

## Original Research

# Bone Mineral Density, Serum Albumin and Serum Magnesium

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Noboru Saito, MD, Naoto Tabata, MD, Saburo Saito, MD, Yoshihisa Andou, MD, Yukiko Onaga, MD, Akihiro Iwamitsu, MD, Morihide Sakamoto, MD, Tuyoshi Hori, MD, Harumi Sayama, MD, and Toshiko Kawakita, MD

*Department of Internal Medicine and Center for Lifestyle-related Diseases, and Center for Liver Diseases, Miyazaki Medical Center Hospital, Miyazaki, Kyoto Preventive Medical Center, Kyoto, JAPAN*

**Key words:** Bone mineral density, bone fracture, serum magnesium, serum albumin, elderly inpatient

**Objectives:** This study explores clinical and laboratory abnormalities that contribute to the prevalence of bone fractures in frail and control elderly patients, to ascertain factors that relate to bone strength and fragility.

**Methods:** Patients were selected as free from renal failure and not taking supplements or medications that affect their magnesium status, and categorized according to their underlying diseases, sex and age, and evaluated by tests of bone strength.

**Results:** Findings, differentiating elderly patients on the basis of their magnesium, calcium, serum albumin, body mass, bone mineral density and their fracture occurrence were tabulated.

**Conclusion:** Evidence is presented of low magnesium and albumin serum levels, especially in women with low bone density, as well as of low calcium and trace minerals.

## INTRODUCTION

Elderly patients often suffer from fractures of long bones (FLB) and of vertebrae (FV) as a result of postural instability and bone fragility caused by osteoporosis. Bone quality can be estimated by bone mineral density (BMD), and bone micro-structure, which may be compatible with about 70% bone strength. In this study the percentage to the peak BIVID (p13MD) of young adults was used for comparison. Clinically, BMD and the occurrence of bone fracture (BF) reflect bone strength. This study aimed to clarify the relation between clinical data and BMD or 13F in patients.

## SUBJECTS AND METHODS

To exclude patients with renal failure, only out- and in-patients with blood urea nitrogen (BUN) levels below 30 mg/dL were included. Patients taking magnesium oxide or furosamide were excluded. Using criteria of 75 g oral glucose tolerance test (GTT), 217 outpatients aged mean 57.7 years (159

males [M], 58 females [F]) were diagnosed as diabetic, borderline and normal types, who ingested 1600–1800 kcal/day in males and 1300–1600 kcal/day in females. Fasting blood samples were obtained early in the morning to obtain biochemical data. Serum Mg was measured by colorimetry with xylidil blue, serum Ca by OCPC method. Statistical analysis was carried out with Student's t test, showing  $p < 0.05$  as a significant difference.

Of 112 elderly inpatients aged 80.1 years (26 were men and 86 were women), who ingested 1200 to 1600 kcal/day, 63.9% had experienced cerebral infarction, 12.2% had experienced cerebral hemorrhage, 29.3% had hypertension, 12.2% had diabetes mellitus, 14.3% had ischemic heart disease and 8.2% had atrial fibrillation. Medication consumed included calcium (Ca)-antagonists 30.6% [M] and 23.6% [F], ACE inhibitors 2.7% [M] and 1.2% [F], AII receptor antagonists 12.9% [M] and 8.1% [F], HMG coenzyme reductase inhibitors 5.6% [M] and 7% [F], antidiabetic oral agents 2.7% [M] and 1.2% [F], insulin 2.7% [M] and 7.2% [F].

A subgroup of 31 males aged mean 60.7 years were examined and had tests done every one to six months for a mean of 22.8 months; all showed an increase of BIVID during the period.

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Address reprint requests to: Noboru Saito, MA, CAN, Department of Internal Medicine and Center for Lifestyle-related Diseases, Miyazaki Medical Center Hospital, 2-16 Takamatsu-cho Miyazaki City, Miyazaki, 880-0003 JAPAN. E-mail: hit.yama@d6.dion.ne.jp.

