

*Case Report***Improved activities of daily living in a patient with subtrochanteric femur fracture through incorporation of continuous positive airway pressure therapy following convalescent rehabilitation**

Hiroshi Kakuta, MD,<sup>1</sup> Michio Yamaguchi, PT,<sup>1</sup> Kazuyoshi Sugawara, PT,<sup>1</sup> Naomi Kuge, PT, PhD,<sup>1</sup> Hirofumi Imai, MD,<sup>2</sup> Akira Rikimaru, MD, PhD,<sup>1</sup> Hironao Yokomichi, MD, PhD,<sup>1</sup> Takashi Sakamoto, MD,<sup>3</sup> Ken Sugiyama, MD, PhD,<sup>4</sup> Shin-Ichi Izumi, MD, PhD,<sup>5</sup> Michio Hongo, MD, PhD<sup>1</sup>

<sup>1</sup>Kurokawa General Hospital, Taiwa, Miyagi, Japan

<sup>2</sup>Minamisanriku Hospital, Minamisanriku, Miyagi, Japan

<sup>3</sup>Sendai Red Cross Hospital, Sendai, Miyagi, Japan

<sup>4</sup>Sato Hospital, Sendai, Miyagi, Japan

<sup>5</sup>Tohoku University Graduate School of Biomedical Engineering, Sendai, Miyagi, Japan

**ABSTRACT**

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**Objective:** Sleep disorders interfere with activities of daily living (ADL) in elderly individuals. In Japan, at least 3 million people are estimated to have sleep apnea syndrome (SAS), and many potential patients are yet to be diagnosed and treated. In women, the incidence of SAS increases 2–4 fold after menopause due to reduced hormone levels. In addition, women rarely present with typical symptoms of SAS, such as daytime sleepiness and snoring, and thus they are not screened for SAS as often as men. This study aimed to evaluate the utility of continuous positive airway pressure therapy (CPAP) to improve ADL.

**Methods:** This report describes an elderly woman with dementia, depression, and angina who developed disuse syndrome after surgery for subtrochanteric fracture of the left femur, and was treated with CPAP and other general measures.

**Results:** The patient showed progressive improvement

in ADL by the simplification of medications, management of general health, diagnosis of SAS, and incorporation of CPAP therapy following convalescent rehabilitation.

**Conclusion:** Activities of daily living can be improved in orthopedic patients with SAS by using CPAP and other general lifestyle measures.

**Key words:** convalescent rehabilitation, sleep apnea syndrome, continuous positive airway pressure therapy, subtrochanteric femur fracture, postoperative disuse syndrome

**Introduction**

Sleep disorders in elderly individuals adversely affect their activities of daily living (ADL) [1], and ADL in elderly patients with sequelae of stroke can be improved through continuous positive airway pressure (CPAP) therapy [2]. Here, we diagnosed obstructive sleep apnea syndrome (OSAS) in a patient who developed disuse syndrome after surgery for subtrochanteric fracture of the left femur. We report the improvement in her ADL through treatment of SAS following convalescent rehabilitation.

**Case**

The patient was an 85-year-old woman living with her son and daughter-in-law whose chief complaint was the inability to walk. Her family history was unremarkable. She had a history of depression, dementia, and angina. She presented at hospital A after a fall at home. Simple radiography revealed a subtrochanteric fracture of the left femur (Figure 1). Wire cerclage was performed under lumbar anesthesia using the Accord cable system and a

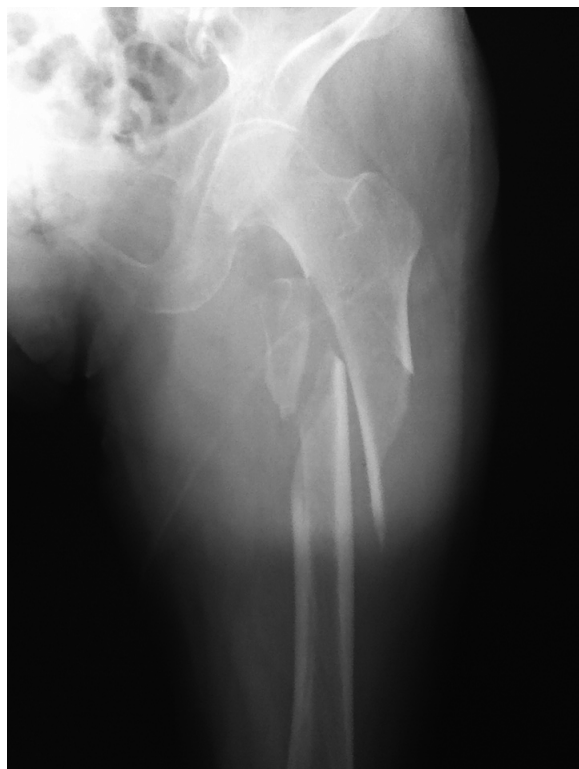
Correspondence: Hiroshi Kakuta, MD

Department of Medicine, Kurokawa General Hospital, Nishihinoki 60, Yoshiokaaza, Taiwa, Kurokawagun, Miyagi 981-3682, Japan.

