Coffee Consumption and Bone Mineral Density in Dialysis Patients

Alicja E. Grzegorzewska, Monika Młot–Michalska

The influence of ingested coffee on bone mineral density (BMD) and the related risk of pathologic fractures is controversial. We decided to check if dialysis patients drinking coffee may have a BMD different from that of non coffee drinkers.

*We studied 30 dialysis patients (26 on hemodialysis, 4 on peritoneal dialysis). Group I (*n *= 11, 5 women) included patients who regularly drank at least 1 cup of coffee daily [dialysis duration: 29.1 months (range: 8.7 – 59.6 months); age: 56.0 ± 14.6 years]. Group II (*n *= 19, 13 women) consisted of patients who said that they were nondrinkers of coffee [dialysis duration: 15.2 months (range: 6.3 – 45.4 months); age: 56.3 ± 19.8 years]. We examined BMD in all subjects in two sites (femoral neck and L2 – L4 lumbar region) by dual-energy X-ray absorptiometry. Serum parathyroid hormone, calcium–phosphate balance parameters, blood pH, serum markers of inflammation, bioimpedance records of body composition, and markers of nutrition were simultaneously evaluated.*

Compared with group II, group I showed significantly lower L2 – L4 parameters: BMD (0.906 ± 0.236 g/cm^2 *vs. 1.172 ± 0.227 g/cm*^{2}, $p = 0.005$*), percent of peak BMD (78.4% ± 18.9% vs. 98.4% ± 17.0%,* $p = 0.006$*), percent of age norm (82.7% ± 18.2% vs. 105.9% ± 17.7%* $p = 0.002$*), T-score [–2.07 (range: –3.95 to 2.02) vs. –0.51 (range: –2.29 to 4.07),* $p = 0.020$*], and Z-score [–1.25 (range: –4.41 to 1.90) vs. 0.26 (range: –1.48 to 4.49),* $p = 0.006$*]. Serum albumin concentration was higher in group I [4.0 g/dL (range: 3.1 – 4.3 g/dL) vs. 3.3 g/dL (range: 2.9 – 4.4 g/dL),* $p = 0.020$*].*

Our results suggest that regular coffee consumption may contribute to BMD loss in dialysis patients.

From: Chair and Department of Nephrology, Transplantology and Internal Diseases, Karol Marcinkowski University of Medical Sciences, Poznań, Poland.

Key words

Coffee, bone mineral density, dialysis

Introduction

Coffee is a solution reported to contain more than a thousand different chemicals, including carbohydrates, lipids, nitrogenous and phenolic compounds, vitamins, minerals, and alkaloids, among them caffeine, cafestol, and kahweol (1). Coffee intake may influence bone mineral density (BMD) by decreasing body calcium and phosphorus content. It was shown that caffeine increases urinary calcium (2) and phosphorus (3) excretion. Coffee consumption was observed to cause a negative shift in overall calcium balance, but was not related to bone turnover (mineralization and resorption rates) in postmenopausal crush fracture osteoporosis (4). Additionally, caffeine interacts with the tt genetic variant of vitamin D receptor (elderly women with the TT genotype were less affected by caffeine-induced bone loss than were women with the tt genotype) (5). The urinary phenomenon associated with caffeine may be of smaller importance in dialyzed patients with low residual renal function, but the contribution of caffeine to decreased overall calcium balance and the genetic determinants may have both a noticeable meaning.

Of six cross-sectional studies exploring the association between caffeine consumption and BMD, only two indicated accelerated loss of BMD in coffee drinkers (5,6). The other four showed no significant influence (7–10). In three prospective cohort studies, increased risk for hip fracture with caffeine consumption was found in women (11–13). Two studies showed no such association (14,15). The foregoing data indicate that the influence of ingested coffee on BMD and the related risk of pathologic fracture is controversial. We decided to investigate whether coffee-drinking dialysis patients may have a BMD different from that of non coffee drinkers.