**Table 1.** Percentage to Peak BMD (pBMD) and Clinical Data in Adult Outpatients

Percentage to pBMD (%)		80	>80-99	100
Male (M)		72.3 ± 6.9	89.4 ± 5.3	109.9 ± 9.3
Female (F)		72.3 ± 6.9	90.5 ± 4.9	112.4 ± 8.0
Numbers	M	18	82	59
	F	18	26	14
Age (years old)	M	60.4 ± 7.8	58.8 ± 7.2	57.6 ± 8.3
	F	60.1 ± 6.3*	54.5 ± 7.9*	51.4 ± 11.6*
BMI (kg/m <sup>2</sup> )	M	21 ± 3.3*	22.3 ± 2.4*	23.4 ± 2.7*
	F	21 ± 3.3*	22.8 ± 3.5*	24.5 ± 4.9*
Serum Mg (mg/d)	M	2.19 ± 0.19*	2.29 ± 0.16*	2.9 ± 0.18
	F	2.19 ± 0.19**	2.22 ± 0.18**	2.14 ± 0.14**
Serum albumin (g/dL)	M	4.1 ± 0.26	4.18 ± 0.25**	4.31 ± 0.25**
	F	4.1 ± 0.26	4.16 ± 0.1	4.05 ± 0.26
Serum Ca (mg/dL)	M	9.6 ± 0.28	9.4 ± 0.9	9.5 ± 0.40
	F	9.4 ± 0.42	9.5 ± 0.35	9.5 ± 0.56

M-I-SD. \* *p* < 0.05, \*\* *p* < 0.005.

BIVID of these outpatients was measured in lumbar vertebra by dual-energy X-ray absorptiometry (DXA). Fracture of long bone (FLB) had occurred in 50 inpatients aged mean 83.3 years (14 M and 36 F). Controls composed 97 patients aged mean 77.2 years (41 M and 56 F). BMD in elderly patients was measured using the forearm by DXA. Among the frail bed-ridden elderly patients, 12 suffered from FLB (91.7%) or FV (91.7%). The sex and age-matched controls were 12 inpatients.

## RESULTS

Adult outpatients below 80% of the peak of BMD (pBMD) were found to be 11.3% of the males and 31.1% of the females, while patients over 100% of the pBMD were found to be 37% and 24.1% respectively, indicating higher BMD in males. Diabetic (37.1% males, 39.7% females), borderline (37.1%, 22.4%) and normal (25.8%, 37.9%) types were found, indicating no significant difference between sexes. When pBMD was lower, body mass index (BMI) was lower and age was significantly higher in adult outpatients of both sexes (Table 1).

Serum Mg and Albumin levels were significantly lower in the lowest pBMD of females (Table 1).

None of the elderly inpatients below 40% of pBMD were males; 30.2% were females. Among those with 80-99% of pBMD, 25% were males and 3.5% were females, showing higher pBMD in males. Age was significantly higher in cases where pBMD was lower (Table 2). BMI, serum Mg, Ca and Alb were significantly lower in females when pBMD was lower (Table 2).

In comparison between inpatients with FLB and those without BF, age and BMI did not differ and serum Mg and Hb were significantly lower in ones with FLB (Table 3). Serum Ca and Alb were significantly lower in females with FLB.

In frail cases with BF serum Mg, Zn and hemoglobin (Hb) were lower (Table 4).

## DISCUSSION

Osteoporosis is diagnosed when the pBMD is below 80%, but usually below 70% of pBMD, and there is bone fragility.

**Table 2.** Percentage to Peak BMD (pBMD) and Clinical Data in Elderly Inpatients

Percentage to pBMD (%)		40>	40-59	60-79	80-99
Male (M)		—	52.1 ± 5.0	68.3 ± 5.1	87.0 ± 5.1
Female (F)		29.8 ± 7.4	49.2 ± 6.3	66.3 ± 4.7	94.0 ± 7.0
Numbers	M	0	10	17	9
	F	26	43	14	3
Age (years old)	M	—	83.7 ± 9.3*	76.5 ± 12.2*	73.8 ± 10.2*
	F	84.9 ± 6.6**	82.2 ± 7.4**	76.6 ± 9.2	52.3 ± 5
BMI (kg/m <sup>2</sup> )	M	—	18.3 ± 4.0*	20.3 ± 3.5	19.1 ± 4.2*
	F	17.7 ± 3.4**	18.8 ± 3.3**	21.8 ± 3.6**	20.4 ± 1.7
Serum Mg (mg/d)	M	—	2.38 ± 0.46 (4)	2.25 ± 0.21 (10)	2.08 ± 0.28 (5)
	F	2.19 ± 0.28*	2.23 ± 0.34* (14)	2.40 ± 0.15* (26)	2.25 ± 0.21 (2)
Serum albumin (g/dL)	M	—	3.32 ± 0.53	3.48 ± 0.53	3.29 ± 0.63
	F	3.29 ± 0.48**	3.56 ± 0.38**	3.79 ± 0.40**	4.10 ± 0.36
Serum Ca (mg/dL)	M	—	9.4 ± 0.6	10.0 ± 0.59	9.48 ± 0.41
	F	9.5 ± 0.64	9.8 ± 0.59	9.8 ± 0.37	9.7 ± 0.25