E-mail: hiroshikk@jadecom.jp

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**Figure 1.** Femur fracture on simple radiography performed at the previous hospital at initial visit.

long Gamma nail. On postoperative day 27, the patient was transferred to our hospital to undergo rehabilitative intervention for postoperative disuse syndrome. Oral medications at admission were loxoprofen sodium, rebamipide, donepezil, midodrine hydrochloride, alfacalcidol, bifidobacteria, warfarin, isosorbide dinitrate, and mianserin hydrochloride. Before the bone fracture, her ADL included slow ambulation with a cane.

On physical examination, the patient was found to be in poor general health with reduced communication ability. She had no respiratory discomfort or pain at the surgical site. Her height was 140 cm, weight was 39 kg, body mass index 19.9 kg/m<sup>2</sup>, and blood pressure 119/83 mmHg. She was wearing a pair of elastic compression stockings but had no pedal edema. Mild dry rales were detected in the right lung.

Neurological examination revealed no brain abnormalities. Motor system examination by manual muscle testing (MMT) revealed MMT4 in the right and left arms, MMT3 in the right leg, and MMT2 in the left leg. Cutaneous and proprioceptive sensory processing were normal. Both coordination and deep tendon reflexes were normal, and no pathologic reflexes were detected.

### Investigations

**a. Imaging:** Simple chest radiography (XP) and chest computed tomography (CT) revealed a large pleural effusion in the right lung (> left lung).

**b. Clinical biochemistry:** Total protein, 5.2 g/dL;



**Figure 2.** Chest computed tomography performed at the time of transfer to our hospital.

albumin, 3.0 g/dL; aspartate aminotransferase, 14 IU/L; alanine aminotransferase, 6 IU/L; blood urea nitrogen, 15 mg/dL; creatinine, 0.53 mg/dL; sodium, 138 mEq/L; potassium, 3.3 mEq/L; chloride, 94 mEq/L; glucose, 89 mg/dL; white blood count, 5370 cells/ $\mu$ L; red blood count, 3.12 million cells/ $\mu$ L; hemoglobin, 9.4 g/dL; C-reactive protein, 1.6 mg/dL; urine glucose, (-); urine protein, (-); B-type natriuretic peptide (BNP), 58.7 pg/mL (normal <18.4); and thyroid function tests (all normal).

**c. Echocardiography:** Aortic diameter, left axis deviation, interventricular septum, posterior wall thickness in diastole, and left ventricular diastolic and systolic dimensions were all within normal range. Additional findings included ejection fraction of 71%, third-degree aortic insufficiency, third-degree tricuspid insufficiency, first-degree pulmonary valve insufficiency, no pericardial fluid, no left ventricular hypertrophy, no left ventricular wall motion abnormalities, and no left atrial load.

### Evaluation for rehabilitation:

Partial assistance was needed when turning in bed or getting up from bed, but only standby assistance was required when seated in bed with her legs hanging over the side of the bed. She was not examined in other positions. Functional independence measure (FIM) score was 37 points. All motor items scored 1 point.

### Post-admission course:

From post-admission day 2, physical therapy (average 1.1 units/day) was performed to strengthen muscles, increase the range of motion at joints, and train for basic movements.

The patient's poor communication ability was attributed to the synergistic effect of multidrug regimens, not dementia. Accordingly, we terminated the administration of oral donepezil and maprotiline hydrochloride, the latter having been prescribed upon admission to our hospital instead of mianserin

hydrochloride. Her communication ability gradually improved. The patient presented with hypoxemia; a large pleural effusion was observed on the chest XP and CT (Figure 2). Echocardiography showed combined valvular disease and no left ventricular hypertrophy, but mild heart failure was suspected based on the BNP levels. Because the patient's appetite and blood albumin levels improved along with her communication, short-term furosemide was administered to treat the pleural effusion. On post-onset day 7, the pleural effusion was verified to have resolved, and daytime oxygen saturation (SaO<sub>2</sub>) increased to 95–98%. On day 18, while sleeping at night, SaO<sub>2</sub> decreased to around 70–80% due to prolonged bouts of apnea.