Patients and methods

Uremic patients older than 18 years treated with peritoneal dialysis (PD) or intermittent hemodialysis (HD) qualified for the study. Patients were excluded if they met at least one of the following conditions:

- Dialysis treatment ongoing for less than 6 months
- Parathyroidectomy during last 6 months
- Recognized disease (except diabetes mellitus) that is not a complication of uremia or dialysis treatment and that could influence bone metabolism (for example, primary gout, rheumatoid arthritis, thyroid gland imbalance, tumor)
- Presence of an implanted medical device (for example, a pacemaker or infusion pump)
- Currently taking drugs that influence bone metabolism (for example, glucocorticosteroids, estrogens, androgens) and having taken such drugs within 2 months before the study examination
- Acute infection or inflammation during the month before the study examination

We studied 30 patients that met all criteria. The patients were allocated to two groups. Group I patients included those who regularly drank at least 1 cup (250 mL) of caffeinated coffee daily (approximately 140 mg of caffeine daily) for at least 3 years; group II patients consisted of those who said that they were nondrinkers of coffee.

Group I consisted of 11 patients (5 women, 6 men) of mean age 56.0 ± 14.6 years, treated with hemodialysis (HD, n = 4) or peritoneal dialysis (PD, n = 7). Mean dialysis duration was 29.1 months (range: 8.7 – 59.6 months). Group II included 19 PD patients (13 women, 6 men) of mean age 56.3 ± 19.8 years. Mean PD duration was 15.2 months (range: 6.3 – 45.4 months).

We used dual-energy X-ray absorptiometry to assess BMD at the femoral neck and L2 – L4 lumbar region in these patients. Serum intact parathyroid hormone concentration, calcium–phosphate balance parameters, blood pH, serum markers of inflammation, serum and anthropometric markers of nutrition, and bioimpedance records of body composition were evaluated and compared for both groups.

In PD patients, all study measurements were performed with a “dry” peritoneal cavity after drainage of dialysate, which was not replaced until completion of all study procedures. In HD patients, a blood sample was taken before the midweek HD session; other examinations were started at 30 minutes after the HD session.

The normality of distribution of variables was checked by the Shapiro–Wilks test for each group separately. Results are expressed as mean ± 1 standard deviation or as median and range, as appropriate. Comparisons between the examined groups for the non adjusted results were performed using the Student t-test for unpaired data if the distribution in both groups was normal or otherwise by the Mann–Whitney test. Results adjusted for sex, age, and treatment with anticoagulants were compared using the analysis of covariance methodology. A p value below 0.05 was judged to be significant. The statistical analysis was performed using Statistica 7.1 (StatSoft, Tulsa, OK, U.S.A.).

Results

Coffee drinkers (group I) showed significantly lower BMD parameters measured in the L2 – L4 lumbar region (Figures 1 – 5) than did coffee abstinents (group II). In the lumbar spine, osteoporosis (T-score < –2.5) was observed only in coffee drinkers; coffee abstinents usually showed normal bone mass (T-score > –1.0, Table I). Serum albumin concentration was higher in

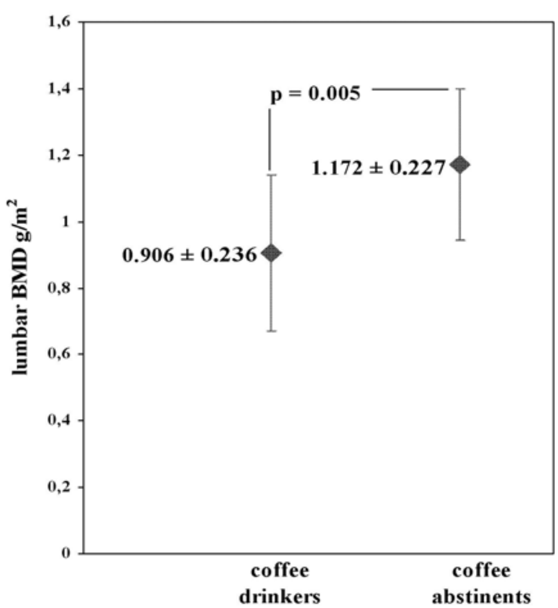

FIGURE 1 Lumbar bone mineral density (BMD) in dialyzed coffee drinkers and coffee abstinents.

