

[ CASE REPORT ]

## Vitamin D Deficiency-induced Osteomalacia in a Patient with Anorexia Nervosa

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### Abstract:

A 48-year-old woman with a 9-year-history of anorexia nervosa (AN) was admitted complaining of generalized bone pain. Blood tests showed hypocalcemia and hyperphosphatasemia, and a radiological survey revealed multiple rib fractures, suggesting complication with osteomalacia. Two years earlier, she had undergone subtotal colectomy for colon cancer. Her serum 25-hydroxy vitamin D concentration was below the detectable level. In addition to a poor nutritional intake and insufficient sun exposure, malabsorption of fat-soluble substances in the intestine and phosphate loss from the kidneys might have contributed to the development of her osteomalacia.

**Key words:** anorexia nervosa, osteomalacia, vitamin D deficiency

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### Introduction

Anorexia nervosa (AN) is an eating disorder characterized by a distorted recognition of body shape and the excessive restriction of calorie intake to avoid body weight gain. Malnutrition causes various medical complications, including bone, endocrine, or even nephrological problems. A decrease in the bone mineral density (BMD) is the prominent feature, and such patients are at an increased risk of bone fracture (1). While osteoporosis is a well-known bone complication among patients with AN, the development of osteomalacia, a pathological softening of the bones resulting from incomplete mineralization, is rarely reported among these patients (2-5).

We herein report a 48-year-old woman with AN who visited our emergency department complaining of severe generalized bone pain. She had been diagnosed with AN nine years earlier and had undergone subtotal colectomy two years earlier. While osteoporosis was initially suspected, a

blood test and radiological survey indicated that she had osteomalacia.

### Case Report

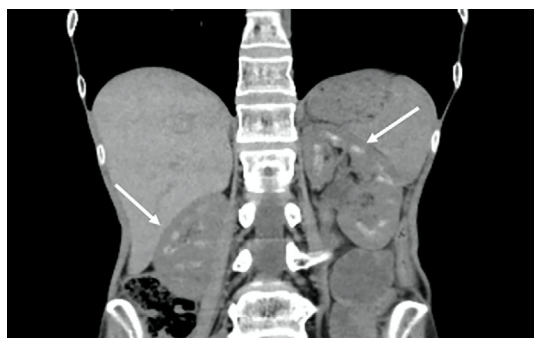
A 48-year-old woman with a history of AN (restricting type) was brought to our emergency department presenting with difficulty breathing due to bilateral rib pain. She also complained of severe bone pain in her upper limbs, lower limbs, and hip during active motion. Due to these symptoms, she was unable to move by herself. Her bone pain had started three months earlier without any traumatic events and gradually worsened.

She recounted that her body weight had been 47 kg at 18 years old. After marrying in her late 20s, she had been a housewife. She had been diagnosed with AN at 39 years old in a local hospital. She was obsessed with her body weight and imposed an extremely unbalanced diet on herself, particularly avoiding the consumption of fat-containing foods, and observed a severe calorie restriction of 600 kcal per day.

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**Figure 1.** CT revealed bilateral nephrocalcinosis (arrows).

She denied any previous episodes of binge-eating or purging behaviors. She was hospitalized at that time due to severe weight loss [body mass index (BMI), 11.5 kg/m<sup>2</sup>] and hypokalemia (2.7 mEq/L). She received nutritional support and cognitive-behavioral therapy, but she discontinued medical follow-up soon after discharge.

At 45 years old, she was admitted to our hospital due to nephrolithiasis (day 0). Computed tomography (CT) incidentally revealed bilateral medullary nephrocalcinosis (Fig. 1). Weight loss (BMI, 13.1 kg/m<sup>2</sup>), hypokalemia (2.1 mEq/L), and a decreased BMD of lumbar spine (0.549 g/cm<sup>2</sup>, T-score: -3.9) were noted, but she refused to undergo a psychiatric consultation. She did not re-visit the outpatient unit for follow-up after discharge. At 46 years old, she was again admitted for obstructive ileus. Colonoscopy revealed advanced cancer in the sigmoid colon and multiple adenomas in the transverse colon. She underwent laparoscopic subtotal colectomy, and nearly 10 cm of her terminal ileum was simultaneously resected (day 211). She refused to receive adjuvant chemotherapy. After surgery, she spent almost all day staying at home and seldom went outside.

