Calcif Tissue Int (2000) 66:119–122

Calcified
Tissue
International

Osteoporosis After Gastrectomy: Bone Mineral Density of Lumbar Spine Assessed by Dual-Energy X-ray Absorptiometry

Y. Adachi,[1] E. Shiota,[2] T. Matsumata,[3] Y. Iso,[3] R. Yoh,[3] S. Kitano[1]

[1]First Department of Surgery, Oita Medical University, 1-1 Idaigaoka, Hasama-machi, Oita 879-5593, Japan
[2]Department of Orthopedics, Saiseikai Yahata General Hospital, 5-9-27 Haruno-machi, Kitakyushu 805-0050, Japan
[3]Department of Surgery, Saiseikai Yahata General Hospital, 5-9-27 Haruno-machi, Kitakyushu 805-0050, Japan

Received: 5 January 1998 / Accepted: 13 August 1999

Abstract. Although osteoporosis is a common clinical disorder associated with gastric surgery, long-term effects of gastrectomy on bone metabolism are still unclear. The purpose of this study was to clarify the incidence and risk factors of osteoporosis after gastrectomy using univariate and multivariate analyses of quantitative measurements. The study included 59 patients who had undergone gastrectomy more than 5 years before. There were 38 men and 21 women, aged 37–81 years, mean 64 years. Bone mineral density (BMD) of L2–L4 spine was measured using dual-energy X-ray absorptiometry (DXA). Absolute value of BMD (g/cm^2) and age- and sex-matched BMD (%) were given. The mean BMD was 0.766 g/cm^2, and the incidence of osteoporosis (BMD less than 0.70 g/cm^2) was 37%: 18% in men and 71% in women. The mean age- and sex-matched BMD was 85.9%: 87.5% in men and 83.1% in women. Univariate and multivariate analyses revealed that BMD was significantly associated with the age and sex of patients, but was not influenced by the type of gastrectomy (partial versus total) and years after operation (<20 versus 20<). Our study clarified the fact that postgastrectomy osteoporosis was frequent in the aged or female patients. BMD should be evaluated after gastrectomy, especially in the aged and in women.

Key words: Osteoporosis — Gastrectomy — Dual-energy X-ray absorptiometry — Bone mineral density — Metabolic bone disease.

Bone loss is a common clinical disorder associated with gastric surgery, and a large number of postgastrectomy patients remain at risk for the development of osteoporosis [1, 2]. Although several authors studied the etiology of metabolic bone disease after gastrectomy [3, 4], the reported incidence of postgastrectomy osteoporosis varies widely because of the variety and difficulty in the quantitative evaluation of bone atrophy [5–7]. The risk of osteoporosis in patients who have had a gastrectomy is difficult to estimate [8, 9], and long-term influence of gastrectomy on bone metabolism is still unclear.

Dual-energy X-ray absorptiometry (DXA) is a widely accepted technique which can correctly and easily quantify bone mineral content of the lumbar spine [10]. Since DXA has high resolution and great speed, and permits accurate and reproducible measurements [11, 12], this noninvasive method clinically serves as a useful technique for identifying and treating osteoporosis [13, 14].

In this study, the long-term influence of gastrectomy on bone mineral density (BMD) was quantitatively examined using DXA, and the incidence and risk factors of osteoporosis after gastrectomy were assessed.