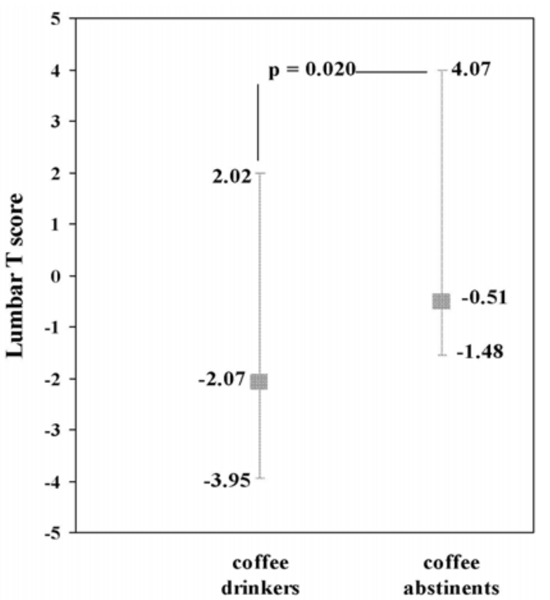

FIGURE 2 Lumbar T score in dialyzed coffee drinkers and coffee abstinents.

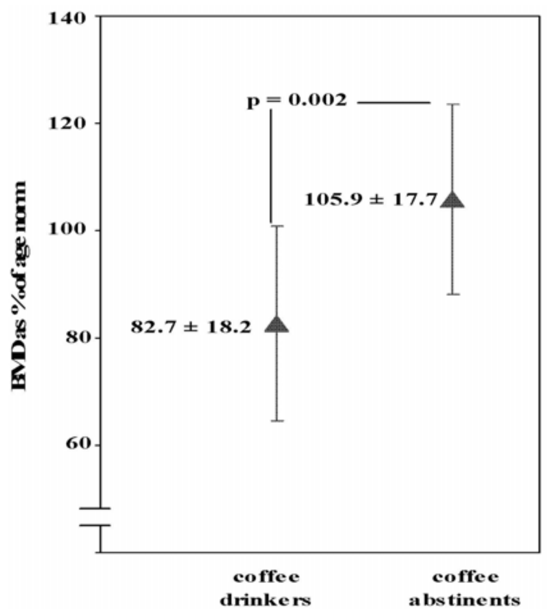

FIGURE 4 Lumbar bone mineral density (BMD) as a percentage of the age norm in dialyzed coffee drinkers and coffee abstinents.

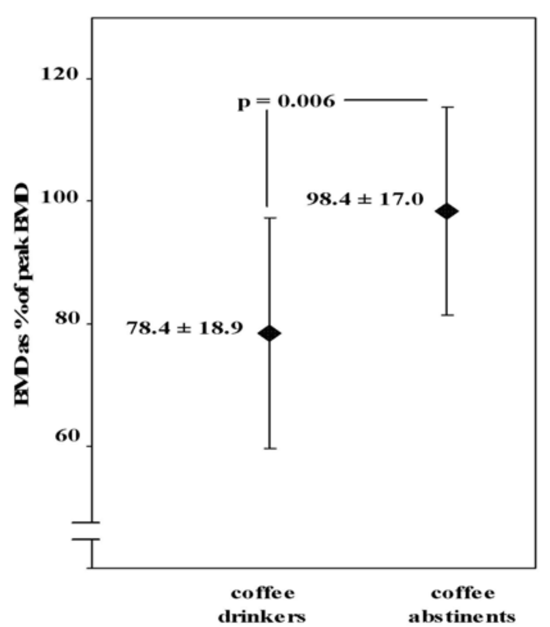

FIGURE 3 Lumbar bone mineral density (BMD) as percentage of peak BMD (in young adults) in dialyzed coffee drinkers and coffee abstinents.