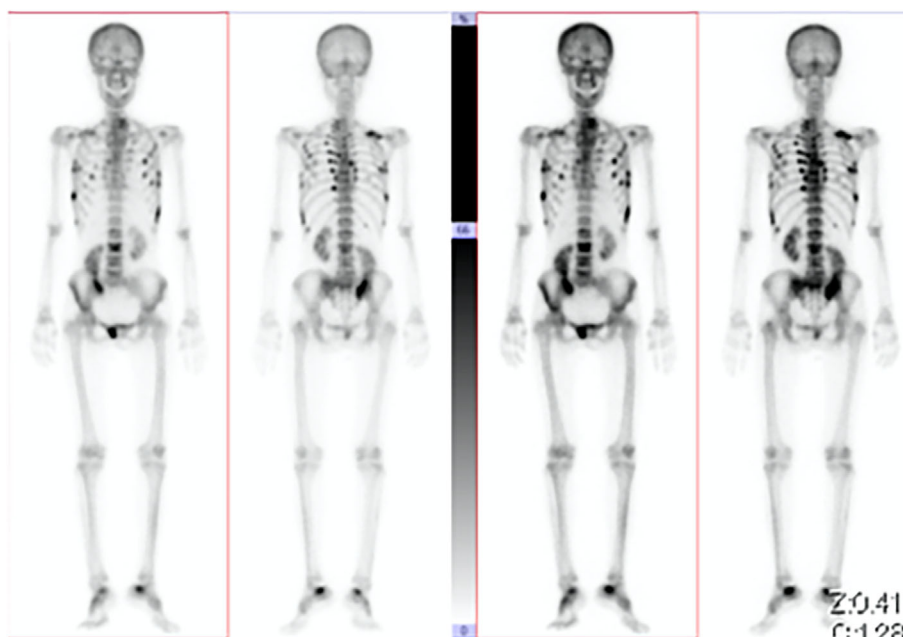
On admission (day 769), she looked emaciated. She was 155.0 cm tall and weighed 33.4 kg (BMI, 13.9 kg/m<sup>2</sup>). Her blood pressure was 99/74 mmHg, pulse rate 71 per minute with regular rhythm, and a body temperature of 36.7 °C. Superficial lymph nodes were not palpable. Auscultation of her heart and lungs was normal, but she complained of severe bilateral rib pain during inhalation. Her abdomen was soft and flat. No skin rashes, edema, or cyanosis was evident. She complained of severe bone pain on both active and passive motion in her upper and lower limbs, hip, and lumbar lesion. Her neurological findings were unremarkable. Chvostek's and Trousseau's signs were not observed. A detailed medical interview revealed that her diet had been extremely restricted and unbalanced in recent years. She avoided consuming fish, milk, or other fat-containing dairy products. She said that just a small amount of steamed chicken, approximately 4 L of carbonated water, several fruits, and sorbet ice were satisfactory for her daily meals. She seldom drank or smoked. She denied any abuse of laxatives or diuretics. She was not taking any calcium- or vitamin D- containing supplements.

Regular blood test results were as follows: hemoglobin,

12.0 g/dL; albumin, 3.7 g/dL; blood urea nitrogen, 25.6 mg/dL; creatinine, 0.79 mg/dL; alkaline phosphatase, 1,508 IU/L; calcium, 7.6 mg/dL; inorganic phosphate, 2.8 mg/dL; and potassium, 2.7 mEq/L. CT revealed multiple rib fractures and the compression fracture of vertebral body Th 7, but no typical findings of Looser's zone were observed. Medullary nephrocalcinosis was unchanged. The BMD of the lumbar spine was 0.473 g/cm<sup>2</sup> (T score: -4.5).

