Rigid Spine Syndrome and Nocturnal Alveolar Hypoventilation

Akihiro Kawata, Masakazu Suga, Kazuhito Miyamoto, Kazuhiko Hirose* and Hitoshi Tanabe

A 17-year-old Japanese woman with rigid spine syndrome (RSS) presented with respiratory failure leading to CO₂ narcosis. The clinical symptoms were drowsiness, asterixis and cardiac arrhythmias. Tracheostomy and temporary ventilatory support abolished these symptoms. However, polygraphic sleep studies without a ventilator revealed Cheyne-Stokes respiration and profound arterial oxygen desaturation during rapid eye movement sleep. Nocturnal ventilatory support improved not only nocturnal hypoxemia, but daytime blood gas values during spontaneous breathing. These findings indicate that the onset of respiratory failure is preceded by severe nocturnal hypoxemia and that the evaluation and control of nocturnal respiratory insufficiency is essential for RSS patients.

(Internal Medicine 32: 638-640, 1993)

Key words: respiratory failure, Cheyne-Stokes respiration, REM sleep

Introduction

The rigid spine syndrome (RSS) has been considered to be a benign disorder clinically characterized by limitation of neck and trunk flexion, scoliosis, mild joint contractures, and mild diffuse nonprogressive muscular weakness (1, 2). However, recent reports have pointed out patients with severe respiratory failure followed by right cardiac failure and death (3-8). In such patients, the respiratory failure resulted mainly from restrictive ventilatory dysfunction caused by respiratory muscle weakness, spine deformity, and diaphragm paralysis. Although sleep-associated hypoventilation was also noted in some patients (4-6), detailed descriptions of nocturnal respiratory status have been sparse to date. Here we report a patient with RSS who showed severe respiratory failure, with special reference to the nocturnal alveolar hypoventilation revealed by polygraphic sleep studies.

Case Report

This 17-year-old woman was the third child of healthy parents who were second cousins. Her elder brother had a similar stature and died of pneumonia at the age of 9. There was no other family history of neuromuscular diseases. Her mother's pregnancy and delivery were uncomplicated. She first walked at 15 months, and was never able to run as quickly as her peers. Limitation of neck and back flexion was noted at age 8 and scoliosis at the age of 14; however her handicap was mild. She enjoyed a typical school-age life until the age of 17, when hoarseness suddenly became apparent accompanied by increasing sleepiness and hand tremor. Left vocal cord palsy due to recurrent nerve palsy was diagnosed by a doctor but its cause was unknown. She was referred to our hospital for further evaluation.

Physical examination showed that she was a very thin (147 cm/42 kg) girl with acrocyanosis, a high-arched palate, and a flat chest. Her pulse was from 60 to 120 beats/min, irregular, and respiration was 22 breaths/min. The respiratory movements of the chest were weak with little excursion. Neurologically, she was drowsy but had normal intelligence. Cranial muscles were normal except for the left vocal cord palsy. Musculature of the trunk and limbs was thin with mild proximal weakness of the shoulder girdle. Flexion of the cervical and upper parts of the thoracic spine was severely limited. There was moderate scoliosis. Her feet could not be dorsiflexed beyond the neutral position, but no other joint contractures were noted. Deep tendon reflexes were absent in the four extremities. Prominent asterixis of the four limbs, the lower jaw and the tongue was present. Neither sensory impairment nor cerebellar signs were noted.

Results of the following laboratory studies were abnormal; hemoglobin 16.3 g/dl, hematocrit 51.7%, LDH 985 IU/l (normal: 50-400), GOT 46 IU/l (0-37). Serum CK level, GPT, aldolase, acid maltase activity in the lymphocytes and
Rigid Spine Syndrome

karyotyping of the leukocytes revealed no abnormalities. Blood
gas analysis showed severe respiratory acidosis (pH 7.312,
PCO₂ 86.3 mmHg, PO₂ 27.8 mmHg, HCO₃ 42.6 mM/l, and BE
15.0 mM/l). A Holter ECG revealed frequent paroxysmal atrial
tachycardia and sinus arrest lasting up to 4.23 seconds. An
eczocardiogram demonstrated dilatation of the right ventricle,
pericardial effusion, and thickening of the mitral valve. X-rays
of her spine revealed scoliosis of the thoracic spine and absence
of normal lumbar and cervical lordosis. No ankylosis or de-
structive lesions were noted. A respiratory function test showed
severe restrictive and mild obstructive dysfunction (vital capac-
ity 1,130 ml, %VC 38%, FEV₁,0% 66%). A surface
electromyogram recorded from upper limb and masseter muscles
revealed electrical silence (duration: 60–130 milliseconds)
in the contracting muscles, associated with asterixis. A needle
electromyogram of the extremities disclosed rapid recruitment
of small, short motor unit potentials (MUPs) and reduced or full
interference patterns of both small, short MUPs and normal
MUPs. There was some spontaneous denervation activity in
several upper and lower limb muscles. Motor and sensory nerve
conduction velocities were within normal range. Biopsy of the
right biceps brachii muscle revealed a marked variation in fiber
diameter with atrophic fibers; some of them exhibited small
angulated fibers. No significant fibrosis nor inflammatory
changes were found. Rimmed vacuoles were seen in a few
fibers. Upon ATPase and NADH staining there was a normal
mosaic structure without selective fiber-type atrophy.

