in the prone position were obtained while the patient’s head was also prone (nose down). Sagittal images at median line obtained in each position are shown in Fig. 1.

Figure 1. Midline sagittal magnetic resonance images obtained in the supine (left), lateral decubitus (middle), and prone (right) position in this patient.
Oropharyngeal stenosis was the most severe in the supine position, due mainly to a retrolapse of elongated soft palate and tongue. Contrarily, the oropharyngeal space was enlarged to the greatest extent in the prone position, probably due to an anterior shift of the retrolapsed tongue. Nasopharyngeal stenosis was also found in the supine position. Compared to oropharyngeal stenosis, however, no remarkable change was found when changing from supine to lateral or prone positions.

Due to severe nasal obstruction, otolaryngological treatment for chronic rhinitis, adenoid vegetation, and enlarged palatine tonsils is now being scheduled, in place of nasal continuous positive airway pressure (CPAP) therapy. The patient is also being treated by diet, and body position training as an alternative therapeutic method. However, despite the recommendation of the prone sleeping position, he mentioned that he was unable to maintain the sleeping position because of unconscious body movements.

**Discussion**

To our knowledge, the effect of sleeping prone in the pathophysiology of OSA has not previously been examined, probably due to the difficulty of free movement during polysomnography imposed by multiple electrode attachment in face, head, and trunk (1). In his study of the effect of body position in sleep apnea, Cartwright (1) reported that only 3 of 30 OSA patients spent any time in the prone position, and the prone position data were excluded from his data analysis. The present case report demonstrates the effect of this sleep posture on OSA. He exhibited no sleep apnea or hypopnea during prone sleep despite a higher AHI in the supine and even in the lateral position.

Time spent in the prone position, however, was very short compared with the other sleep postures. Sleep disordered breathing might have disappeared incidentally. However, the result was accompanied by the remarkable improvement of sleep quality (Table 1). Improvement of sleep architecture, as well as a decrease in AHI in positional apnea patients when changing from supine to lateral sleep posture, has been demonstrated by some investigators (2, 3). We therefore believe that the present data is meaningful.

However, the data reported by George et al (4) differed: 3 of 7 patients with OSA spent small amounts of time in the prone position in their study. Although precise data was not specified, no improvement of AHI in the prone position was found. However, an important point is that all of their patients were very obese (163% of ideal weight), and that they were unable to find much effect of body position on AHI (84.4/h during supine, vs 73.6/h during lateral). Cartwright (1) has suggested that less obese patients (<25% above ideal weight) are more likely to show position-sensitive apneas. In our patient, at least two factors may be responsible for the anatomical narrowing of the upper airway in the supine position. One is the mild obesity (128% of ideal weight), and the other is otolaryngological abnormalities such as adenoid vegetation and enlarged palatine tonsils. This peculiarity may explain why we could find such a remarkable improvement in the disordered breathing in the prone position.

The mechanism for this remarkable improvement is unclear, but one possible explanation, is the effect of gravity on upper airway caliber. Early studies on the pathogenesis of OSA had stressed the importance of posterior displacement of the tongue in precipitating airway occlusions (6). This would presumably decrease to the greatest extent in the prone position due to the change in the gravitational vector. In their study in space, Takasaki et al (7) also demonstrated that gravity may play a much more significant role in the normal healthy human in the increased upper airway resistance during sleep than the relative atonia of the upper airway muscles. The present MRI, which were obtained in the three different postural positions, revealed maximum enlargement of the oropharyngeal space in the prone position, suggesting an important role of the anatomical narrowing of the upper airway contributing to OSA. These images were obtained, however, while the patient was awake; the airway space was evaluated using only sagittal images. In the prone position, the MRI scan was performed while the patient’s head was also prone (nose down); on the other hand the patient’s head was slightly lateral during his 11 minutes of prone sleep. These MRI may not be representative of the true anatomy of the patient during sleep. Furthermore, studies examining the static upper airway size do not address the effect of dynamic factors such as pharyngeal compliance, reflexes, and inspiratory muscle activity that may contribute to OSA (8).

Nasal CPAP and uvulopalatopharyngoplasty (UPPP) are the two most widely used therapeutic modalities, while therapeutic alternatives such as tongue retaining device, orthodontic appliances, sleep position training, and weight loss have been proposed, usually in a limited series of patients (9). On the basis of our observation, sleeping prone might be an effective therapeutic maneuver in some patients with OSA, even when their AHI does not decrease within or close to normal limits when changing from supine to lateral position. However, we failed to detect the efficacy of the sleeping position in this patient because of the difficulty of maintaining the prone sleeping posture. Further studies are needed to confirm the long-term efficacy of this sleeping position.

In summary, the present case report demonstrated the effect of the prone sleeping position on disordered breathing, sleep quality, and MRI findings in OSA. The results indicate that by changing body position, dilatation of the upper airway may be one of the important factors for the decrease in AHI observed in this patient. Further investigations are required to determine the physiological effect of prone sleeping position in patients with OSA.

**References**

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