Given her long-term history of AN and low BMD, we initially considered osteoporosis as a cause of her multiple fractures. However, severe bone symptoms, hypocalcemia and hyperphosphatemia raised the possibility of osteomalacia. Whole-body bone scintigraphy with <sup>99m</sup>Tc hydroxymethylene showed multiple hot spots in her ribs bilaterally and pelvic lesions (Fig. 2). Since neoplastic lesions were not evident on CT, pathological fracture was suspected. Her serum 25-hydroxy vitamin D [25(OH)D] concentration was below detectable limits. Intact parathyroid hormone (PTH), serum tartrate-resistant acid phosphatase-5b (TRACP-5b; marker of bone resorption), and bone-specific alkaline phosphatase (BAP; marker of bone formation) were all increased. Her renal tubular reabsorption of phosphate (%TRP) was decreased. The decreased %TRP in our patient seemed attributable to the biologic effect of PTH. However, her urinary β2-microglobulin level was also increased; mild glucosuria (200 mg/24 h) and pan-aminoaciduria were later confirmed, indicating possible complication with reabsorptive malfunction in the renal proximal tubules. The serum fibroblast growth factor (FGF)-23 level was not increased, so tumor-induced osteomalacia was deemed unlikely. The laboratory findings are summarized in Table 1. We diagnosed her with osteomalacia caused by vitamin D deficiency.

To manage her vitamin D deficiency, she began treatment with calcitriol at a dose of 0.5 µg/day. At the same time, we decided to administer 300 mg of oral phosphate products daily because her serum phosphate levels were low normal with decreased %TRP. Her bone pain improved dramatically. She regained the ability to walk by herself four weeks after the initiation of treatment. After discharge, she continued regular outpatient follow-up and reported that she had gradually increased her daily calorie intake and incorporated more vitamin D-containing foods into her diet. While she never revealed the details of her modified diet to her physicians, she did say that she sometimes went outside with her husband in the daytime following the improvement of her bone pain. Her alkaline phosphatase level was normalized six months later. During the follow-up period, she experienced no recurrent episodes of symptomatic fracture. It is reasonable to conclude that, in addition to these medications, both the improvement of her diet and sun-exposure time also contributed to the recovery of her serum calcium, phosphate, and 25(OH)D levels (Fig. 3).



**Figure 2.**  $^{99m}\text{Tc}$  hydroxymethylene bone scintigraphy. Multiple hot spots were noted in the bilateral ribs and pelvic lesion.

## Discussion

The present case demonstrated the importance of recognizing osteomalacia as a bone complication of AN. The delay in the appropriate diagnosis and treatment may have caused further fractures and resulted in severe and irreversible physical disability.

Osteomalacia is characterized by decreased osteoid mineralization associated with bone fragility. Vitamin D deficiency is an important cause of osteomalacia (6). Vitamin D is a fat-soluble substance that plays a crucial role in calcium/phosphate regulation and bone health. Certain foods, such as fish, vegetables, and fortified dairy products, contain high quantities of vitamin D. Furthermore, vitamin D3 (cholecalciferol) is synthesized in human skin after sufficient ultraviolet B exposure. Thus, an adequate food intake and sun exposure are necessary to prevent vitamin D deficiency. A systematic review reported that vitamin D deficiency remains a public health issue worldwide (7). In a Japanese large-scale cohort study, women, examined month (October, November, December), a smoking habit, lack of regular outdoor walking, increased PTH level, and poor dietary intake of vitamin D were identified as risk factors for vitamin D deficiency [defined as serum 25(OH)D level <10 ng/mL] (8).

The lifestyle of our patient (consuming an extremely unbalanced diet while staying indoors almost all day and avoiding sun exposure) strongly suggests that both her nutritional intake and cutaneous production of vitamin D were poor. In addition, two other mechanisms may have contributed to the onset of her osteomalacia: (1) malabsorption of vitamin D and (2) impaired phosphate re-absorption in the

kidney.