Respiratory support with a ventilator and nasal intubation
was performed for CO₂ narcosis. Soon after the procedure,
the drowsiness, asterixis and arrhythmias completely disappeared.
Because of repeated bronchopneumonia and weakness of cough-
ing out sputa she was tracheotomized. She was successfully
withdrawn from the ventilator while awake, maintaining nor-
mal blood gas tensions. However, without the ventilatory
support, polygraphic sleep studies conducted with a pulse
oximeter revealed numerous repetitive episodes of oxygen
desaturation (Fig. 1A) associated with Cheyne-Stokes respira-
tion which occurred exclusively during REM sleep (Fig. 1B). In
the Cheyne-Stokes respiration, central apneas rarely appeared.
The lowest arterial oxygen saturation (SaO₂) was 60%. The
SaO₂ during non-REM sleep was within normal range. She was
therefore treated with nocturnal ventilatory support, which
resulted in complete abolition of the Cheyne-Stokes respiration
and oxygen desaturation.

---

Fig. 1. A) Arterial oxygen saturation (SaO₂) and EEG sleep stage (1–4) throughout the
night. Without ventilatory support there was good oxygenation in non-REM sleep but
marked desaturation in REM sleep. B) Polygraphic sleep recording during a REM sleep
period showing Cheyne-Stokes respiration. Abdomen: abdominal excursions measured with
magnetometer, ECG: electrocardiogram, EEG: electroencephalogram, EMG:

---

Internal Medicine Vol. 32, No. 8 (August 1993)
Discussion

The patient showed typical clinical features of RSS except for the absence of apparent joint contractures of extremities. With regard to the origin of the disease, an autosomal recessive mode of inheritance was suspected.

Her outstanding manifestations upon admission were drowsiness, asterixis, and cardiac arrhythmias, among which asterixis had not been reported in RSS thus far. However, since these symptoms disappeared after blood gas tensions normalized, they can be attributed to chronic hypoxemia or CO₂ narcosis. Similar drowsiness and asterixis had been reported in a patient with congenital myopathy who showed chronic alveolar hypoventilation (9). The arrhythmias are probably secondary changes due to heart failure following respiratory failure.

Although there are no specific histological findings in muscles of RSS, Onodera et al suggested that cases of RSS with rimmed vacuoles might frequently show restrictive respiratory failure (10). However, this is not the case with regard to this patient because the number of rimmed vacuoles was too small to be regarded as a pathognomonic finding to explain overall myopathic changes.

Recently Morita et al discussed the significance of restrictive respiratory dysfunction in RSS and attached great importance to the flat chest and the fixed thorax caused by contractures of costovertebral joints (7). They also stressed the beneficial effects of nocturnal ventilatory support, but did not show the nocturnal status of spontaneous breathing. In this context, some reports have shown central and obstructive sleep apneas in patients with RSS, which have been recurrently observed particularly during REM sleep (4, 5). Although central apneas occurred in our patient, the SaO₂ fluctuations during REM sleep were chiefly caused by the Cheyne-Stokes respiration characterized by a repeating pattern of increasing and decreasing tidal volume. Similar respiratory pattern has been noted in a RSS patient, but there was no REM sleep during the study night (6). The Cheyne-Stokes respiration or periodic breathing per se is not uncommon in normal older men, and SaO₂ is known to fall to an average of 95.8% (11). In addition, a significant loss of intercostal and diaphragmatic muscle activity during REM sleep causes arterial O₂ desaturation even in normal subjects (12). In such situations, airway closure and shunting are shown to occur with reduced functional residual capacity (12). These mechanisms might have been augmented in our patient by the weakness of respiratory muscles and restrictive respiratory dysfunction, leading to severe O₂ desaturation.

The present report suggests that RSS patients may present with subtle symptoms and signs of nocturnal hypoventilation which may not be recognized until the patients develop severe respiratory failure when awake. Furthermore, it indicates that nocturnal mechanical ventilation improves not only sleeping blood gas levels, but daytime values during spontaneous breathing. It is, therefore, essential for the prognosis of RSS to evaluate and to control the nocturnal respiratory sufficiency. Actually, nocturnal respiratory support has been reported to prevent the progression of the disease for 5 years (6, 7). However, follow-up examination of daytime blood gas values is highly important because the respiratory muscle weakness might gradually develop to a degree of decompensated respiratory status.

Acknowledgements: We thank Drs. Y. Kumagai, K. Kawata and T. Tobita for their assistance in the treatment of the patient, and Dr. H. Hayashi for helpful discussion.

References