Case Report

Daytime hypertension, sleep apnea and metabolic alkalosis in a haemodialysis patient—the result of sodium bicarbonate abuse

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Key words: daytime hypertension; sleep apnea; metabolic alkalosis; haemodialysis; sodium bicarbonate

Introduction

Obstructive sleep apnea (OSA) is common in middle-aged men and is mostly the result of obesity [1–5]. OSA has been linked statistically to not only morning headache [6] but also hypertension [1–5], and a relationship is supported by some research data [2,5,7]. Long-term hypertension may be caused by hypoxia acting via increased carotid chemoreceptor stimulation of the sympathetic nervous system [7]. A large proportion of chronic haemodialysis patients who complain of daytime fatigue or sleepiness apparently suffer from sleep apnea [8,9].

We observed a male haemodialysis patient who complained of morning headache and had hypertension. We found sleep apnea provoked or aggravated by metabolic alkalosis resulting from sodium bicarbonate abuse. After cessation of sodium bicarbonate ingestion, sleep apnea episodes, headache and hypertension disappeared. Metabolic alkalosis must be considered in the differential diagnosis of sleep apnea in haemodialysis patients.

Case

A 55-year-old man with end-stage renal failure due to idiopathic nephrotic syndrome was admitted to our hospital in July 1997. His chief complaint was non-pulsating headache which woke him up in the morning and persisted until noon. His intermittent headache attacks had started around June 1996, and his blood pressure rose at the same time. Postdialytic body weight was lowered accordingly, which did not affect his daytime hypertension and additional antihypertensive drugs were prescribed. Routine blood tests prior to haemodialysis sessions were all typical for a chronic haemodialysis patient except for severe metabolic alkalosis with compensatory hypoventilation. He had no drugs which might have induced metabolic alkalosis. He denied having ingested medication other than that prescribed. He had neither vomiting nor diarrhea episodes, and his daily urine volume was negligible. Computed tomography of the head disclosed slight brain atrophy possibly due to subclinical multiple cerebral infarction.

Upon admission, he was a middle-aged male, weight 48.2 kg at a height of 166.5 cm. Blood pressure was 130/80 mmHg under antihypertensive medication, i.e. long-acting nifedipine 40 mg/day, amlodipine 10 mg/day and doxazosin 4 mg/day. His heart rate was regular at 78 beats/min and daytime respiratory rate was 12 breaths/min. Physical and neurological examinations were normal. Haematocrit was 29% under administration of 4500 u/week of rhEpo. Predialytic arterial blood sample showed pH 7.47, P$_{a}$CO$_2$ 54.7 mmHg, P$_{a}$O$_2$ 55.6 mmHg and HCO$_3$ 40.1 mmol/l under room air conditions. The postdialytic cardiothoracic ratio was 47%.

Morning headache and respiratory acidosis suggested the possibility of sleep apnea. Overnight polysomnography was carried out, which revealed frequent episodes of apnea during sleep (Figure 1A). During his hospital stay, metabolic alkalosis gradually improved and episodes of sleep apnea became less frequent (Figure 1B). Repeated history taking finally disclosed that he had consumed antacids, i.e. 4–5 g sodium bicarbonate daily. Although morning headache disappeared in parallel with improvement of sleep apnea, blood pressure remained high. After 4 weeks, blood pressure started to decrease. After 2 months, no antihypertensive medication was needed, and his blood pressure was between 100/50 and 120/60 mmHg prior to each session.

Discussion

This was a chronic haemodialysis patient with morning headache and daytime hypertension possibly caused...
by metabolic alkalosis and resultant sleep apnea. Recently, the relationship between OSA and hypertension has been emphasized [1–5,7,10–12]. The mechanisms responsible for persistent daytime hypertension have not been elucidated. A direct pathophysiological link between OSA and daytime hypertension has recently been established in an elegant experiment by Brooks et al. [7]. They induced OSA in four dogs by intermittent airway occlusion during nocturnal sleep. It resulted in acute transient increases in night-time blood pressure, and eventually produced sustained daytime hypertension. Not night-time but daytime hypertension was detected 3 weeks after the end of experiment. Recurrent arousal from sleep without airway occlusion did not result in daytime hypertension despite the same degree of night-time hypertension, indicating that disruption of sleep architecture is not the underlying stimulus. It appears that hypoxia and/or fluctuations in intrathoracic pressure are of critical importance. A high prevalence of sleep apnea is observed in dialysis patients. Millman et al. [13] and Kimmel et al. [9] found 12 (41%) of 29 patients with chronic renal failure and 16 (73%) of 26 patients, respectively, had sleep apnea documented by overnight polysomnography. Fletcher [8] proposed several possible explanations for the high frequency of sleep apnea in chronic renal failure in his review. First, hypocapnia associated with chronic metabolic acidosis may be lowering the apnea-PCO2 threshold, predisposing to periodic breathing. Secondly, chronic acidemia may alter the hydrogen-ion set point for respiration (increased sensitivity), predisposing to a shortened feedback loop and unstable breathing patterns [14]. Thirdly, Fein et al. [15] have suggested that uremic toxins acting on the central nervous system may result in a reduction of airway muscle tone during sleep or an instability of respiratory control. They showed improvement in sleep apnea events in one subject after aggressive haemodialysis. Mendelson et al. [16] found a trend toward longer duration apnea episodes on the haemodialysis night compared with the off, however.

In the present case, obesity and airway obstruction, strong predisposing factors for sleep apnea [2], were absent. Sleep apnea was presumably triggered by metabolic alkalosis that diminished the central ventilatory drive. In fact, cessation of sodium bicarbonate intake immediately decreased the number of sleep apnea episodes. According to the possible links between OSA and hypertension mentioned above, hypoxia and the resultant increased sympathetic nerve activity might have accounted for, or at least contributed to, hypertension, but a role of excess sodium intake can not be excluded, although sodium removal by haemodialysis did not affect his blood pressure. We are aware of observation that in animals and patients with normal renal function sodium elevates blood pressure when given with chloride, but not with bicarbonate [17].

**References**

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Received for publication: 3.8.98
Accepted in revised form: 7.10.98