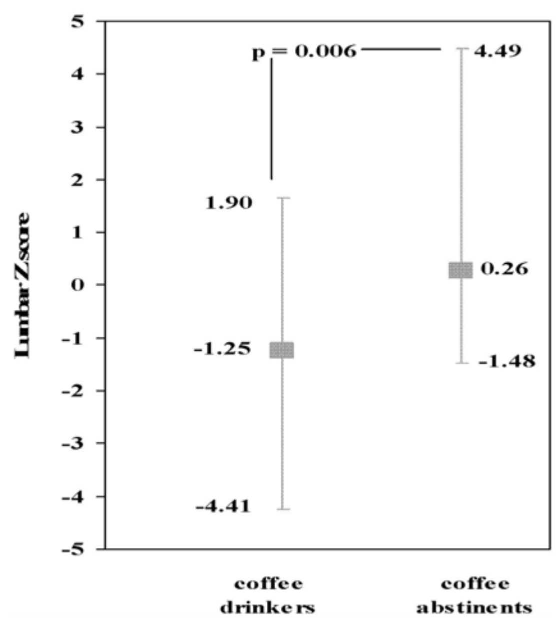

FIGURE 5 Lumbar Z score in dialyzed coffee drinkers and coffee abstinents.

group I than in group II [4.0 g/dL (range: 3.1 – 4.3 g/dL) vs. 3.3 g/dL (range: 2.9 – 4.4 g/dL), $p = 0.020$].

After adjustment of all results for sex, age, and treatment with anticoagulants, the differences between groups in lumbar spine BMD and serum albumin concentration remained statistically significant. Additionally, some BMD parameters in the femoral neck became significantly different between groups, showing lower BMD in coffee drinkers (Table II).

Total body mass was similar in both groups, but after adjustment, coffee drinkers showed significantly lower body fat mass and higher lean body mass (Table III).

We observed no significant differences between groups in calcium–phosphate parameters, markers of inflammatory status, blood pH, blood count, C-reactive protein, anthropometric measurements, or bioimpedance records (Table IV).

Discussion

Our results indicate that, in dialysis patients, regular coffee consumption may influence BMD loss. In the study patients, we previously showed the negative influence of age, sex, and treatment with anticoagulants on femoral neck BMD (16,17). After adjustment

TABLE I T-Score values in the study patients who drank coffee (group I) and in those who did not (group II)

T Score	*Femoral neck*		*Lumbar spine L2–L4*	
	I	*II*	*I*	*II*
More than –1.0	4	8	2	12
Less than –1.0 and more than –2.5	3	8	5	7
Less than –2.5	4	3	4	0

TABLE II Bone mineral density (BMD) in the femoral neck (FN) of study patients who drank coffee (group I) and in those who did not (group II): statistical analysis after adjustment for sex, age, and anticoagulant treatment

Parameter	*Group I*	*Group II*	p *Value*
FN BMD (g/cm^2)	0.776±0.182	0.835±0.126	0.006
FN T score [mean (range)]	–2.28 (–4.06 to 2.37)	–1.29 (–3.39 to 1.15)	0.034
FN BMD as % YA [mean (range)]	72.0 (54.2 to 136.0)	84.0 (59.0 to 114.0)	0.041
FN Z score [mean (range)]	–1.42 (–2.36 to 2.97)	–0.57 (–2.36 to 2.01)	0.170
FN BMD as % AM [mean (range)]	79.9 (68.7 to 148.0)	92.5 (67.0 to 129.0)	0.207

YA = young adult; AM = age matched.

TABLE III Selected results of anthropometric parameters and bioimpedance records of the study patients who drank coffee (group I) and those who did not (group II): statistical analysis after adjustment for sex, age, and anticoagulant treatment

Parameter	*Group I*	*Group II*	p *Value*
TBM (kg)	72.2±14.9	72.2±10.5	0.081
Waist circumference (cm)	95.8±14.9	97.1±12.0	0.026
Hip circumference (cm)	100.0±10.5	102.0±10.9	0.028
FBM (kg)	20.9±7.9	22.5±7.6	0.046
FBM%TBM	28.7±8.6	30.9±8.8	0.001
LBM (kg)	54.9±12.6	49.7±9.1	0.002
LBM%TBM	71.3±8.6	69.1±8.8	0.001
TBW (L)	40.2±8.0	38.1±7.5	0.000
TBW%TBM	55.4±5.3	52.7±6.6	0.007

TBM = total body mass; FBM = fat body mass; LBM = lean body mass; TBW = total body water.

