

Exploration on the relationship between the elderly osteoporosis and cardiovascular disease risk factors

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Abstract. – OBJECTIVE: To explore and discuss the correlation between osteoporosis and the risk factors of cardiovascular diseases in the elderly.

PATIENTS AND METHODS: A total of 1240 patients, who were hospitalized in our hospital from January 2012 to January 2017, with the age ≥ 65 years old, were selected. All the patients were divided into osteoporosis group and normal bone mass group according to their bone mineral density. The general conditions, biochemical indexes, combined cardiovascular diseases, and the related risk factors, were recorded and analyzed.

RESULTS: The proportion of patients with coronary heart diseases, hyperlipidemia, diabetes mellitus, and smoking in osteoporosis group was significantly higher than that in normal bone mass group ($p < 0.05$). Results of binary logistic regression analysis showed that homocysteine (HCY), low density lipoprotein (LDL) and total cholesterol (TC) were the major risk factors of osteoporosis in the elderly patients. High-density lipoprotein (HDL) and body weight were protective factors for senile patients with osteoporosis. Female, hypertension, coronary heart diseases, hyperlipidemia, and diabetes mellitus were the main risk factors of complication in the elderly patients with osteoporosis.

CONCLUSIONS: Senile osteoporosis is closely correlated with cardiovascular diseases and related risk factors, including hypertension, coronary heart disease as well as hyperlipidemia, and should be early prevented and treated.

Key Words:

Elderly, Osteoporosis, Cardiovascular diseases, Risk factors, Correlation.

Introduction

China is entering the stage of an aging society and the trend keeps rising. The incidence rate of

osteoporosis (OP) and cardiovascular diseases is rising straightly with age¹. OP is a systemic metabolic bone disease, which is characterized by decrease of bone mass, as well as degeneration of bone microstructure and is prone to lead to fracture due to increasing bone fragility²⁻⁴. Cardiovascular disease is a circulatory system disease mainly caused by arteriosclerosis, including coronary heart disease, hypertension, hyperlipidemia, congestive heart failure and cerebrovascular disease^{5,6}.

Although plenty of studies on OP and cardiovascular diseases have been carried out at home and abroad so far, there are still some controversies on the findings. Therefore, taking the elderly people in our hospital as the research object, this research further discussed and analyzed the relationship between senile OP and cardiovascular disease risk factors so as to provide new thoughts for clinical prevention of OP.

The primary purpose of this study was to explore and discuss the correlation between osteoporosis and the risk factors of cardiovascular diseases in the elderly.

Patients and Methods

Patients

1240 patients who were admitted to our hospital from January 2012 to January 2017, aged ≥ 65 years and with an average age of 71.4 ± 3.6 years, were selected. Among all the cases, endocrine disorders of thyroid gland, parathyroid gland, adrenal gland, etc., were excluded; severe liver and kidney diseases, various types of cancers and chronic diseases of gastrointestinal tract were ruled out; fracture in any part of body had not been discovered in the past 6 months. The

diagnosis of OP was conducted according to the diagnostic criteria of the World Health Organization; all the patients were divided into OP group and normal bone mass group according to their bone mineral density. Signed written informed consents were obtained from all participants before the study. This work was approved by the Ethics Committee of People's Hospital of Qinghai Province.

Methods

The patient's sex, height, body weight, body mass index (BMI) and blood pressure on the day of admission were recorded; the combined cardiovascular disease and its risk factors (hypertension, coronary heart disease, hyperlipidemia, etc.) were registered. The fasting blood test indexes of the two groups were recorded respectively on the second day of admission; the indexes consisted of serum homocysteine (HCY), uric acid (UA), total cholesterol (TC), triglyceride (TG), high density lipoprotein (HDL) and low density lipoprotein (LDL).

Single factor analysis was performed on the clinical data and biochemical indexes of the two groups of patients. With whether suffering from OP as dependent variable, two-category multivariate logistic regression analysis was implemented to screen for risk factors independently associated with the onset of OP.

