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Relationship between age, osteoporosis and coronary artery calcification detected by high-definition computerized tomography in Chinese elderly men

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ABSTRACT

Background: Few studies have analyzed the relationship between bone mineral density (BMD) and coronary artery calcification (CAC) in older men, and it remains subject to debate. The present study was designed to evaluate the age-related acceleration of osteoporosis and CAC, as well as the relationship between BMD and CAC in Chinese elderly men.

Methods: Participants included 120 men older than 60 years. CAC was measured with high-definition computerized tomography. It is a highly sensitive technique for detecting the CAC and provides the most accurate CAC scores up to date.

Results: Mean (standard deviation) age was 73 (8.5) years. For osteoporosis, there was a strongly inverse correlation between age and BMD of all scanned body parts ($p < 0.05$ for all) except the lumbar spine 1–4 ($p > 0.05$ for all). For CAC, there was a moderately positive correlation of agatston, volume and mass scores with age. CAC was present in 67% of participants. There was no significant correlation between all kinds of CAC scores including agatston, volume and mass scores, and BMD of all scanned body parts including lumbar spine 1–4, femoral neck, femoral trochanter and total femur ($p > 0.05$ for all). BMD of all these body parts had no ability to identify the CAC ($p > 0.05$ for all). Furthermore, on multiple linear regression analysis, the relationship between CAC scores and BMD remained statistically non-significant.

Conclusions: Age constituted an important factor common for loss of BMD and development of CAC detected by HDCT, and no direct relationship was observed between osteoporosis and CAC in Chinese elderly men.

1. Introduction

Osteoporosis is a common feature among the elderly. It represents a major public health problem that affects both men and women, usually as they grow older. Coronary artery calcification (CAC) is also a highly prevalent condition among the elderly, and its development has been demonstrated to be associated with future cardiovascular risk (Watanabe, Lemos, Manfredi, Draibe, & Canziani, 2010). Until recently, several clinical data have reported a relationship between osteoporosis and vascular calcification, including carotid artery plaque, aortic calcification and arterial stiffness (Frost et al., 2008; Jorgensen, Joakimsen, Rosvold Berntsen, Heuch, & Jacobsen, 2004). More importantly, previous studies have realized that bone mineral density (BMD) is implicated with CAC. However, while most of these studies have considered osteoporosis as a disease of older women and specially chosen older women as the study participants, it is an undeniable fact that accelerated osteoporosis also occurs in older men. Other studies have proved that there is a sex difference in terms of vascular calcification and osteoporosis acceleration in natural aging process (Lin, Liu, Chang, & Shen, 2011). Few studies have analyzed the relationship between BMD and CAC in older men, and it remains subject to debate (Choi et al., 2009). High-definition computerized tomography (HDCT) is a highly sensitive technique for detecting the CAC and provides the most accurate CAC scores up to date. In the study presented here, we aimed to evaluate the age-related acceleration of osteoporosis and CAC detected by HDCT, as well as the relationship between BMD and CAC in Chinese elderly men.

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Table 1
Baseline characteristics of participants grouped by age.