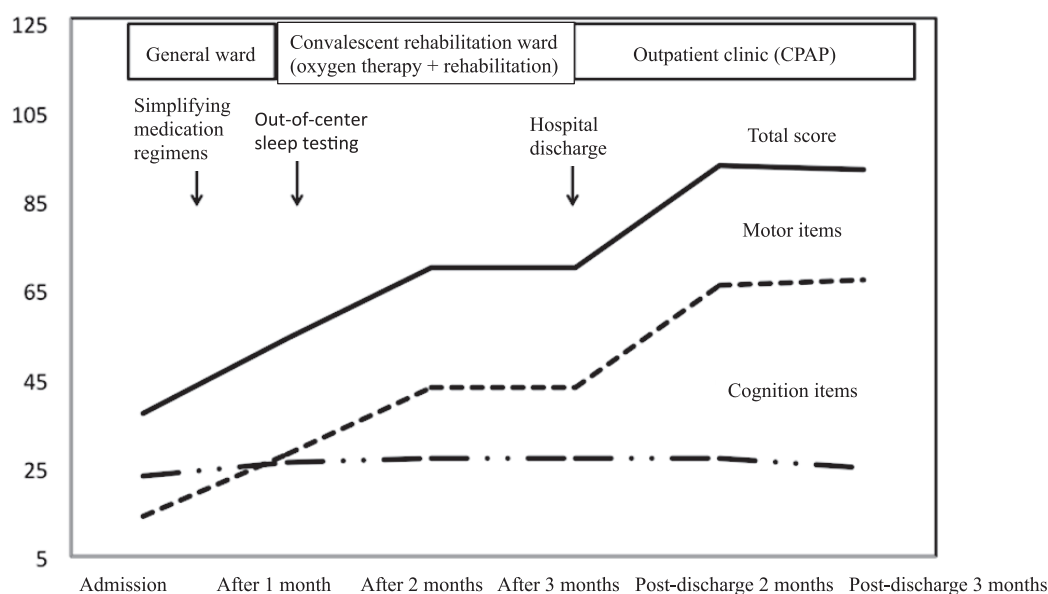
On day 25, out-of-center sleep testing, conducted for a definitive diagnosis of SAS, revealed an apnea-hypopnea index (AHI) of 49.2 /h (normal, <5 /h) and an oxygen desaturation index of 56 /h.

On day 30, the patient was transferred to the convalescent rehabilitation unit. Prompt incorporation of full-night polysomnography (PSG) and CPAP was initially planned, but because these procedures are not covered by national health insurance for screening or treatment in convalescent rehabilitation inpatient units, they were both scheduled for after hospital discharge. The patient underwent rehabilitation (physical therapy only, average 2.6 units/day) during the day and received oxygen therapy to prevent hypoxia during the night. This improved her ADL, and FIM scores increased from 37 points at admission to 70 points at discharge

(day 95). On day 99, she was readmitted for one night for full-night PSG. We diagnosed severe OSAS and incorporated CPAP on the next day (day 100) based on the PSG findings: AHI of 59.6 /h (244 apneic episodes), longest duration of apnea 141.5 s, and lowest SaO<sub>2</sub> 20% (Table 1). After CPAP, treatment outcome was checked monthly through EncoreAnywhere™, a cloud-based patient compliance management system. In the first month, CPAP use was 11%, showing poor adherence to treatment. We carefully explained the danger of leaving severe SAS untreated and the benefits of CPAP to the patient and her family. Two months later (day 150), the rate of use during the previous month markedly improved to 89.7%, the mean AHI also improved to 5.4 /h (almost normal, ≤5), and the FIM score increased to 93 (Figure 3). Three months after discharge (day 185), 1-month usage of CPAP was 94.1%, the mean AHI was 7.1 /h, and the FIM score was 92 points. Subsequently, the rate of use of CPAP was maintained at above 80%. FIM items that improved after discharge were dressing (improved from FIM1 (needing assistance) to FIM5 (needing standby)), bowel/bladder management (improved from FIM3 to FIM6 (independence)), and bathing (improved from FIM1 to FIM4). The patient was bedridden at the time of admission to our hospital but was ambulatory, using a wheelchair or walking frame, at the time of discharge. After undergoing CPAP therapy at home, she could walk 15 m continuously with the help of a walker (Table 2). The patient no longer had dyspnea, which she had during hospitalization, and this may be

