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ORIGINAL ARTICLE

# Severe aortic arch calcification predicts mortality in patients undergoing peritoneal dialysis



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## KEYWORDS

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**Background/Purpose:** Vascular calcification can predict cardiovascular (CV) morbidity and mortality in patients with end-stage renal disease. We evaluated the prevalence, association factors, and outcomes of chest X-ray-detected aortic arch calcification (AoAC) in patients undergoing peritoneal dialysis (PD).

**Methods:** We included 190 patients undergoing PD (mean age, 52.6 ± 14.3 years) for whom chest radiographs were available. AoAC revealed by chest X-ray was graded from 0 to 3 according to an AoAC score (AoACS). Multiple regression analyses were used to determine the factors associated with AoACS. After adjusting for age, sex, PD duration, diabetes mellitus, mean

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blood pressure, and history of CV disease, the association between AoAC grading and mortality were assessed using the Kaplan–Meier curve and Cox proportional hazard model.

**Results:** Age ( $p < 0.001$ ), PD duration ( $p = 0.004$ ), history of CV disease ( $p < 0.001$ ), and renal Kt/V ( $p = 0.031$ ) were associated with AoACS. After a mean follow-up of  $55.1 \pm 32.1$  months, patients with Grade 2 ( $p = 0.011$ ) or Grade 3 ( $p < 0.001$ ) AoAC had higher all-cause mortality than patients with Grade 0 AoAC. In addition, patients with Grades 2 and 3 AoAC had higher CV-related mortality than those with Grades 0 and 1 AoAC ( $p = 0.013$ ). Grade 2 [hazard ratio (HR) = 2.736; 95% confidence interval (CI), 1.038–7.211;  $p = 0.042$ ] and Grade 3 AoAC (HR = 3.289; 95% CI, 1.156–9.359;  $p = 0.026$ ) remained associated with all-cause mortality after adjustment. Similarly, Grades 2 and 3 AoAC (HR = 36.05; 95% CI, 3.494–372;  $p = 0.026$ ) significantly correlated with CV mortality after adjustment.

**Conclusion:** In patients undergoing PD, CXR-detected severe AoAC was an independent risk factor for all-cause and CV mortalities.

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## Introduction

Cardiovascular (CV) events have been a major cause of death in patients with end-stage renal disease (ESRD)<sup>1,2</sup>; the incidence is 10 to 30 times higher than that of the general population.<sup>3</sup> In addition to the traditional risk factors of CV events, uremia-specific phenomena including vascular calcification are also responsible for the higher incidence of CV events in patients with ESRD.<sup>4</sup> Vascular calcification, which may involve arterial media, atherosclerotic plaques, or cardiac valves,<sup>4</sup> is highly prevalent in patients with ESRD including younger age groups.<sup>5,6</sup> The existence and extent of vascular calcification are strong predictors of CV morbidity and mortality in both patients undergoing hemodialysis (HD) and those undergoing peritoneal dialysis (PD).<sup>7–13</sup>

In order to evaluate or quantify vascular calcification, several imaging techniques such as electron beam computed tomography (EBCT), multislice spiral CT (MSCT), echocardiography, vascular ultrasound, and plain radiography have been used. Among them, EBCT and MSCT are still considered the gold standards for quantifying coronary or aortic calcification.<sup>14</sup> However, these methods are expensive and expose the patients to high doses of radiation and risks of cancer.<sup>15,16</sup> Chest radiography (CXR), comparatively, is an inexpensive test with lower radiation exposure. Currently, it is a simple and useful tool to evaluate aortic arch calcification (AoAC); the presence or progression of AoAC has been shown to correlate with all-cause and CV mortality in patients with ESRD,<sup>17</sup> patients undergoing HD,<sup>18–20</sup> and even in patients undergoing PD.<sup>13</sup>

The aim of this study was to evaluate the prevalence and associated risk factors of CXR-detected AoAC in patients undergoing PD because its clinical significance has not yet been fully investigated. The prognostic value of CXR-detected AoAC in long-term CV morbidity as well as all-cause and CV mortalities was also analyzed.

## Methods

### Patients

In October 2006, 192 patients underwent PD for more than 3 months at the National Taiwan University Hospital. Among

them, two patients were excluded from the study because chest radiographs were unavailable or death occurred in November 2006. Finally, 190 patients were enrolled and were followed-up for 8 years. More than 75% patients received continuous ambulatory PD, and all patients used lactate-buffered dialysate. The study was approved by the Institution Review Board of the hospital (number 200912054R) and was in adherence with the Declaration of Helsinki.

### AoAC revealed by CXR

The chest radiographs of patients between June and August 2006 were evaluated. AoAC was assessed by a specific scale developed in a previous study.<sup>21</sup> Briefly, a scale, divided into 16 circumferences, was applied over AoAC revealed by CXR as shown in Figure 1. The number of sectors occupied by AoAC, ranging from 0 to 16, were recorded as AoAC score (AoACS). Two radiologists, both specializing in CXR, independently reviewed these images. The images of 80 patients were reassessed by these two radiologists because of interreader variability. Among these 80 images, 19 images were initially scored 0 by only one radiologist. Among the remaining 61 images, 46 images had initial scores varying  $\leq 2$ .

AoAC extent was divided into four grades: Grade 0, AoACS = 0; Grade 1, AoACS = 1–4; Grade 2, AoACS = 5–8; and Grade 3, AoACS = 9–16.

### Demographic and clinical data collection

All the data were collected in October 2006. Patients' age, sex, body height (BH), body weight (BW), systolic blood pressure, diastolic blood pressure (DBP), diabetes mellitus (DM), peritoneal equilibrium test, and dialysis adequacy indices, including peritoneal urea clearance (Kt/V), renal Kt/V, total Kt/V (the sum of peritoneal and renal Kt/Vs), and standardized total weekly creatinine clearance, were recorded. Duration of PD was defined as the interval between the initiation of PD and the time when CXR was performed. CV disease (CVD) was defined as a history of coronary artery disease, cerebrovascular accident, or peripheral arterial occlusive disease. Coronary artery disease

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