Abdominal Aortic Calcification Score on Plain Radiograph as a Predictor of Coronary Artery Calcification Score on Computed Tomography and T Score on BMD in Dialysis Patients

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Introduction & Aims

- Vascular calcification (VC) is commonly found and associated with cardiovascular morbidity and mortality in dialysis patients
- Not only coronary artery calcification scores (CACS) on computed tomography (CT) but also several VC scores on plain radiographs can predict cardiovascular events
- However, there is no study about the correlation between CACS on CT and VC scores of several sites on plain radiographs
- We evaluated which VC scores among several VC scores on plain radiographs are a predictor of CACS on CT in dialysis patients
- In addition, we investigated the association between VC scores and bone mineral density (BMD)

Methods

- Study design
  - Cross-sectional study, single Dong-A University Dialysis Center
  - From March 2013 to September 2014
- Subjects
  - Patients who were receiving hemodialysis (HD) or peritoneal dialysis (PD)
- Measurements
  - VC through the plain radiographs of the feet, hands and pelvis, and lateral lumbar spine
  - Significant VC was any one finding among the following findings on plain radiographs:
    - ✓ score of abdominal aortic calcification (AAC) ≥5
    - ✓ score of the hands and pelvis ≥3
    - ✓ presence of medial artery calcification on the feet
  - CACS by CT
    - ✓ Severe CACS was defined as CACS >1000
  - BMD by DEXA (radius, lumbar, femoral)
  - Fibroblast growth factor 23 (FGF-23), fetuin-A, osteoprotegerin (OPG), receptor activator of nuclear factor kappa-B ligand (RANKL), testosterone (male) were analyzed with ELISA
- Inclusion criteria
  - Male or female patients aged over 20 years
  - ESRD patients on dialysis for at least 6 month
- Exclusion criteria
  - Who underwent 2 or more weeks of hospitalization due to episode of acute infection or cardiovascular disease within 4 month before study initiation
  - Who have changed the dialysis modality
  - Kidney transplantation
  - Pregnancy

Results

- The mean age of the enrolled patients was 58.6±10.2 years and 38 patients undergoing HD were identified (62.3%). Dialysis vintage was 50.2±36.8 months. Of the 61 patients, prevalence rate of significant VC and severe CACS was 75.4% and 26.2% (Table 1).
- Patients treated with PD had higher OPG to RANKL ratio (P=0.040) and fetuin-A levels (P=0.046), and lower FGF-23 levels (P=0.013) than those with HD (Table 1).
- Patients with severe CACS had higher OPG levels (P=0.019) and significant VC (P=0.008) than those with none to moderate CACS (Table 2).
- Patients with AAC score ≥5 had lower T score of both wrist and hip than patients with AAC score <5 (Table 3).
- CACS is positively correlated with age (r=0.329, P=0.014), AAC score (r=0.543, P <0.001), VC score of the hands and pelvis (r=0.548, p <0.001), medial artery calcification of the feet (r=0.268, P=0.048), and OPG (r=0.383, P=0.011). AAC score is negatively correlated with T score of wrist (right: r=-0.254, P=0.050 and left: r=-0.285, P=0.027) on BMD.
- AAC score (RR 1.190 [95% CI 1.047-1.352], P=0.008) on plain radiographs was independently associated with severe CACS on CT after adjustment variable factors, including age, gender, and dialysis modality (Table 4).

Table 1. Comparison of clinical characteristics in accordance with dialysis modality