Statistical Analysis

All statistics were performed using SPSS19.0 (Version X; IBM, Armonk, NY, USA) software. *t*-test was performed for the comparison of mean value, and χ^2 -test for the significant difference between groups. Logistic regression analysis was used to evaluate the relationship between the parameters of OP and cardiovascular disease risk factors. $p < 0.05$ suggested statistical significance.

Results

Baseline Characteristic and Laboratory Index of Patients

A total of 1024 patients with an average age of 71.4 ± 3.6 years old were selected and divided into OP group ($n=798$) and normal bone mass group ($n=442$) according to their bone mineral density. It was shown that the levels of HCY and LDL in OP group were much higher than those in normal bone mass group and the differences were statistically significant ($p < 0.05$, Table I); the levels of

Table I. Baseline characteristic and laboratory index of included subjects.

	OP group	NBM group
Case (n)	798	442
Age (y)	71.52 ± 5.36	70.47 ± 5.45
Weight (kg)	60.97 ± 12.24	64.18 ± 11.36
BMI (kg/m^2)	24.61 ± 2.78	25.03 ± 2.92
HCY ($\mu\text{mol}/\text{L}$)	$16.01 \pm 8.79^*$	13.47 ± 7.35
UA ($\mu\text{mol}/\text{L}$)	366.44 ± 119.32	350.07 ± 120.18
SBP (mmHg)	136.06 ± 17.25	135.84 ± 16.93
DBP (mmHg)	74.85 ± 7.57	73.90 ± 6.62
TG (mmol/L)	1.23 ± 0.71	1.22 ± 0.64
TC (mmol/L)	4.36 ± 1.27	4.22 ± 1.15
HDL (mmol/L)	1.08 ± 0.31	1.12 ± 0.29
LDL (mmol/L)	$2.43 \pm 0.79^*$	2.21 ± 0.80
LVEF (%)	0.62 ± 0.05	0.63 ± 0.08

Abbreviation: OP Group: osteoporosis group, NBM Group: normal bone mass group, BMI: body mass index, HCY: Homocysteine, UA: uric acid, SBP: systolic blood pressure, DBP: diastolic blood pressure, TG: triglycerides, TC: total cholesterol, HDL: high-density lipoprotein cholesterol, LDL: low-density lipoprotein cholesterol, LVEF: left ventricular ejection fraction. *, $p < 0.05$ in comparison with NBM group..

UA, TG and TC in OP group were slightly higher than those in normal bone mass group while the level of HDL in OP group was slightly lower; the differences between the two groups were not statistically significant ($p > 0.05$, Table I). In this research, there were 792 male patients of whom 462 suffered from OP and 448 female of whom 344 suffered from OP. The overall prevalence of OP was 63.45%, of which the prevalence of OP among female (76.79%) was higher than that among male (58.33%); the difference was statistically significant ($p < 0.05$, Table II).

Comparison of Cardiovascular Disease and Risk Factors

The proportions of smoking, hypertension, coronary heart disease, hyperlipidemia and diabetes in OP group were significantly higher than those in normal bone mass group ($p < 0.05$, Table III). The prevalence of hypertension and hyper-

Table II. Comparison of male and female osteoporosis prevalence (n%).

	OP group	NBM group	χ^2	<i>p</i>
Male	462 (58.33)	330 (41.67)	34.52	0.01
Female	344 (76.79)	100 (24.88)		

Abbreviation: OP group: osteoporosis group, NBM group: normal bone mass group.

Table III. Comparison of cardiovascular disease and risk factors in the study population (n%).

	OP group	NBM group
Hypertension	601 (75.31)*	235 (53.17)
Coronary heart disease	296 (47.12)*	138 (31.22)
Hyperlipidemia	272 (34.09)*	99 (22.40)
Diabetes mellitus	304 (38.10)*	112 (25.34)
Smoking	291 (36.47)*	123 (27.83)
Stroke	56 (7.02)	45 (10.18)
Heart failure	44 (6.52)	23 (5.20)

Abbreviation: OP group: osteoporosis group, NBM group: normal bone mass group. Note: *, $p < 0.05$ in comparison with NBM group.

lipidemia in female OP group was higher than that in male OP group and the difference was statistically significant ($p < 0.05$, Table IV); the proportions of diabetes, stroke and heart failure in female OP group were slightly higher than those in male OP group, but the differences were not statistically significant ($p > 0.05$, Table IV).