TABLE IV Study parameters that were not significantly different ($p > 0.05$) for patients who drank coffee (group I) and those who did not (group II)

Parameter	*Group I*	*Group II*
iPTH (pg/mL)	385.8 (80.1–913.0)	194.1 (12.3–1967.0)
ALP (IU/L)	78.0±20.7	86.5±40.8
Total Ca (mg/dL)	8.7±0.8	9.1±0.9
Phosphates (mg/dL)	5.3±1.1	5.4±1.5
Blood pH	7.36 (7.30–7.46)	7.36 (7.31–7.45)
Hemoglobin (g/dL)	11.5±1.3	11.4±1.1
WBCs (G/L)	7.2±2.7	7.1±1.5
Platelets (G/L)	223±87	241±57
MCV (fL)	87.2±19.2	94.4±5.2
CRP (mg/L)	1.80 (0.00–17.60)	0.00 (0.00–31.30)
Ferritin (ng/mL)	294±128	411±274

iPTH = intact parathyroid hormone; ALP = alkaline phosphatase; WBCs = white blood cells; MCV = mean corpuscular volume; CRP = C-reactive protein.

for these confounders, the differences between the groups in the lumbar spine BMD remained statistically significant and also revealed a lower BMD in the femoral neck in coffee drinkers.

Coffee consumption has been associated with lower BMD in some cross-sectional studies (5,6), but not in others (7–10). Similarly, increased risk for hip fracture with caffeine consumption was shown in some prospective cohort studies (11–13), but not in all (14,15). Differences in results may be related to the amount of caffeine ingested (5,13,18), lifetime intake of coffee (19), concomitant calcium intake (6,18,19), sex (11–13), body mass index (20), and genetic factors (5).

Total body mass was similar in both groups, but coffee drinkers had a lower body fat mass and a higher lean body mass. These findings, together with higher serum albumin concentration in coffee drinkers, exclude protein undernutrition as a reason for lower BMD in this group. According to previous studies, a better nutrition status in coffee drinkers may diminish bone loss related to caffeine consumption (20).

The literature shows varying patterns of BMD in the lumbar spine and femoral neck. Serum zinc was observed to be significantly associaed with lumbar spine but not femoral neck BMD (21). Adults with sickle cell disease (22) had an abnormal BMD in 79.6% of cases, with predilection for the lumbar spine ($p = 0.001$). Deep review of factors related to variation in premenopausal bone mineral status carried out by Tudor–Locke and McColl (23) concluded that smoking had a detrimental effect on premenopausal bone—most apparent in the spine. A population based-study showed that the interaction between coffee and smoking appears to have a deleterious effect on the distal radius, but not to the same extent on the ultradistal radius (24). Moderate alcohol consumption had a positive effect on ultradistal radius BMD, but no significant association was found in the distal radius (24). However, regardless of possible predilections for bone changes in some skeletal regions, the effects of deleterious factors may be lifetime-dependent. A retrospective study conducted on 980 postmenopausal women indicated that increasing lifetime intake of caffeinated coffee (2 or more cups daily) was associated with decreasing BMD at both the spine and hip (19). Our study revealed that differences in BMD in two groups may be more evident after adjustment of results for other confounders also influencing BMD, such as age, sex, and anticoagulant treatment.

The influence of coffee on BMD in dialysis patients needs further investigation. Our study indicates that coffee consumption may be one of the determinants of BMD in dialysis patients.

References

1 Higdon JV, Frei B. Coffee and health: a review of recent human research. Crit Rev Food Sci Nutr 2006;46:101–23.

2 Massey LK, Whiting SJ. Caffeine, urinary calcium, calcium metabolism and bone. J Nutr 1993;123:1611–14.

3 Sakamoto W, Nishihira J, Fujie K, *et al.* Effect of coffee consumption on bone metabolism. Bone 2001;28:332–6.

4 Hasling C, Søndergaard K, Charles P, Mosekilde L. Calcium metabolism in postmenopausal osteoporotic women is determined by dietary calcium and coffee intake. J Nutr 1992;122:1119–26.

5 Rapuri PB, Gallagher JC, Kinyamu HK, Ryschon KL. Caffeine intake increases the rate of bone loss in elderly women and interacts with vitamin D receptor genotypes. Am J Clin Nutr 2001;74:694–700.