Characteristics	Total (n = 61)	HD (n = 38)	PD (n = 23)	P value
Age (years)	58.6±10.2	58.3±10.2	59.2±10.5	0.754
Male, n (%)	26 (42.6)	19 (50.0)	7 (30.4)	0.134
Duration (months), n (%)	50.2±36.8	55.1±40.3	41.9±29.1	0.176
DM, n (%)	34 (55.7)	17 (44.7)	17 (73.9)	0.026
Calcification scores on plain radiograph, n (%)				
Abdominal aorta	6.0±6.5	7.5±7.3	3.7±3.9	0.011
Abdominal aorta ≥5, n (%)	32 (52.5)	23 (62.2)	9 (39.1)	0.082
Hands and pelvis	2.9±2.6	2.4±2.5	3.7±2.6	0.042
Hands and pelvis ≥3, n (%)	32 (52.5)	16 (43.2)	16 (69.6)	0.047
Feet	0.8±0.9	0.7±0.8	1.0±0.9	0.157
Feet ≥1, n (%)	31 (50.8)	17 (45.9)	14 (60.9)	0.261
Significant VC	46 (75.4)	27 (73.0)	19 (82.6)	0.391
Severe CACS	16 (26.2)	10 (28.6)	6 (30.0)	0.911
Testosterone	3.6±1.5	2.9±1.1	4.0±1.5	0.061
FGF-23 (pg/mL)	1758.5±143.8	2269.7±1416.8	1126.9±1218.5	0.013
Fetuin-A (μg/mL)	211.8±51.7	196.9±45.4	227.4±54.2	0.046
RANKL	317.5±305.7	390.0±393.1	245.0±62.0	0.135
OPG	22.8±8.8	21.3±8.1	24.4±9.3	0.241
OPG/RANKL	0.11±0.08	0.09±0.07	0.14±0.09	0.040

Table 2. Comparison of clinical characteristics in accordance with coronary artery calcification scores on CT

Characteristics	None to Moderate CACS (n = 39)	Severe CACS (n = 16)	P value
Age (years)	56.2±11.0	65.3±6.4	0.016
Male, n (%)	17 (43.6)	7 (43.8)	0.991
HD (vs. PD), n (%)	25 (64.1)	10 (62.5)	0.911
DM, n (%)	18 (46.2)	11 (68.8)	0.127
Calcification scores on plain radiograph, n (%)			
Abdominal aorta	4.1±5.5	11.0±7.0	<0.001
Abdominal aorta ≥5, n (%)	13 (33.3)	15 (93.8)	<0.001
Hands and pelvis	2.0±2.3	4.8±.2	<0.001
Hands and pelvis ≥3, n (%)	16 (41.0)	13 (81.3)	0.007
Feet	0.7±0.8	1.1±0.9	0.075
Feet ≥1, n (%)	17 (43.6)	11 (68.8)	0.090
Significant VC	26 (66.7)	16 (100.0)	0.008
RANKL	349.9±345.1	255.4±89.0	0.419
OPG	21.0±7.8	27.9±9.0	0.019
OPG/RANKL	0.10±0.08	0.14±0.07	0.188

Table 3. Association between abdominal aorta calcification (AAC) scores and T-scores on BMD

T score on BMD	AAC <5 (n = 28)	AAC ≥5 (n = 32)	P value
Forearm			
Right	-2.3±1.2	-3.3±1.4	0.004
Left	-2.2±1.2	-3.2±1.4	0.006
Total hip			
Right	-1.3±0.9	-2.1±1.1	0.010
Left	-1.4±0.9	-2.1±0.9	0.011
Femur neck			
Right	-0.7±0.9	-1.3±1.1	0.020
Left	-0.8±0.8	-1.2±0.9	0.041
L-spine			
L1	-0.2±1.5	-0.7±2.1	0.272
L2	-0.1±1.8	-0.6±2.2	0.485
L3	-0.4±1.6	-0.9±1.7	0.311
L4	-0.8±1.6	-1.5±1.6	0.147

Table 4. Independent factors associated with degree of coronary artery calcification scores (CACS) on CT

Characteristics	Severe CACS on CT	
	RR* (95% CI)	P value
Age (years)	1.045 (0.964-1.133)	0.283
Male, n (%)	1.068 (0.267-4.272)	0.926
HD (vs. PD), n (%)	2.537 (0.524-12.293)	0.248
Calcification scores on plain radiograph, n (%)		
Abdominal aortic calcification	1.190 (1.047-1.352)	0.008

*Clinical parameters (age, gender, dialysis modality) were examined with severe CACS.

Conclusions

- AAC score among several VC scores on plain radiographs is the most reliable predictor of CACS on CT and T score on BMD in dialysis patients.

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