**Table 1.** Polysomnography data.

Total sleep time		338 min
	REM	47 min (13.9%)
	Stage 1	199.5 min (59%)
	Stage 2	91 min (26.9%)
	Stage 3+4	0.5 min (0.1%)
Total number of awakenings (/h)		438 (46.1 /h)
Apnea-hypopnea	Total number (AHI/h)	336 (59.6 /h)
Apnea	Total number (AI/h)	244 (43.3 /h)
	Type	Central 2
		Obstructive 236
		Mixed 6
	Longest duration	141.5 sec
Hypopnea	Total number (HI/h)	92 (16.3 /h)
	Longest duration	68.5 sec
Oxygen saturation	Mean	94%
	Lowest	20%
	Oxygen desaturation index (ODI)	37.4 /h
Leg EMG	Leg movement (LM) index /h	11.8 /h
	LM index for periodic limb movement	6.4 /h
Body position	Supine	570 min
	Prone	0 min
	Right lateral	0 min
	Left lateral	0 min



**Figure 3.** Treatment outcome based on the Functional Independence Measure scores.

attributable to the improvement in ADL due to stable cardiovascular function. After near-continuous CPAP therapy for three years, hardly any decline in ADL was observed. On day 1284, while in CPAP therapy, an examination was performed using Smart Watch PMP-300E, which can also measure respiratory effort. Instead of sleep apnea, which was previously observed 244 / night, nonpathological hypopnea was observed, and the AHI value was 2.4 /h, indicating marked improvement. Written informed consent was obtained from the patient and her family prior to preparing this report.

### Discussion

In this study, by simplifying medications, performing rehabilitation and oxygen therapy, and incorporating CPAP, ADL was improved in a patient with preexisting dementia and depression, with poor communication

ability, and nighttime  $\text{SaO}_2$  reduction, as well as postoperative complications after surgery for subtrochanteric femur fracture. Improvement was especially notable in the motor items; no difference was observed in the cognition items.

Treatment outcomes of CPAP vary widely among elderly patients with OSAS. A study of stroke patients undergoing rehabilitation reported that CPAP therapy for OSAS improved ADL, but not cognitive impairment [2]. Also, other studies showed that CPAP therapy improved (1) exercise tolerance, ventilatory function, and respiratory pattern during rehabilitation after coronary artery bypass [3], (2) exercise tolerance among patients with congestive heart failure [4], and (3) sleepiness, 6-min walking distance, exercise time, maximum oxygen consumption, dyspnea, and fatigue in patients with OSAS [5].

Regarding neuropsychological symptoms, 53.9%

**Table 2.** Summary of treatment courses and outcomes.

Intervention	General ward	Convalescent rehabilitation ward	Hospital admission for the night	Post-discharge 2 months	Post-discharge 3 months
Treatment	Night: Oxygen therapy Day: Rehabilitation	Night: Oxygen therapy Day: Intensive rehabilitation		CPAP Daycare service for ADL rehabilitation	CPAP Daycare service for ADL rehabilitation
PSG	Day 25: Out-of-center sleep testing AHI: 49.2 times/h ODI (3%): 56 times/h		Day 99: Full-night polysomnography AHI: 59.6 times/h ODI (3%): 37.5 times/h Longest apnea: 141.5 sec Longest hypopnea: 68.5 sec		
FIM	At transfer: 37 points	At discharge (day 95): 70 points		Day 150: 93 points	Day 185: 92 points
Ambulation	Bedridden	Wheelchair With a walking frame			With a wheeled walker 15 m without rest

and 46.1% of patients with OSAS have anxiety and depression, respectively [6]. OSAS facilitates the decline of cognitive function, but CPAP impedes the progression of cognitive impairment [7].

A previous study described the association of OSAS and depression with intractable angina [8], suggesting that the depression, dementia, and angina observed in our patient might have been features of OSAS. Additionally, the high incidence of falls and bone fractures in elderly women who take daily afternoon naps [9] suggests that daytime somnolence due to SAS increases the risk of bone fracture.

The present patient was referred to our hospital after surgery for subtrochanteric femur fracture and had OSAS in addition to impaired responsiveness due presumably to the effect of excessive antipsychotic drugs. Her physical functions were improved significantly by the incorporation of CPAP.

This patient also had improved ADL by CPAP therapy for OSAS, in addition to the reduction of over-medication, treatment of pleural effusion, and rehabilitation. Our findings show the importance of OSAS screening and management in elderly patients with complicated conditions.

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