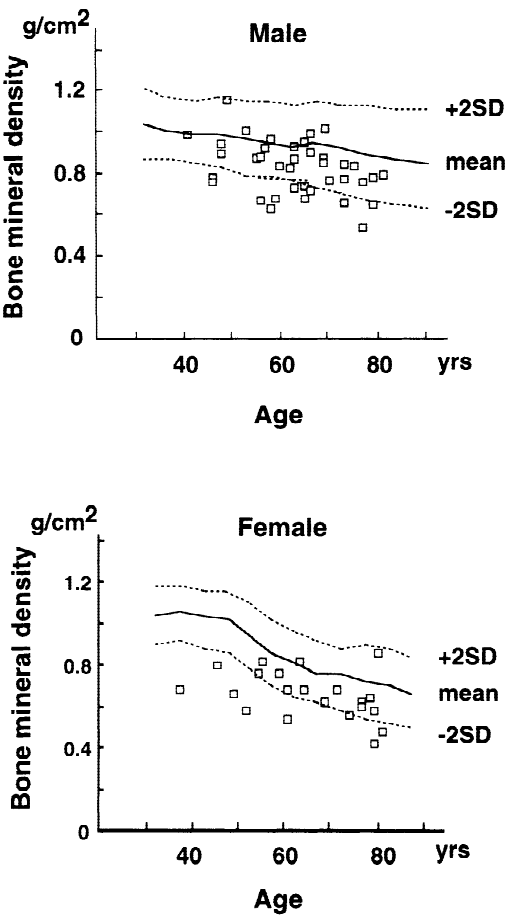

Fig. 1. Bone mineral density of lumbar spine after gastrectomy assessed by dual-energy X-ray absorptiometry. The mean and SD refer to healthy Japanese controls (n = 5306 for men; n = 6076 for women).

Correspondence to: Y. Adachi

Table 1. Univariate analysis of BMD of lumbar spine after gastrectomy

Variable	No. of patients	BMD (g/cm^2)	*P* value
Age, years			
<70	39	0.802 ± 0.132	
70<	20	0.694 ± 0.145	<0.01
Sex			
Male	38	0.821 ± 0.130	
Female	21	0.664 ± 0.114	<0.01
Body mass index, kg/m^2			
<20	43	0.740 ± 0.133	
20<	16	0.808 ± 0.157	NS
Disease			
Peptic ulcer	24	0.790 ± 0.160	
Gastric cancer	35	0.749 ± 0.136	NS
Gastrectomy			
Partial	49	0.771 ± 0.149	
Total	10	0.740 ± 0.126	NS
Time after operation, years			
<20	38	0.747 ± 0.130	
20<	21	0.799 ± 0.166	NS

BMD, bone mineral density; NS, not significant

Table 2. Multivariate analysis of BMD of lumbar spine after gastrectomy

Variable	Regression coefficient	Standard error	Relative risk	*P* value
Sex				
(male versus female)	−0.1544	0.0328	−0.515	<0.001
Age, years				
(<70 versus 70<)	−0.0714	0.0328	−0.238	0.038

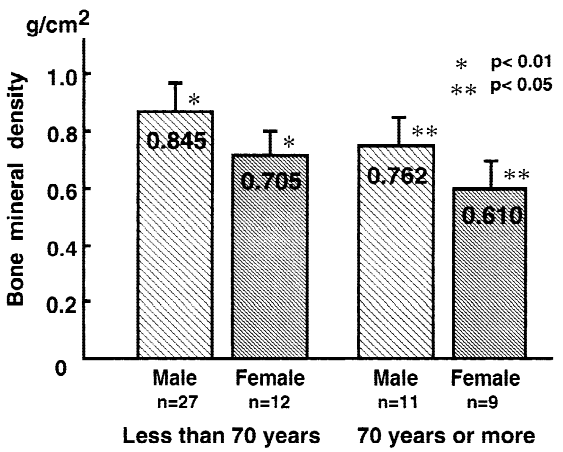

Fig. 2. Bone mineral density of lumbar spine after gastrectomy with regard to the age and sex of patients. The mean BMD was the lowest in women aged 70 years or more.

Patients and Methods

Fifty-nine gastrectomized patients with a minimum of 5-year follow-up were examined. They were still leading active and normal lives, and had no other potential causes of altered bone mineral metabolism, such as alcoholism, renal insufficiency, steroid medication, or hormone therapy. Other conditions associated with bone loss and excluded in this study were hormonal disorders, rheumatoid arthritis, diabetes mellitus, multiple myeloma, and bone metastasis of tumors. Radiographic studies of the thoracic and lumbar spine showed no scoliosis, osteophytes, compression, or fractures.