Characteristics	Total (n = 120)	Age < 75 years (n = 66)	Age ≥75 years (n = 54)	P value
Age (year)	73 ± 8.5	67 ± 4.9	81 ± 3.5	< 0.001
History of smoking (%)	15(25.0)	11(33.3)	4(14.8)	0.099
Body mass index (kg/m^2)	25.1 ± 2.8	24.7 ± 2.9	25.4 ± 2.8	0.354
Comorbidity				
Hypertension (%)	44(73.3)	19(57.6)	25(92.6)	0.002
Diabetes mellitus (%)	29(48.3)	17(51.5)	12(44.4)	0.586
Coronary artery disease (%)	44(73.3)	19(57.6)	25(92.6)	0.002
Clinical presentation				
MSBP (mmHg)	126 ± 15.6	122 ± 16.5	129 ± 13.7	0.087
MDBP (mmHg)	72 ± 10.8	72 ± 10.9	72 ± 11.0	0.821
Heart rate (bpm)	72 ± 10.6	74 ± 12.6	69 ± 7.1	0.110
LVEF (%)	60 ± 4.8	61 ± 4.0	59 ± 5.5	0.209
Laboratory test				
Fasting blood glucose (mmol/L)	5.33 ± 0.69	5.31 ± 0.74	5.36 ± 0.64	0.780
Triglyceride (mmol/L)	1.46 ± 0.63	1.49 ± 0.68	1.43 ± 0.59	0.707
HDL-c (mmol/L)	1.15 ± 0.30	1.18 ± 0.31	1.11 ± 0.27	0.349
LDL-c (mmol/L)	2.45 ± 0.78	2.47 ± 0.71	2.42 ± 0.86	0.820
Serum calcium (mmol/L)	2.27 ± 0.16	2.29 ± 0.19	2.25 ± 0.10	0.290
Serum phosphorus (mmol/L)	1.12 ± 0.17	1.12 ± 0.19	1.11 ± 0.16	0.884
Bone mineral density				
Lumbar spine 1–4 (g/cm^2)	1.183 ± 0.240	1.190 ± 0.274	1.174 ± 0.195	0.808
Corresponding T score	0.97 ± 1.70	1.14 ± 1.77	0.76 ± 1.63	0.395
Left femoral neck (g/cm^2)	0.876 ± 0.150	0.916 ± 0.140	0.827 ± 0.150	0.020
Corresponding T score	−0.78 ± 1.15	−0.50 ± 1.09	−1.13 ± 1.14	0.033
Right femoral neck (g/cm^2)	0.868 ± 0.158	0.916 ± 0.137	0.811 ± 0.166	0.010
Corresponding T score	−0.82 ± 1.20	−0.45 ± 1.01	−1.27 ± 1.27	0.007
Left femoral trochanter (g/cm^2)	0.821 ± 0.154	0.857 ± 0.149	0.777 ± 0.152	0.046
Corresponding T score	−0.03 ± 1.30	0.24 ± 1.24	−0.36 ± 1.30	0.071
Right femoral trochanter (g/cm^2)	0.801 ± 0.160	0.844 ± 0.144	0.750 ± 0.166	0.023
Corresponding T score	−0.20 ± 1.35	0.12 ± 1.21	−0.60 ± 1.43	0.037
Left total femur (g/cm^2)	0.975 ± 0.166	1.012 ± 0.158	0.930 ± 0.168	0.056
Corresponding T score	−0.10 ± 1.28	0.16 ± 1.21	−0.41 ± 1.31	0.086
Right total femur (g/cm^2)	0.963 ± 0.173	1.005 ± 0.155	0.911 ± 0.184	0.037
Corresponding T score	−0.21 ± 1.34	0.09 ± 1.19	−0.57 ± 1.44	0.055
CAC scores				
Agatston score	454 ± 861	264 ± 371	686 ± 1188	0.085
Volume score	172 ± 309	105 ± 137	254 ± 425	0.091
Mass score	58 ± 105	35 ± 51	85 ± 143	0.092

MSBP: mean systolic blood pressure; MDBP: mean diastolic blood pressure; LVEF: left ventricular ejection fraction; HDL-c: high density lipoprotein-cholesterol; LDL-c: low density lipoprotein-cholesterol; CAC: coronary artery calcification.

2. Methods

2.1. Study participants

Participants included 120 men older than 60 years who visited Chinese People's Liberation Army General Hospital. Criteria for exclusion included: 1) patients receiving percutaneous coronary intervention, coronary artery bypass graft, cardiac valve replacement or cardiac pacemaker implantation; 2) patients with a disorder influencing bone and calcium metabolism, such as thyrotoxicosis, hyperparathyroidism, chronic renal failure, neoplastic or infectious diseases; and 3) patients consuming drugs interacting with bone and calcium metabolism, such as glucocorticosteroid, estrogen and bisphosphonate.

2.2. Physical examination

Each participant underwent a complete physical evaluation by the well-trained staffs. Height was measured in the standing position using a wall-mounted measuring tape and body weight was measured with a digital scale wearing a standardized health check-up clothes. Body mass index (BMI) was calculated as weight in kilogram, divided by height in meter squared. Mean systolic and diastolic blood pressure (MSBP and MDBP) was measured using a standard mercury sphygmomanometer, with participants in a seated position after having rested quietly for 10 min. Standard echocardiogram was performed and left ventricular ejection fraction was calculated.

2.3. Bone mineral density

BMD was evaluated by dual energy X-ray absorptiometry (DEXA; Lunar Prodigy, GE Healthcare, Wisconsin, USA) with the software (enCORE 11.20.068) provided by the manufacturer in the lumbar spine (L1–L4) and femur (femoral neck, femoral trochanter and total femur). All analyses were performed according to the consensus of two observers blind to clinical aspect of participants. For DEXA measurements there was limited intra-observer variation, with observers being on average within 3.1% of the pooled mean value. Similarly, there was good interobserver agreement, with an average variation of 2.2%.

2.4. Coronary artery calcium scores

CAC was measured with HDCT (Discovery CT 750 HD, GE Healthcare, Wisconsin, USA). CAC scores were determined using the Agatston, volume and mass scoring systems on a three-dimensional workstation (Advantage Windows Workstation 4.5, GE Healthcare, Wisconsin, USA) with the software (Smart score 4.0, GE Healthcare, Wisconsin, USA) (Agatston et al., 1990; Horiguchi et al., 2009). Calculation formulas of CAC scores were as follows: 1) Agatston score =

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