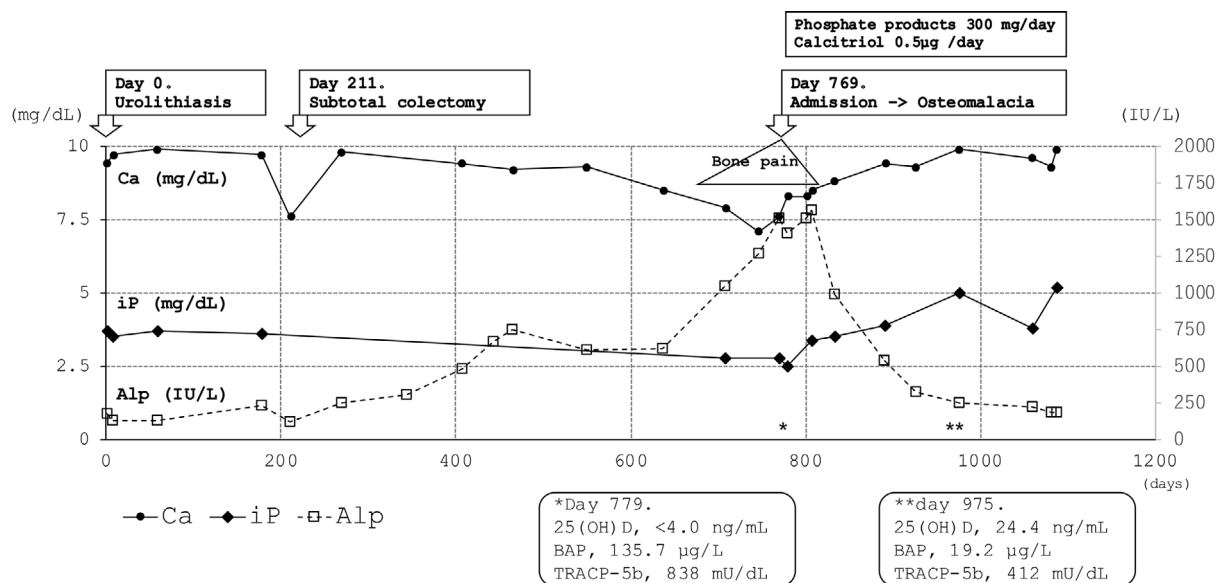
First, nearly 10 cm of the terminal ileum was resected in our patient simultaneously with subtotal colectomy. Patients with short-bowel syndrome, inflammatory bowel disease, liver or pancreatic disease, or a history of gastric bypass surgery are known to be complicated with fat malabsorption syndrome. Of note, bile acids play a pivotal role in the enteral absorption of lipophilic substances, including vitamin D. Bile acids are preserved in the human body by the enterohepatic circulation. The transport of bile acids in the enteral lumen is efficiently mediated by the sodium-dependent bile acid transporter, which is expressed in the enterocytes of the terminal ileum (9). This transporter is important for the usual bile acid re-absorption process, since congenital mutations in this gene cause primary bile acid malabsorption syndrome (10). Thus, resection of the terminal ileum may have further exacerbated her vitamin D deficiency by disturbing the enterohepatic circulation of bile acids and resultant malabsorption of fat-soluble substances (i.e. vitamin D).

Second, her phosphate reabsorption was low (%TRP 60.5%, normal range: 80-90%) despite her relatively low serum phosphate level (2.8 mg/dL, normal range: 2.7-4.6) at the time of admission. One explanation for decreased %TRP is the hormonal effect of increased PTH. Hypocalcemia stimulates PTH secretion and promotes active calcium absorption by enhancing transport in the cortical thick ascending limb of the loop of Henle and distal convoluted tubule. In exchange, phosphorus reabsorption in the renal proximal tubule is inhibited by the inactivation of sodium/phosphate cotransporters, leading to increased phosphate excretion in the urine. It is reasonable to say that the present patient's hypocalcemia (7.6 mg/dL, normal range: 8.8-10.1) caused by the poor dietary calcium intake and vitamin D deficiency