There were 38 men and 21 women, including 18 postmenopausal and 3 premenopausal women, aged 37–81 years, mean 64 years. Diseases requiring gastrectomy were gastroduodenal ulcer in 24 patients and gastric cancer in 35. Operative procedures were distal gastrectomy in 49 patients and total gastrectomy in 10. The lapse of time after operation ranged from 5 to 35 years, with a mean of 16 years.

BMD of L2–L4 spine was examined by DXA using a Norland XR-26HS Bone Densitometer (Norland, USA). Absolute BMD (g/cm^2) and age- and sex-matched BMD (%) were given in each measurement. According to WHO 1994 assessment [15], women were defined as having osteoporosis when the BMD value was more than 2.5 SD below the mean of young adults (0.70 g/cm^2 on Norland XR-26HS model). This definition was applied to men with regard to BMD values for osteoporosis.

Statistically significant differences were analyzed by the Student's *t* test, and independent risk factors were investigated by multivariate analysis.

Results

BMD after Gastrectomy

The BMD ranged from 0.415 g/cm^2 to 1.149 g/cm^2, with a mean of 0.766 g/cm^2 (Fig. 1). Incidence of osteoporosis (BMD less than 0.70 g/cm^2) was 37%: 18% in men and 71%

Table 3. Age- and sex-matched BMD of lumbar spine after gastrectomy

Variable	No. of patients	Age- and sex-matched BMD (%)	*P* value
Age, years			
<70	39	87.4 ± 13.0	
70<	20	83.0 ± 14.6	NS
Sex			
Male	38	87.5 ± 13.1	
Female	21	88.1 ± 14.4	NS
Body mass index, kg/m^2			
<20	43	84.3 ± 12.6	
20<	16	88.6 ± 15.0	NS
Disease			
Peptic ulcer	24	87.0 ± 14.2	
Gastric cancer	35	85.6 ± 13.3	NS
Gastrectomy			
Partial	49	86.7 ± 14.0	
Total	10	82.4 ± 11.6	NS
Time after operation, years			
<20	38	84.4 ± 13.1	
20<	21	88.7 ± 14.3	NS

in women. Univariate and multivariate analyses revealed that the BMD was significantly associated with the age and sex of patients (Tables 1, 2), and the mean BMD was lowest in women aged 70 years or more (0.610 g/cm^2) (Fig. 2). However, the BMD was not influenced by the type of gastrectomy (partial versus total) and years after operation (<20 versus 20<) (Table 1).

Age- and Sex-Matched BMD

The BMD of 52 patients (88%) was below the mean BMD of age- and sex-matched healthy Japanese controls. The mean of age- and sex-matched BMD was 85.9%: 87.5% (12.5% decrease) in men and 83.1% (16.9% decrease) in women. The age- and sex-matched BMD was not influenced by the type of gastrectomy (partial versus total) and years after operation (<20 versus 20<) (Table 3).

Discussion

Several authors have examined bone mineral content after gastrectomy using single or dual photon absorptiometry [5–7]. Nilas et al. [5] show reduced BMD in men with Billroth II gastrectomy (89% as compared with normal subjects), and Nishimura et al. [6] indicate decreased BMD after partial or total gastrectomy (91% in men and 85% in women as compared with age-matched controls). Other authors [7, 8] also found lower BMD in men who had undergone partial gastrectomy (85%) and total gastrectomy (86%) than in the control population. Recently, DXA was introduced for the quantitative analysis of metabolic bone disease [11, 12]. Inoue et al. [14] demonstrated that BMD in gastrectomized patients (0.85 g/cm^2) is significantly lower than that in healthy men (0.96 g/cm^2). Our results of age- and sex-matched BMD were identical to these data.