6 Harris SS, Dawson–Hughes B. Caffeine and bone loss in healthy postmenopausal women. Am J Clin Nutr 1994;60:573–8.

7 Hannan MT, Felson DT, Dawson–Hughes B, *et al.* Risk factors for longitudinal bone loss in elderly men and women: the Framingham Osteoporosis Study. J Bone Miner Res 2000;15:710–20.

8 Lloyd T, Johnson–Rollings N, Eggli DF, Kieselhorst K, Mauger EA, Cusatis DC. Bone status among postmenopausal women with different habitual caffeine

intakes: a longitudinal investigation. J Am Coll Nutr 2000;19:256–61.
9 Lloyd T, Rollings NJ, Kieselhorst K, Eggli DF, Mauger E. Dietary caffeine intake is not correlated with adolescent bone gain. J Am Coll Nutr 1998;17:454–7.
10 Reid IR, Ames RW, Evans MC, Sharpe SJ, Gamble GD. Determinants of the rate of bone loss in normal postmenopausal women. J Clin Endocrinol Metab 1994;79:950–4.
11 Kiel DP, Felson DT, Hannan MT, Anderson JJ, Wilson PW. Caffeine and the risk of hip fracture: the Framingham Study. Am J Epidemiol 1990;132:675–84.
12 Hernandez–Avila M, Colditz GA, Stampfer MJ, Rosner B, Speizer FE, Willett WC. Caffeine, moderate alcohol intake, and risk of fractures of the hip and forearm in middle-aged women. Am J Clin Nutr 1991;54:157–63.
13 Cummings SR, Nevitt MC, Browner WS, *et al.* Risk factors for hip fracture in white women. Study of Osteoporotic Fractures Research Group. N Engl J Med 1995;332:767–73.
14 Huopio J, Kröger H, Honkanen R, Saarikoski S, Alhava E. Risk factors for perimenopausal fractures: a prospective study. Osteoporos Int 2000;11:219–27.
15 Fujiwara S, Kasagi F, Yamada M, Kodama K. Risk factors for hip fracture in a Japanese cohort. J Bone Miner Res 1997;12:998–1004.
16 Grzegorzewska AE, Mlot–Michalska M. Influence of age and sex on bone mineral density in dialysis patients. Adv Perit Dial 2007;23:77–81.
17 Grzegorzewska AE, Mlot–Michalska M. Selected determinants of bone mineral density in dialyzed patients (Abstract). Perit Dial Int 2008;28(Suppl 1):S9.
18 Hallström H, Wolk A, Glynn A, Michaëlsson K. Coffee, tea and caffeine consumption in relation to osteoporotic fracture risk in a cohort of Swedish women. Osteoporos Int 2006;17:1055–64.
19 Barrett–Connor E, Chang JC, Edelstein SL. Coffee-associated osteoporosis offset by daily milk consumption. The Rancho Bernardo Study. JAMA 1994;271:280–3.
20 Korpelainen R, Korpelainen J, Heikkinen J, Väänänen K, Keinänen–Kiukaanniemi S. Lifestyle factors are associated with osteoporosis in lean women but not in normal and overweight women: a population-based cohort study of 1222 women. Osteoporos Int 2003;14:34–43.
21 Shamshirsaz AA, Bekheirnia MR, Kamgar M, *et al.* Metabolic and endocrinologic complications in β-thalassemia major: a multicenter study in Tehran. BMC Endocr Disord 2003;3:4.
22 Sarrai M, Duroseau H, D'Augustine J, Moktan S, Bellevue R. Bone mass density in adults with sickle cell disease. Br J Haematol 2007;136:666–72.
23 Tudor–Locke C, McColl RS. Factors related to variation in premenopausal bone mineral status: a health promotion approach. Osteoporos Int 2000;11:1–24.
24 Forsmo S, Schei B, Langhammer A, Forsén L. How do reproductive and lifestyle factors influence bone density in distal and ultradistal radius of early postmenopausal women? The Nord–Trøndelag Health Survey, Norway. Osteoporos Int 2001;12:222–9.

Corresponding author:
Alicja E. Grzegorzewska, MD PhD, Chair and Department of Nephrology, Transplantology and Internal Diseases, Karol Marcinkowski University of Medical Sciences, Al. Przybyszewskiego 49, Poznań 60-355 Poland.
E-mail:
alicja_grzegorzewska@yahoo.com