

Correlation research between osteoporosis and left ventricular hypertrophy in older men

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Abstract

Introduction: The aim of the study was to correlate between osteoporosis and left ventricular hypertrophy (LVH) in older men.

Material and methods: One hundred and forty-six cases of senile male subjects were selected and divided into a normal bone mineral density group, an osteopenia group, and an osteoporosis group based on bone mineral density (BMD). Detailed history inquiry and clinical examination were used to determine biochemical indicators. Femoral neck BMD and lumbar BMD were determined. Electrocardiography was performed to calculate the left ventricular mass index (LVMI). One-way analysis of variance and multiple linear regression analysis were performed.

Results: With the bone mass reduced, LVMI was gradually increased ($p < 0.05$), incidence of left ventricular hypertrophy was increased, and there were significant differences ($p < 0.05$). With LVMI as the dependent variable, multiple linear regression analysis showed that lumbar bone density, body mass index, age and serum creatinine were associated with LVMI independently ($p < 0.05$).

Conclusions: In patients with osteoporosis and osteopenia, LVH rates were much higher than in normal bone mineral density patients. Moreover, there might be a relationship between osteoporosis and LVH.

Key words: osteoporosis, left ventricular hypertrophy, elderly men.

Introduction

Osteoporosis and cardiovascular disease (CVD) are common chronic diseases in the elderly. Their high morbidity and mortality rates seriously affect the life quality of the elderly. Many recent cross-sectional studies have shown that CVD incidence is increased in osteoporotic patients, and the incidence of osteoporosis is also higher in patients with CVD [1–6]. Experimental studies have also shown that there may be a correlation between the two diseases in the pathophysiological mechanism [7–9]. Left ventricular hypertrophy (LVH) is a clear independent risk for CVD [10–12]. This paper aims to evaluate the correlation between osteoporosis and left ventricular hypertrophy in elderly men.

Material and methods

Search strategy and selection criteria

This study was conducted at First Affiliated Hospital of Chongqing Medical University in Chongqing, and patients admitted to our outpa-

tient clinic from September 2010 to June 2014 were collected. One hundred and forty-six cases of patients were eventually included as the research objects, with the average age of 75 ± 9 years old. Inclusion criteria: (1) male; (2) more than 60 years but less than 90 years old; (3) the study was approved by the hospital ethics committee, and the objects had signed the informed consent. Exclusion criteria: (1) severe liver and kidney dysfunction; (2) acute infection and malignant tumors; (3) patients with renal resection or maintenance dialysis; (4) cardiac valvular disease, and cardiomyopathy; (5) diseases affecting bone metabolism such as severe anemia, multiple myeloma, etc.; (6) secondary hypertension and malignant hypertension; (7) severe organic endocrine disease (thyroid disease, hyperparathyroidism, etc.); (8) long-term use of drugs affecting bone metabolism such as glucocorticoid, estrogens, diphosphonate, etc.

Detailed history and general clinical examination

Detailed history inquiry and general clinical examination: Patients' ages, diabetes and hypertension conditions and course of hypertension were recorded. Body height and body mass were calculated by the specialist personnel. Body mass index = body weight / body height² (kg/m²). Blood pressure was measured by the specialist personnel. The subjects were taken for venous blood after fasting for 8–12 h. An automatic biochemical analyzer was used to detect fasting blood glucose (FBG), serum creatinine (Scr), total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), and triacylglycerol (TG).

Determination of bone mineral density

Lunar Prodigy Advance PA +300164 dual energy X-ray absorptiometry (DXA) was used to determine the femoral bone mineral density (BMD) in the left proximal femoral neck, greater trochanter, intertrochanteric and Ward's triangle, to determine the lumbar BMD of L1–L4 posteroanteriorly. Bone mineral density was obtained with the total bone mass (g) divided by the bone area (cm²) in the scanning area, with the unit of g/cm². According to the *Diagnostic Criteria of Chinese Osteoporosis Diagnosis Standard* in 1999, research objects were determined for bone density based on dual energy X-ray absorptiometry: reduction of BMD value within 1 standard deviation from the peak of a normal adult with the same gender and race was considered as normal; reduction between 1 and 2.5 standard deviations was considered as low bone mass (osteopenia); reduction of more than 2.5 standard deviations was considered as

osteoporosis. Daily quality control measurements were performed on the DXA machine to ensure scanner reliability.