**Table 1. Laboratory Data on Admission.**

<b>Blood cell count</b>		nomal value	Na (mEq/L)	139	(138-145)
WBC ( $\mu\text{L}$ )	5,500	(3,300-8,600)	K (mEq/L)	2.7*	(3.6-4.8)
RBC ( $\times 10^4/\mu\text{L}$ )	430	(386-492)	Cl (mEq/L)	99*	(101-108)
Hb (g/dL)	12.0	(11.6-14.8)	Ca (mg/dL)	7.6*	(8.8-10.1)
Plt ( $\times 10^4/\mu\text{L}$ )	34.1	(15.8-34.8)	iP (mg/dL)	2.8	(2.7-4.6)
<b>Urinalysis</b>			Mg (mg/dL)	2.31*	(1.7-2.3)
Glucose	(-)		BUN (mg/dL)	25.6*	(8-18.4)
Protein	(-)		Cr (mg/dL)	0.79	(0.65-1.07)
Blood	(-)		BS (mg/dL)	99	
RBC (/HPF)	<1		HbA1c (%)	5.6	(4.6-6.2)
$\beta 2\text{MG}$ ( $\mu\text{g/L}$ )	2,915.5*	(0-335)	<b>Venous blood gas (room)</b>		
%TRP	60.5*	(80-90)	pH	7.384	
TmP/GFR	1.70		pO <sub>2</sub> (mmHg)	67.2	
Pan-aminoaciduria	(+)	(-)	pCO <sub>2</sub> (mmHg)	42.1	
<b>24hr urine collection</b>			HCO <sub>3</sub> <sup>-</sup> (mEq/L)	24.6	
Ca (mg)	183		<b>Additional data</b>		
iP (mg)	544		IgG (mg/dL)	869	(861-1,747)
Glucose (mg)	200		IgA (mg/dL)	145	(93-393)
Creatinine (mg)	421		IgM (mg/dL)	74	(33-183)
<b>Biochemical data</b>			serum M protein	(-)	
TP (g/dL)	6.8	(6.6-8.1)	BJP	(-)	
Alb (g/dL)	3.7*	(4.1-5.1)	ANA	<40	
AST (IU/L)	32*	(13-30)	anti-SS-A	<0.5	
ALT (IU/L)	30	(10-42)	anti-SS-B	<0.5	
Alp (IU/L)	1,508*	(106-322)	TSH ( $\mu\text{IU/mL}$ )	2.84	(0.5-5)
LDH (IU/L)	269*	(124-222)	fT4 (ng/dL)	0.68*	(0.9-1.7)
$\gamma$ -GTP (IU/L)	57	(13-64)	iPTH (pg/mL)	542*	(10-65)
Amy (IU/L)	203*	(44-132)	1, 25(OH) <sub>2</sub> D (pg/mL)	18*	(20-60)
CPK (IU/L)	219*	(41-153)	25(OH)D (ng/mL)	<4*	(>30)
T-bil (mg/dL)	0.4	(0.4-1.5)	BAP ( $\mu\text{g/L}$ )	135.7*	(3.8-22.6)
CRP (mg/dL)	0.10	(0-0.14)	TRACP-5b (mU/dL)	838*	(120-420)
			FGF23 (pg/mL)	<10	

ANA: anti-nuclear antibody, BAP: bone-specific alkaline phosphatase, BJP: Bence Jones protein,  $\beta 2\text{MG}$ : beta-2 microglobulin, FGF23: fibroblast growth factor 23, HbA1c: hemoglobin A1c, iPTH: intact parathyroid hormone, TRACP-5b: tartrate-resistant acid phosphatase-5b, %TRP: renal tubular reabsorption of phosphate, 25(OH)D: 25-hydroxy vitamin D, 1, 25(OH)<sub>2</sub>D: 1, 25-dihydroxy vitamin D. Abnormal values are indicated by asterisks (\*).



**Figure 3. Clinical course.** Her bone pain dramatically improved after supplementation with vitamin D and phosphate products. Serum alkaline phosphatase was normalized six months later.

**Table 2. Summary of the Previous Cases.**

case	1 <sup>2)</sup>	2 <sup>3)</sup>	3 <sup>4)</sup>	4 <sup>5)</sup>	5 (present case)
age	32	27	60	21	48
gender	woman	woman	woman	woman	woman
history of anorexia	since adolescent	since 14-year-old	later childhood	since 12-year-old	since 39-year-old
kidney function	N.D	N.D	right kidney had lost function (detail N.D)	Cr 0.29 mg/dL	Cr 0.79 mg/dL
height (cm)/weight (kg)	153/38	133/25	N.D	120/24	155/33.4
BMI (kg/m <sup>2</sup> )	16.2	14.1	N.D	16.7	13.9
Ca (mg/dL)	8.8 (normal range N.D)	8.4 (8.9-10.4)	7.9 (8.7-10.3)	5.6 (normal range N.D)	7.6 (8.8-10.1)
iP (mg/dL)	2.3 (3-4.5)	2.4 (2.6-4.4)	N.D	4.1 (normal range N.D)	2.8 (2.7-4.6)
Alp (IU/L)	1,180 (70-215)	N.D	1,289 (115-359)	1,517 (normal range N.D)	1,508 (106-322)
BAP	N.D	77 IU/L (6-21)	N.D	150 µg/L (7.0-10.0)	135.7 µg/L (3.8-22.6)
intact PTH (pg/mL)	normal (value N.D)	400 (20-100)	858 (10-65)	478 (16-65)	542 (10-65)
25(OH)D (ng/mL)	undetectable (value N.D)	2.8 (8-40)	<5 (7-41)	<5 (30-60)	<4 (>30)
1, 25(OH) <sub>2</sub> D (pg/mL)	N.D	61 (16-62)	7.0 (20-60)	5.2 (20-60)	18 (20-60)
BMD	osteopenia	lumbar spine: 0.208 g/cm <sup>2</sup> (Z score, -7.43), femoral neck: 0.121 g/cm <sup>2</sup> (Z score, -7.21)	L2-4: T score, -6.8, total hip: T score, -7.31	total hip bone: 0.176 g/cm <sup>2</sup> (T score, -6.2)	lumbar spine: 0.473 g/cm <sup>2</sup> (T score, -4.5)
bone biopsy	(+)	(-)	(-)	(-)	(-)
looser's zone	(+)	(+)	N.D	(-)	(-)
bone scintigraphy	multiple spots (+)	N.D	N.D	(-)	multiple spots (+)
treatment	refused	vitamin D 5,000 IU + calcium 1 g	alfacalcidol	alfacalcidol 0.5 µg + calcium lactate 2 g	calcitriol 0.5 µg + phosphate products 300 mg
outcome	died one year later	able to stand alone 4 months later, but did not re-visit again	died one month after admission	able to ambulate 8 weeks later	able to walk by herself 4 weeks later