M ± SD: Cases.

\* *p* < 0.05, \*\* *p* < 0.005.

**Table 3.** Fractures of Long Bones (FLB) Inpatients

		With bone fracture	Without bone fracture
Number	M	14	41
	F	36	56
Age (years old)	M	79.7 ± 14	74.0 ± 11.5
	F	84.7 ± 9.1	79.6 ± 9.8
Body mass index (kg/m <sup>2</sup> )	M	19.1 ± 2.7	19.3 ± 3.1
	F	17.24 ± 3.1	19.6 ± 4.5
Serum, magnesium (mg/dL)	M	2.06 ± 6.22	2.31 ± 0.21**
	F	2.04 ± 0.26	2.34 ± 0.19**
Serum calcium (mg/dL)	M	9.33 ± 0.78	9.51 ± 0.65
	F	9.20 ± 0.75	9.68 ± 0.49**
Serum albumin (g/dL)	M	3.16 ± 0.67	3.51 ± 0.52
	F	3.38 ± 0.04	3.66 ± 0.39**
Hemoglobin (g/dL)	M	11.1 ± 2.3	12.5 ± 1.8
	F	11.2 ± 1.3	12.1 ± 1.26**

M ± SD. \*p < 0.01, \*\*p < 0.005. M = Male, F = Female.

Mean BMD of young adults is pBMD. Osteopenia is diagnosed with BMD below 80% and more than 70% of pBMD. BMD can represent approximately 70% of bone strength; the other contributors to bone strength may be architecture, turnover rate and microfracture of bone.

Antiresorptive agents can increase vertebral BMD with resultant reduced risk of vertebral fracture. Increasing BMD is not always a perfect strategy to attenuate the risk of occurrence of BF. Other factors, such as age, serum Mg, albumin, Hb, Ca and Zn, indicative of malnutrition states, may be responsible for BF risks, in addition to low BMI and BIVID. The influence of a diabetic state on BMD and FB remains to be studied.

## CONCLUSION

A decrease of pBMD was associated with decreases of either BMI in cases of both sexes, of serum Mg, and of serum

**Table 4.** The Influence of Bone Fracture (BF) in Sex- and Age-Matched Inpatients

	Bone fracture in frail inpatients	Without bone fracture in inpatients
Number (Male, Female)	12 (2, 10)	12 (2, 10)
Age (Years old)	87.6 ± 7.6	87.1 ± 7.6
Body mass index (kg/m <sup>2</sup> )	17.3 ± 3.9	18.3 ± 3.8
Serum magnesium (mg/dL)	1.8 ± 0.16	2.38 ± 0.33**
Serum calcium (mg/dL)	8.92 ± 0.74	9.47 ± 0.58
Serum zinc (µg/dL)	54.5 ± 12.8	77.2 ± 22.7*
Serum copper (µg/dL)	94.7 ± 24.5	107.4 ± 29.4
Serum total protein (g/dL)	6.39 ± 0.78	6.48 ± 0.27
Serum albumin (g/dL)	3.18 ± 0.46	3.52 ± 0.44
Haemoglobin (g/dL)	10.5 ± 1.59	12.5 ± 1.88*
Serum creatinine (mg/dL)	0.65 ± 0.42	0.56 ± 0.26
Blood urea nitrogen (mg/dL)	19.5 ± 6.6	18.2 ± 4.2

M-tSD. \*p < 0.01, \*\*p < 0.005.

Alb in females, and with an advance of age in females. Elderly inpatients with FLB showed significantly lower levels of serum Mg and Hb in both sexes, and of serum Ca, Alb and Zn in females compared to elderly patients without BF.

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Received August 5, 2004.