Echocardiography (ECG)

Transthoracic echocardiographic studies were performed, with the subject in the left lateral decubitus position at rest, using the GE Vivid 7 digital ultrasound system (Vivid 7 General Electric Company, USA). Color Doppler ultrasound was used with the probe frequency of 2.5 MHz, and the acoustic window was placed at approximately the left sternal line, in the third and fourth intercostal spaces. Measurements recommended by the American Society of Echocardiography were adopted for ultrasound images with satisfactory quality in the left ventricular long axis, and each cardiac indicator was measured: left ventricular end diastolic diameter (LVEDD), interventricular septum and left ventricular posterior wall thickness (LVPWT). Left ventricular mass index (LVMI) was calculated by the formula [13, 14]: $LVMI [g/m^2] = \{1.04 \times [(LVST (\text{left ventricular septum thickness}) + LVEDD + PWT)^3 - LVEDD^3] - 13.6\} / \text{height}^2$.

Left ventricular mass index was used for judging the presence of LVH. The diagnostic criterion was that: LVH was considered with regard to $LVMI > 49.2 \text{ g/m}^2$. Left ventricular hypertrophy rates of the three groups were calculated separately. All Doppler measurements were taken at least 3 times, results were averaged, and all the patients were scanned by an experienced physician specialized in cardiac sonography.

Statistical analysis

SPSS 16.0 was used for research data. Measurement data that did not coincide with the normal distribution were transferred by natural logarithm ln. Single factor analysis was used for comparison of mean measurement data of 3 groups, where least significant difference (LSD) was used for two variables with homogeneity of variance, while Dunnett's test was used for two variables with non-homogeneity of variance. The χ^2 test was used for comparison between the groups. Multiple linear regression analysis was used for multiple-factor analysis. $P < 0.05$ was considered significant.

Results

General clinical examination results (Table I)

The research subjects were divided into a normal bone mass group ($n = 44$), an osteopenia group ($n = 62$) and an osteoporosis group ($n = 40$) in accordance with the BMD. The three groups of patients were compared for body mass index (BMI), prevalence of hypertension and diabetes,

Table I. General clinical examination results of the three groups of patients

Variable	Normal BMD group (n = 44)	Osteopenia group (n = 62)	Osteoporosis group (n = 40)
Age [years]	72.33 ±7.47	73.68 ±10.21	79.24 ±8.53 ^{b,c}
Incidence of diabetes (%)	38.66	36.59	37.50
Hypertension (%)	70.52	71.63	69.55
Course of hypertension [years]	13.24 (19.36, 25.75)	11.72 (9.02, 21.35)	10.50 (8.13, 19.54)
BMI [kg/m ²]	25.51 ±3.36	24.29 ±3.02	23.82 ±3.90
SBP [mm Hg]	137.13 ±15.92	130.71 ±13.68 ^a	129.42 ±17.78 ^c
DBP [mm Hg]	75.73 ±9.56	67.64 ±9.68	73.72 ±8.24
FBG [mmol/l]	6.32 ±0.82	6.27 ±1.13	6.44 ±1.27
Scr [μmol/l]	82.73 ±27.51	77.03 ±26.35	77.56 ±40.03
TC [mmol/l]	5.28 ±0.77	5.61 ±0.79 ^a	5.44 ±0.67
LDL-C [mmol/l]	3.20 ±0.81	2.84 ±0.92	2.93 ±0.83
HDL-C [mmol/l]	1.35 ±0.27	1.26 ±0.25	1.27 ±0.26
TG [mmol/l]	1.77 ±0.58	1.69 ±0.46	1.55 ±0.77