Correlation Between Risk Factors of Cardiovascular Disease and Osteoporosis

With whether suffering from OP as dependent variable, smoking, body weight, BMI, HCY, UA, systolic blood pressure (SBP), diastolic blood pressure (DBP), TG, TC, HDL, LDL and other factors were introduced into the binary Logistic model; the results showed that HCY, LDL and TC were major risk factors in the elderly patients with OP ($p < 0.05$, Table V) and that HDL and body weight were protective factors in the elderly patients with OP ($p < 0.05$, Table V).

Correlation Between Cardiovascular Disease and Osteoporosis

With whether suffering from OP as dependent variable, smoking, sex, hypertension, coronary heart disease, hyperlipidemia, diabetes mellitus, stroke and heart failure were introduced into the

Table IV. Comparison of cardiovascular disease and risk factors in different gender group with osteoporosis (n%).

	Male OP group	Female OP group
Hypertension	326 (70.56)*	273 (79.36)
Coronary heart disease	169 (36.58)	128 (39.83)
Hyperlipidemia	95 (20.56)*	137 (22.40)
Diabetes mellitus	160 (34.63)	135 (39.24)
Stroke	33 (7.14)	29 (8.43)
Heart failure	19 (4.11)	21 (6.10)

Abbreviation: OP group: osteoporosis group, NBM group: normal bone mass group. Note: *, $p < 0.05$ in comparison with NBM group.

binary Logistic model; the results showed that female, hypertension, coronary heart disease, diabetes and hyperlipidemia were major risk factors in the elderly patients with OP ($p < 0.05$, Table VI).

Discussion

OP with bone metabolism disorder is often accompanied by other senile diseases and has aroused the attention and research of many domestic and overseas scholars in the cardiovascular field in recent years²⁻⁵. Studies show that bone mineral density, as a risk factor for the occurrence of cardiovascular events and death, performs better than traditional risk factors, such as hyperlipidemia and smoking, in predicting development of diseases^{2,4}. It has been confirmed that the cardiovascular disease risk factors, including hypertension, diabetes, hyperhomocysteinemia and oxidative stress, are concerned with decline in bone mineral density^{5,6}. This research explored and discussed the correlation between OP and cardiovascular diseases.

In this research, the overall prevalence of OP among the elderly people was 63.45%, of which the prevalence of OP among female was signifi-

Table V. Logistic regression analysis between the parameters of cardiovascular disease risk factors and osteoporosis.

	β	SE	Wals	p	OR	95% CI
HCY	0.051	0.009	24.92	< 0.001	1.13	0.05-0.72
TC	0.709	0.272	28.21	< 0.001	1.08	0.39-1.24
HDL	-0.096	0.341	30.07	0.02	0.71	-0.63- -0.02
LDL	0.942	0.165	33.78	< 0.001	2.79	0.71-1.53
Weight	-0.023	0.104	10.98	< 0.001	0.95	-0.05- -0.01

Abbreviation: HCY: Homocysteine, TC: total cholesterol, HDL: high-density lipoprotein cholesterol, LDL: low-density lipoprotein cholesterol. Note: $p < 0.05$ suggests statistically significant difference.

Table VI. Logistic regression analysis between cardiovascular disease and osteoporosis.

	β	SE	Wals	<i>p</i>	OR	95% CI
Female	0.615	0.173	10.84	< 0.001	1.62	0.21-0.96
Hypertension	1.059	0.147	46.82	< 0.001	2.96	0.74-1.65
Coronary heart disease	0.646	0.169	13.95	< 0.001	1.65	0.26-0.98
Hyperlipidemia	0.537	0.151	8.56	0.01	1.60	0.20-0.89
Diabetes mellitus	0.404	0.172	7.58	0.03	1.43	0.11-0.75
Stroke	-0.618	0.219	10.68	0.79	0.44	-1.12– -0.26
Heart failure	-0.356	0.259	2.27	0.54	0.69	-0.78– -0.24

Note: *p* < 0.05 suggests statistically significant difference.

cantly higher than that among male; meanwhile, the prevalence of hypertension and hyperlipidemia in female OP group was higher than that in male OP group. It suggests that the risk of OP will rise obviously with age and it is particularly significant among women. The results of logistic regression analysis indicated that female was an independent risk factor for OP. Such difference in sex may have a correlation with decreased sex hormones secretion and declined ovarian function after the menopause in female³.