The present study clarified that the incidence of osteoporosis after gastrectomy was 18% in men and 71% in women. We measured BMD of the lumbar spine using DXA [11, 12], conformed to WHO assessment in 1994 [15] which categorizes that osteoporosis has a value for BMD of more than 2.5 SD below the young adult mean value, and regarded the patients with BMD less than 0.70 g/cm^2 as having osteoporosis. Furthermore, our study excluded the patients who had undergone gastrectomy within 5 years, because those patients might have weight loss, malnutrition, or recurrent disease [16] which were thought to affect BMD measurements. Thus, we believe our results demonstrate an actual and reliable incidence of osteoporosis associated with gastrectomy.

In our series, the BMD of three aged women was extremely low, showing less than 0.550 g/cm^2. They included a 62-year-old woman who had undergone total gastrectomy 9 years before, a 79-year-old woman who had undergone partial gastrectomy 13 years before, and an 81-year-old woman who had undergone partial gastrectomy 6 years before. In these three patients, one or more factors—age, sex, and duration after operation, in addition to the gastrectomy—were considered to be associated with the marked decrease of BMD.

Furthermore, there were four young women aged 37, 46, 49, and 52 years whose BMD was apparently lower than that of healthy controls; the duration after surgery was 7, 5, 8, and 5 years, respectively; and the age- and sex-matched BMD was 67.0%, 79.4%, 72.0%, and 55.0%, respectively. In these premenopausal young women, gastrectomy might have strongly influenced the decrease of BMD.

It has been mentioned that risk factors of osteoporosis after gastrectomy are age and sex of patients [6, 8], operative procedures [5, 6], postoperative period [8, 14], body mass index [7, 9], and smoking [7]. In our study on multivariate analysis, age and sex of patients were independently correlated with decreased BMD. Previous studies report that calcium deficiency occurs in 30–50% of gastrectomized patients [17], and reduced vitamin D and calcium absorption is a major contributor to decreased BMD following gastrectomy [3–5, 18, 19]. In the aged or female patients with gastrectomy, it might be expected that vitamin D and calcium supplementation could prevent or treat postgastrec-

tomy osteoporosis [8, 10, 20]. However, Tovey et al. [21] found that calcium supplementation had no effect on the BMD of patients with gastrectomy, and suggested that osteoporosis after gastrectomy was more resistant to treatment than postmenopausal osteoporosis.

Nishimura et al. [6] showed that total gastrectomy patients manifest a higher incidence of decreased BMD than partial gastrectomy patients (56% versus 25%). Mellström et al. [7] reported that BMD is significantly low in men with a Billroth II operation but not in those with a Billroth I operation. However, a recent study using DXA [14] demonstrated that BMD is not different between total and partial gastrectomy cases. In our series, BMD measured by DXA was not different among patients who had had a Billroth I gastrectomy, Billroth II gastrectomy, or total gastrectomy. The results suggest that operative procedures do not necessarily influence the BMD level when more than 5 years have elapsed after gastrectomy.

In the present study, BMD was significantly decreased in the aged women and young women during a long-term period after gastrectomy. Recently, we examined 33 patients taking an H_2-receptor antagonist for over 2 years, and showed that chronic use of antacids had little influence on the BMD [22]. The results suggested that decreased gastric acidity was not always associated with decreased BMD, and osteoporosis after gastrectomy must be attributed to other causes such as poor dietary intake, rapid gastric emptying, and rapid intestinal transit [4].

Acknowledgment. We thank M. Inomata, J. Tsuchihashi, and T. Izumi for their technical assistance and critical comments.