Alp: alkaline phosphatase, BAP: bone-specific alkaline phosphatase, BMD: bone mineral density, N.D: not described, PTH: parathyroid hormone

Normal ranges are in parenthesis.

stimulated the PTH secretion (serum intact PTH 542 pg/mL, normal range: 10-65) and resulted in decreased phosphate absorption. Another explanation is the re-absorptive dysfunction in renal tubules. Indeed, patients with AN are known to be associated with various types of kidney disease, such as acute kidney injury, chronic kidney disease, and electrolyte disturbances (11). A renal biopsy of an AN patient with prolonged hypokalemia revealed interstitial damage (vacuolar change and degeneration in tubular cells, lymphocytic infiltration, or fibrosis in interstitial space) and hyperplasia of the juxtaglomerular apparatus (12). Chronic hypokalemia is assumed to cause tubulo-interstitial damage by ammonia-

mediated complement activation (so-called hypokalemic nephropathy) (13). Furthermore, Hasegawa et al. reported a patient with AN associated with tubulo-interstitial nephritis and hypokalemia who had biopsy-proven widespread calcification of the renal tubules (14). Although the exact pathophysiology is unclear, several other reports have also described cases of nephrocalcinosis among patients with AN (15-17). While our patient did not undergo a kidney biopsy, her hypokalemia had already been noted nine years earlier, and CT revealed bilateral medullary nephrocalcinosis. Considering her elevated urinary  $\beta$ 2-microglobulin level and later confirmed mild glucosuria and pan-aminoaciduria,

we speculate that her condition was complicated by renal tubular re-absorptive dysfunction caused by hypokalemic nephropathy and medullary nephrocalcinosis.

While osteoporosis is well-known, osteomalacia is rarely reported as a complication of AN. We were only able to find four other relevant case reports (2-5). Three of the 4 cases showed hypophosphatemia (Table 2), but 1 case reported by Watanabe et al. had a normal serum inorganic phosphate level (4.1 mg/dL). Patients with vitamin D deficiency-induced rickets are not necessarily complicated with hypophosphatemia (18), although the exact reason for this remains unknown. Serum phosphate levels can be rapidly affected by the dietary phosphate load or glucose metabolism. Therefore, physicians should not exclude the possibility of vitamin D deficiency simply because of the absence of hypophosphatemia.

Generally speaking, osteomalacia is a rare clinical entity compared to osteoporosis. In Japan, the measurement of 25 (OH)D, which reflects the amount of vitamin D storage in human body, was not covered by the national health insurance system until 2016. This fact raises the possibility that vitamin D deficiency had not been properly diagnosed in ordinary clinical practice before 2016 in Japan. It is therefore possible that a considerable number of AN patients who had been diagnosed with osteoporosis were actually complicated with vitamin D deficiency-induced osteomalacia. Hotta et al. reported the high prevalence of vitamin D deficiency in Japanese patients with AN (19). We therefore suggest that, in addition to osteoporosis, vitamin D deficiency-induced osteomalacia should be considered when managing bone complications of AN from now on.