In this test, the proportions of smoking, hypertension, coronary heart disease, hyperlipidemia and diabetes in OP group were much higher than those in normal bone mass group. In terms of smoking which is a traditional risk factor for cardiovascular disease, hosts of research have proven that some hazardous substances in tobacco have toxic effects on bone cells; it can influence absorption of calcium and accelerate bone loss, causing decline in bone mineral density⁶.

The results of logistic regression analysis confirmed that hypertension was a risk factor for OP and that the relative risk of hypertension was the highest (odds ratio (OR) = 2.96), exceeding that of coronary heart disease, hyperlipidemia, diabetes and other risk factors. It suggests that the elderly patients should control their hypertension effectively. A large number of basic studies have proven that hypertension is closely related to OP^{4,6}. A previous research⁷ has suggested that thiazide drugs are useful in treating OP; therefore, more attention should be paid to patients with OP combined with hypertension and their antihypertensive agents should be chosen carefully in clinical practice. At present, more studies on the correlation between antihypertensive agents and OP need to be implemented.

The traditional risk factors for coronary heart disease consist of hypertension, diabetes, hyperlipidemia and smoking; new risk factors for

the disease, such as HCY, UA and inflammatory markers, have been found continuously in the past few years^{5,6}. The test results indicated that HCY, like LDL and TC, was also a risk factor for OP. The specific mechanism of HCY is still unclear but related research has discovered that high HCY level can increase the quantity and activity of osteoclasts, inhibit the activity of osteoblasts and indirectly reduce the activity of collagens at the same time; meanwhile, high HCY level can reduce collagen junction mediated by lysine and increase the accumulation of advanced glycation end products, leading to decline in osteogenesis.

Research made by Lampropoulos et al⁷ has indicated that OP has a close correlation with vascular calcification and hyperlipidemia. The test results also suggested that hyperlipidemia, LDL and TC were the major risk factors of OP, of which the OR value of LDL (2.79) was the highest. HDL and body weight were the protective factors of OP^{8,9}. Relevant studies have shown that blood lipid level is closely related to bone mass and bone fragility and that there is an inseparable relationship between OP and hyperlipidemia as well as blood lipid level¹⁰. Consequently, the treatment of OP combined with hyperlipidemia treatment can perform better in preventing cardiovascular events and fractures.

The results of this research also showed that diabetes mellitus is one of the major risk factors for OP among senile patients. Studies^{11,12} at home and abroad have not yet clearly defined the pathological mechanism of diabetes complicating OP; it is generally recognized that it may be related to decreased sensitivity or insufficient secretion of insulin, declined synthesis of bone matrix and osmotic diuresis due to hyperglycemia. When treating aged patients with diabetes, it may be beneficial to their quality of life and prognosis to treat OP actively and take effective intervention measures at the same time¹³. To sum up, senile

OP is closely related to cardiovascular disease and its risk factors. With regard to the elderly patients with cardiovascular diseases, particularly female patients, screening for OP should be strengthened, the cardiovascular disease risk factors should be controlled positively and the occurrence and development of OP should be further prevented or delayed by combining with effective anti-osteoporotic treatment.

Conclusions

The risk of OP will rise with age and it is particularly significant among women. OP is closely related to cardiovascular diseases; the proportions of smoking, hypertension, coronary heart disease, hyperlipidemia and diabetes in OP group were significantly higher than those in normal bone mass group. Related logistic analysis suggests that HCY, LDL and TC are major risk factors for senile OP and that female, hypertension, coronary heart disease, hyperlipidemia and diabetes are main risk factors of complication in the elderly patients with OP.

Conflict of Interest

The Authors declare that they have no conflict of interests.

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