References

1. Morgan DB, Wales MB (1965) Search for osteomalacia in 1228 patients after gastrectomy and other operations on the stomach. Lancet ii:1085–1088
2. Eddy RL (1971) Metabolic bone disease after gastrectomy. Am J Med 50:442–449
3. Thompson GR, Neale G, Watts JM, Booth CC (1966) Detection of vitamin-D deficiency after partial gastrectomy. Lancet i:623–626
4. Klein KB, Orwoll ES, Lieberman DA, Meier DE, McClung MR, Parfitt AM (1987) Metabolic bone disease in asymptomatic men after partial gastrectomy with Billroth II anastomosis. Gastroenterology 92:608–616
5. Nilas L, Christiansen C, Christiansen J (1985) Regulation of vitamin D and calcium metabolism after gastrectomy. Gut 26:252–257
6. Nishimura O, Furumoto T, Nosaka K, Kouno K, Sumikawa M, Hisaki T, Odachi T, Mizumoto K, Kishimoto H, Yamamoto K, Koga S (1986) Bone disorder following partial and total gastrectomy with reference to bone mineral content. Jpn J Surg 16:98–105
7. Mellström D, Johansson C, Johnell O, Lindstedt G, Lundberg PA, Obrant K, Schöön IM, Toss G, Ytterberg BO (1993) Osteoporosis, metabolic aberrations, and increased risk for vertebral fractures after partial gastrectomy. Calcif Tissue Int 53:370–377
8. Bisballe S, Eriksen EF, Melsen F, Mosekilde L, Sorensen OH, Hessov I (1991) Osteopenia and osteomalacia after gastrectomy: interrelations between biochemical markers of bone remodelling, vitamin D metabolites, and bone histomorphometry. Gut 32:1303–1307
9. Wetscher G, Redmond E, Watfah C, Perdikis G, Gadenstätter M, Pointner R (1994) Bone disorders following total gastrectomy. Dig Dis Sci 39:2511–2515
10. Tovey FI, Hall ML, Ell PJ, Hobsley M (1991) Postgastrectomy osteoporosis. Br J Surg 78:1335–1337
11. Borders J, Kerr E, Sartoris DJ, Stein JA, Ramos E, Moscona AA, Resnick D (1989) Quantitative dual-energy radiographic absorptiometry of the lumbar spine: in vivo comparison with dual-photon absorptiometry. Radiology 170:129–131
12. Sartoris DJ, Resnick D (1989) Dual-energy radiographic absorptiometry for bone densitometry: current status and perspective. AJR 152:241–246
13. Kin K, Kushida K, Yamazaki K, Okamoto S, Inoue T (1991) Bone mineral density of the spine in normal Japanese subjects using dual-energy X-ray absorptiometry: effect of obesity and menopausal status. Calcif Tissue Int 49:101–106
14. Inoue K, Shiomi K, Higashide S, Kan N, Nio Y, Tobe T, Shigeno C, Konishi J, Okumura H, Yamamuro T, Fukunaga M (1992) Metabolic bone disease following gastrectomy: assessment by dual energy X-ray absorptiometry. Br J Surg 79:321–324
15. Kanis JA, Melton LJ III, Christiansen C, Johnston CC, Khaltaev N (1994) The diagnosis of osteoporosis. J Bone Miner Res 9:1137–1141
16. Adachi Y, Oshiro T, Mori M, Maehara Y, Sugimachi K (1997) Prediction of early and late recurrence after curative resection for gastric carcinoma. Cancer 77:2445–2448
17. Thompson JC (1991) The stomach and duodenum: postoperative complications. In: Sabiston DC Jr (eds) Textbook of surgery: the biological basis of modern surgical practice, 14th ed. WB Saunders, Philadelphia, pp 778–780
18. Maier GW, Kreis ME, Zittel TT, Becker HD (1997) Calcium regulation and bone mass loss after total gastrectomy in pigs. Ann Surg 225:181–192
19. Zittel TT, Zeeb B, Maier GW, Kaiser GW, Zwirner M, Liebich H, Starlinger M, Becker HD (1997) High prevalence of bone disorders after gastrectomy. Am J Surg 174:431–438
20. Dawson-Hughes B, Harris SS, Krall EA, Dallal GE (1997) Effect of calcium and vitamin D supplementation on bone density in men and women 65 years of age or older. N Engl J Med 337:670–676
21. Tovey FI, Hall ML, Ell PJ, Hobsley M (1994) Cyclical etidronate therapy and postgastrectomy osteoporosis. Br J Surg 81:1168–1169
22. Adachi Y, Shiota E, Matsumata T, Iso Y, Yoh R, Kitano S (1998) Bone mineral density in patients taking H_2-receptor antagonist. Calcif Tissue Int 62:283–285