BMI – body mass index, SBP – systolic blood pressure, DBP – diastolic blood pressure, FBG – fasting blood glucose, Scr – serum creatinine, TC – total cholesterol, LDL-C – low-density lipoprotein cholesterol, HDL-C – high-density lipoprotein cholesterol, TG – triacylglycerol. ^aSignificant difference between normal BMD group and osteopenia group ($p < 0.05$). ^bSignificant difference between osteopenia group and osteoporosis group ($p < 0.05$). ^cSignificant difference between normal BMD group and osteoporosis group ($p < 0.05$). Data conforming to normal distribution are presented as $x \pm s$. Data not conforming to normal distribution are presented as median (lower quartile, upper quartile).

FBG, Scr, TC, TG, LDL-C and HDL-C, medication of anti-hypertensive drug and statins, course of hypertension, glycosylated hemoglobin, diastolic blood pressure and blood lipid. There were no significant differences ($p > 0.05$). Total cholesterol of the osteopenia group was higher than the normal bone mass group, and the difference was significant ($p < 0.05$). Age of the osteoporosis group was significantly lower than the normal bone mass group ($p < 0.05$) and also significantly higher than the osteopenia group ($p < 0.05$). There was no significant difference in age between the normal bone mass group and the osteopenia group ($p > 0.05$). Systolic blood pressure of the osteopenia group was lower than the normal bone mass group ($p < 0.05$), and systolic blood pressure of the osteoporosis group was lower than the normal bone mass group ($p < 0.05$). There was no statistically significant difference in systolic blood

pressure between the osteoporosis group and the osteopenia group ($p > 0.05$).

Comparison of bone mineral density and left ventricular mass index (Table II)

Left ventricular mass index in the normal bone mass group was significantly lower than that of the osteoporosis group ($p < 0.05$) and significantly lower than that of the osteopenia group ($p < 0.05$), but there was no significant difference between the osteoporosis group and the osteopenia group ($p > 0.05$). Left ventricular hypertrophy incidence in the normal bone mass group was significantly lower than that of the osteoporosis group ($p < 0.05$), and significantly lower than that of the osteopenia group ($p < 0.05$), but there was no significant difference between the osteoporosis group and the osteopenia group ($p > 0.05$).

Table II. Single factor analysis of LVEF, LVMI, LVH incidence and BMD in the three groups of patients

Variable	Normal BMD group (n = 44)	Osteopenia group (n = 62)	Osteoporosis group (n = 40)	P-value
LVEF (%)	69.41 ±25.82	67.43 ±26.32	66.1 ±26.40	0.89
LVMI [g/m]	44.24 ±8.19	50.68 ±11.26 ^a	52.5 ±12.17 ^c	< 0.01
Incidence of LVH (%)	43.72	59.43 ^a	67.86 ^{b,c}	0.02

LVEF – left ventricular ejection fraction, LVMI – left ventricular mass index, LVH – left ventricular hypertrophy. ^aSignificant difference between normal BMD group and osteopenia group ($p < 0.05$). ^bSignificant difference between osteopenia group and osteoporosis group ($p < 0.05$). ^cSignificant difference between normal BMD group and osteoporosis group ($p < 0.05$).

Multiple linear regression analysis (Table III)

With LVMI as the dependent variable, age, BMI, systolic blood pressure, TC, LDL-C, HDL-C, TG, Scr, glycosylated hemoglobin and lumbar BMD as covariates, multiple linear regression analysis was used for screening independent variables. Lumbar BMD, BMI, age and Scr were included in the equation. Regression equation: $LVMI = 17.215 - 12.237 \times \text{lumbar BMD} + 0.893 \times \text{BMI} + 0.223 \times \text{age} + 0.045 \times \text{Scr}$.

Discussion

Due to the influences of sexual hormone function, LVH prevalence shows gender differences [15, 16]. In this study, incidence of left ventricular hypertrophy and LVMI of elderly male patients with osteoporosis and osteopenia were significantly higher than in patients with normal bone mass. Young *et al.* studied older women and found that bone mineral density was the independent factor determining LVMI, which was similar to the results of this study [17].