### Conclusion

In addition to osteoporosis, vitamin D deficiency-induced osteomalacia should be considered as a bone complication of AN.

**The authors state that they have no Conflict of Interest (COI).**

### References

- Misra M, Klibanski A. Anorexia nervosa and bone. *J Endocrinol* **221**: R163-R176, 2014.
- Verbruggen LA, Bruyland M, Shahabpour M. Osteomalacia in a patient with anorexia nervosa. *J Rheumatol* **20**: 512-517, 1993.
- Oliveri B, Gomez Acotto C, Mautalen C. Osteomalacia in a patient with severe anorexia nervosa. *Rev Rhum Engl Ed* **66**: 505-508, 1999.
- Yokota F, Yamada T, Matsunaga C, et al. Osteomalacia with severe thoracic and spondylous deformity complicated by osteoporosis. *BMJ Case Rep* **20**: bcr0420114127, 2011.
- Watanabe D, Hotta M, Ichihara A. Osteomalacia, severe thoracic deformities and respiratory failure in a young woman with anorexia nervosa. *Intern Med* **54**: 929-934, 2015.
- Fukumoto S, Ozono K, Michigami T, et al. Pathogenesis and diagnostic criteria for rickets and osteomalacia - proposal by an expert panel supported by Ministry of Health, Labour and Welfare, Japan, The Japanese Society for Bone and Mineral Research and The Japan Endocrine Society. *Endocr J* **62**: 665-671, 2015.
- Palacios C, Gonzalez L. Is vitamin D deficiency a major global public health problem? *J Steroid Biochem Mol Biol* **144**: 138-145, 2014.
- Yoshimura N, Muraki S, Oka H, et al. Profiles of vitamin D insufficiency and deficiency in Japanese men and women: association with biological, environmental, and nutritional factors and coexisting disorders: the ROAD study. *Osteoporos Int* **24**: 2775-2787, 2013.
- Craddock AL, Love MW, Daniel RW, et al. Expression and transport properties of the human ileal and renal sodium-dependent bile acid transporter. *Am J Physiol* **274**: G157-G169, 1998.
- Oelkers P, Kirby LC, Heubi JE, Dawson PA. Primary bile acid malabsorption caused by mutations in the ileal sodium-dependent bile acid transporter gene (SLC10A2). *J Clin Invest* **99**: 1880-1887, 1997.
- Bouquegneau A, Dubois BE, Krzesinski JM, Delanaye P. Anorexia nervosa and the kidney. *Am J Kidney Dis* **60**: 299-307, 2012.
- Arimura Y, Tanaka H, Yoshida T, et al. Anorexia nervosa: an important cause of chronic tubulointerstitial nephropathy. *Nephrol Dial Transplant* **14**: 957-959, 1999.
- Tolins JP, Hostetter MK, Hostetter TH. Hypokalemic nephropathy in the rat. Role of ammonia in chronic tubular injury. *J Clin Invest* **79**: 1447-1458, 1987.
- Hasegawa S, Shibata M, Mochizuki M, Katsuki T, Tada M, Hinoshita F. Non-uniform progression of chronic tubulointerstitial nephritis and widespread nephrocalcinification in a patient with anorexia nervosa. *Intern Med* **56**: 545-549, 2017.
- Roberts MA, Thorpe CR, Macgregor DP, Paoletti N, Ierino FL. Severe renal failure and nephrocalcinosis in anorexia nervosa. *Med J Aust* **182**: 635-636, 2005.
- Lim AK, Hooke DH, Kerr PG. Anorexia nervosa and senna misuse: nephrocalcinosis, digital clubbing and hypertrophic osteoarthropathy. *Med J Aust* **188**: 121-122, 2008.
- Chadi N, Carter S, Loung RPY, Gould M, Hick K. Nephrocalcinosis in a young male with anorexia nervosa. *CEN Case Rep* **6**: 164-168, 2017.
- Kubota T, Kotani T, Miyoshi Y, et al. A spectrum of clinical presentations in seven Japanese patients with vitamin D deficiency. *Clin Pediatr Endocrinol* **15**: 23-28, 2006.
- Hotta M. High prevalence of vitamin D insufficiency and deficiency among patients with anorexia nervosa in Japan. *Osteoporos Int* **26**: 1233, 2015.

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