

and prudence in the case of moderate renal failure (GFR <30 mL/min). All these drawbacks can be obviated by the performance of CEUS, an interesting option especially in patients with CKD.

In conclusion, CEUS is a valuable, safe and easy tool in the diagnosis of vascularized lesions, such as kidney tumours in ADPKD patients.

*Conflict of interest statement.* None declared.

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## Nocturnal hypoxia is associated with elevated C-reactive protein in dialysis patients

Sir,

Sleep apnoea syndrome (SAS), characterized by repetitive nocturnal hypoxia, is a risk factor for cardiovascular disease (CVD) [1]. In addition, dialysis patients have a high prevalence of SAS (20–50%) in comparison to the general population (2–4%) [2]. The purpose of this study was to investigate the relationship between plasma C-reactive protein (CRP), an independent risk factor for CVD [3], and nocturnal hypoxia in dialysis patients.

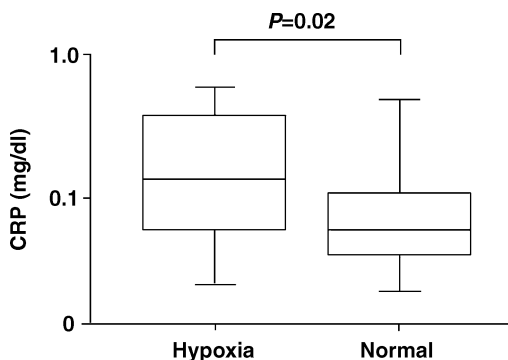
This study followed 88 maintenance haemodialysis patients (male: 53.4%, age: 64.2 ± 24.5 years, BMI: 22.3 ± 9.1, duration of dialysis: 4.7 ± 4.4 years, diabetes mellitus: 39.8%) in Koga Red Cross Hospital, who underwent the overnight pulse oximetry (PULSOX-M24, Teijin Pharma Ltd, Japan) on dialysis day. In addition, blood tests including plasma CRP levels were measured. Plasma CRP was deter-

**Table 1.** Clinical characteristics of the study population

Characteristics	Hypoxia (n = 29)	Normal (n = 59)	P-value
Age (years)	68.4 ± 10.1	62.1 ± 13.1	0.02
Man, n (%)	19 (65.5)	28 (47.5)	0.11
BMI (kg/m <sup>2</sup> )	22.5 ± 6.9	21.8 ± 4.4	0.60
Diabetes mellitus, n (%)	11 (37.9)	24 (40.7)	0.80
Duration of dialysis (years)	3.9 ± 3.4	5.1 ± 4.7	0.20
Kt/V	1.1 ± 0.4	1.3 ± 0.3	0.03
Intra-dialytic weight gain (%)	3.2 ± 1.6	3.6 ± 1.8	0.32
Cardiothoracic ratio (%)	52.7 ± 5.9	49.7 ± 5.0	0.02
ANP (pg/ml)	61.1 ± 63.9	64.6 ± 64.1	0.85
Systolic blood pressure (mmHg)	158.4 ± 20.7	155.0 ± 19.9	0.45
WBC (10 <sup>3</sup> /μl)	5.6 ± 1.5	5.4 ± 1.6	0.67
Haemoglobin (g/dl)	9.0 ± 1.7	9.6 ± 1.4	0.07
Serum albumin (g/dl)	3.6 ± 0.5	3.7 ± 0.5	0.46
3% ODI (events/h)	10.6 ± 10.9	4.6 ± 4.8	0.01
Epworth Sleepiness Scale	6.1 ± 4.2	5.0 ± 4.1	0.23

ANP, atrial natriuretic peptide; ODI, oxygen desaturation index; BMI, body mass index.

Values expressed as mean ± SD or number (percent).



**Fig. 1.** Comparison of plasma CRP between hypoxia and normal groups.

mined using the latex agglutination assay (Pureauto S CRP latex, Daiichi Pure Chemicals, Japan). Patients with systemic inflammatory disease, active malignancy, pulmonary disease and symptomatic heart failure were excluded. The patients with average SaO<sub>2</sub> ≤96% by pulse oximetry were defined as the hypoxia group, and others were defined as the normal group.

Twenty-nine patients (33.0%) were classified into the hypoxia group. Age (68.4 versus 62.1 years,  $P = 0.02$ ), cardiothoracic ratio (CTR) (52.7 versus 49.7%,  $P = 0.02$ ), 3% oxygen desaturation index (ODI) (10.6 versus 4.6/h,  $P = 0.01$ ) and plasma CRP (0.26 versus 0.14 mg/dl,  $P = 0.02$ ) were significantly higher in the hypoxia group than in the normal group (Table 1, Figure 1). On the other hand, Kt/V (1.1 versus 1.3,  $P = 0.03$ ) was significantly lower in the hypoxia group than in the normal group (Table 1). After adjusting for age, BMI, diabetes, Kt/V, CTR, systolic blood pressure, haemoglobin and serum albumin in a logistic regression analysis, nocturnal hypoxia was independently associated with elevated CRP (odds ratio 4.88; 95% confidence interval 1.16–20.60;  $P = 0.03$ ).

CRP is a risk factor for CVD [3], and increased plasma CRP levels have been noted during hypoxic conditions [4]. Shamsuzzaman *et al.* reported that obstructive SAS [mean apnoea-hypopnoea index (AHI):  $60 \pm 5$  events/h] diagnosed by polysomnography (PSG) is associated with elevated CRP in the general population [5]. Although AHI, the total number of apnoea and hypopnoea events per hour, may be associated with the severity of nocturnal hypoxia, the direct relationship between CRP and nocturnal hypoxia has not yet been evaluated. Therefore, the relationship between CRP and nocturnal hypoxia diagnosed by average SaO<sub>2</sub> using pulse oximetry was investigated. Moreover, pulse oximetry is a simple tool and is used for screening SAS in dialysis patients [6], while PSG is costly in terms of both time and money.

In conclusion, this study demonstrated that nocturnal hypoxia is associated with elevated CRP levels in dialysis patients. These findings suggest that nocturnal hypoxia in dialysis patients may be an additional CVD risk and both a careful follow-up and good control of these patients are needed to prevent CVD.

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