In our study, multiple factor analysis showed that BMI, lumbar BMD, age and Scr were associated with LVMI independently. The results showed that for elderly men, low bone mass and osteoporosis might be independent risk factors influencing LVH. Epidemiological studies [18] also showed that osteoporosis and osteopenia were risk factors for cardiovascular disease or atherosclerosis disease. A Moroccan study [19] in postmenopausal women found that incidence of intima-media thickening in the carotid artery and femoral artery in patients with osteoporosis was significantly higher than that of the non-osteoporosis group. Zhang's research results also showed that the incidence of carotid atherosclerotic lesions in elderly male patients with osteoporosis was higher than that of the non-osteoporosis group [20]. These results indicated that low bone mass was related to subclinical target organ damage of atherosclerosis such as LVH.

Left ventricular hypertrophy is an important independent predictor of subclinical target organ damage of atherosclerosis disease [11, 12]. Osteoporosis and atherosclerosis are both diseases closely related to aging. In recent years, more and more evidence has shown that these two diseases are not only related to age [21]. Their common pathogenesis may be related to the oxidation of lipids, primary hyperparathyroidism, damage of vitamin D and vitamin K, and high expression of some inflammatory factors. These factors directly accelerate the atherosclerosis, stimulate osteoclast activity, and promote bone absorption [19]. For example, the reduction of vitamin D not only results in the decrease of bone mass, but also stimulates the renin-angiotensin system and promotes the progress of hypertension, left ventricular hypertrophy, coronary atherosclerosis and heart failure [8]. In addition, clinical studies have shown that certain drugs can treat osteoporosis and atherosclerosis at the same time. For patients treated by diphosphonate, the incidence of cardiovascular calcification drops [22].

There are several limitations to our study. As this was a retrospective analysis, we were only able to collect information from the medical records. Regarding these echocardiographic and bone mineral measurements, there may be more than one technician, and the interperson variability becomes inevitable, when we assess all these measurements as a whole. Furthermore, we used logistic regression analysis to adjust for potential confounding variables and identify independent risk factors for LVH. However, there may be some interaction between the independent variables (e.g. the aging males may have an abnormal Scr level, low BMI, low bone mineral densities and increased left ventricular masses). Also their influence on the incidence of LVH may be affected by other factors. It is also possible that potential confounding variables not included in the analysis

Table III. Multiple linear regression analysis of LVMI and dependent variable in elderly men

Model	Unstandardized coefficients		Standardized coefficients β	t	Sig.
	B	Std. error			
1 Constant	17.215	3.278		1.027	0.203
Lumbar BMD	-12.237	2.320	-0.326	2.655	0.006
BMI	0.893	0.215	0.256	2.606	0.008
Age	0.223	0.077	0.238	2.545	0.012
Scr	0.045	0.009	0.338	2.833	0.002
F (p-value)	7.882 (0.002)		R ²	0.473	

With LVMI as the dependent variable, age, BMI, systolic blood pressure, TC, LDL-C, HDL-C, TG, Scr, glycosylated hemoglobin and lumbar bone mineral density as covariates, multiple linear regression analysis was used for screening independent variables. Lumbar bone mineral density, BMI, age and Scr were included in the equation.

may bias the findings. Finally, the effect of aging on left ventricular mass was not taken into consideration. Also, several important risk factors for osteoporosis and left ventricular hypertrophy, such as smoking, family history of osteoporotic fractures, and vitamin D deficiency, were not considered in this survey. These factors significantly limited the study.

In conclusion, this retrospective study can therefore only provide preliminary data regarding LVH risk assessment in elderly patients with osteoporosis. However, our findings represent a valuable attempt at better understanding of osteoporosis and LVH, and may help to optimize medical management strategies and improve outcomes of these diseases.

Conflict of interest

The authors declare no conflict of interest.

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