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Case Report

Bilateral **fragility** femoral supracondylar fractures in adolescents due to long-term home stay during the COVID-19 pandemic: A case reportHyonmin Choe ^{a, *}, Naomi Kobayashi ^b, Masatoshi Oba ^a, Taro Tezuka ^a, Hiroyuki Ike ^a, Akira Morita ^a, Koki Abe ^a, Yutaka Inaba ^a^a Department of Orthopaedic Surgery, Yokohama City University, Yokohama, Japan^b Department of Orthopaedic Surgery, Yokohama City University Medical Center, Yokohama, Japan

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1. Introduction

COVID-19 pandemic-related restrictions as well as self-imposed restraints have led to elementary and junior high school students staying indoors for a long period. As a consequence, they have decreased exposure to sunlight and face the risk of growth failure and bone fragility due to vitamin D deficiency [1]. Two main sources of vitamin D are ultraviolet rays synthesized in the skin and the foods absorbed orally [2]. Vitamin D deficiency is a worldwide concern, especially among the elderly [3–5]. However, as yet, self-restraint or lockdown has not been reported as causing healthy children and youths to develop osteoporosis and **fragility** fractures during their growth spurt period.

This is the report of the case of a junior high school boy who stayed indoors for approximately two months during the COVID-19 pandemic and, following a little exercise, suffered a **fragility** fracture of the bilateral supracondylar of the femur. We found a

* Corresponding author. 3-9 Fukuura, Kanazawa-ku, Yokohama City, Kanagawa, Japan. Fax: +81 45 781 7922.

E-mail address: hyonmin@hotmail.com (H. Choe).

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significant loss of bone mineral density (BMD) in the patient that may have been due to vitamin D deficiency; however, after supplementation of active vitamin D, his BMD improved significantly.

1.1. Report of the case

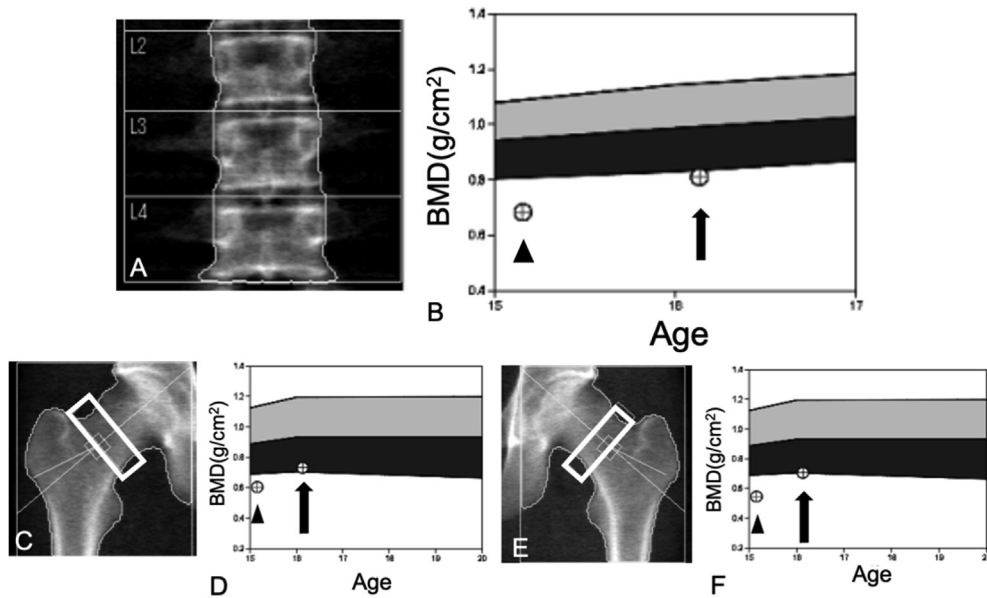
The patient, a 14-year-old boy complaining of thigh pain, was referred to our hospital by his doctor for further examination. He was 165 cm tall, weighed 50 kg, and had a BMI of 18.4 during his first visit to our hospital. **Characteristic findings for osteogenesis imperfecta, such as blue sclerae and dentinogenesis imperfecta, were not observed in his face or features.** He is a black belt holder in karate with a medical history of fractures in his left elbow and fifth digit. Due to the COVID-19 pandemic, the government had declared a state of emergency from Day –66 to Day –12 in spring in his area of residence; thus, he spent 55 days fully indoors, studying and playing video games **and never went out. While he had balanced diet with similar volume to a normal adult during this period, he didn't drink much milk or take any supplements.**

When school resumed on Day 0 in **early summer**, he felt a sense of discomfort in his left knee during the gymnastics class. He could not put his weight on his left knee due to the pain and, consequently, developed additional pain in the right knee. As the pain persisted, he visited a nearby doctor on Day 10. While no abnormalities were observed on plain film X-rays (Fig. 1A and B), an abnormal shadow in the bilateral femoral condyles was seen in an MRI scan (Fig. 1C and D), and the patient was referred to our hospital on Day 13. X-ray findings at our hospital revealed a thickening of the periosteum in the bilateral femoral condyles. An MRI scan on day 21 and a bone scintigraphy on day 29 showed an abnormal legion on the bilateral femoral condyles, indicating fractures in the bilateral supracondylar area of the femur (Fig. 1E–F).

Low bone density was observed from a bone mineral density test conducted on day 46: the lumbar spine had a Z-score of –3.7 (bone density: 0.683 g/cm²) in the lumbar spine, –2.9 (bone density: 0.605 g/cm²) in the right femoral neck, and –3.6 (bone density: 0.544 g/cm²) in the left femoral neck (Fig. 2A–G) [1]. A blood test showed 25OH vitamin D at as low as 18.5 ng/mL (normal value ≥ 30.0 ng/mL); however, high values were recorded for TRAP5b,



Fig. 1. A–H: Right and left knee x-ray image taken on Day 10 (A, B) at a nearby clinic, and on Day 13 (C, D), Day 90 (E, F) and Day 380 (G, H) taken at our hospital. I–K: Right and left knee MRI STIR image (I–J) taken at our hospital on Day 21 and 99 m technetium bone scintigraphy late phase image taken at our hospital on Day 29 (K).



Region of Interest	Bone mineral density (g/cm ²)			Z-score	
	At the presence (Arrowhead)	1 year after (Arrow)	BMD Change	At the presence (Arrowhead)	1 year after (Arrow)
Lumbar body 2-4	0.683	0.809	+18.5%	-3.7	-2.3
Right femoral neck	0.605	0.706	+29.7%	-2.9	-1.9
Left femoral neck	0.544	0.730	+20.6%	-3.6	-1.7

G

Fig. 2. Dual energy X-ray absorptiometry (DEXA) image and BMD change from day 46 to day 380 for lumbar spine (A, B, G) and both femoral neck (C–G).

1120 mU/dL (normal value 170–590 mU/dL), and total P1NP, 660 ng/mL (normal value of 17.1–64.7 ng/mL). **Serum calcium, phosphorus, parathyroid hormone levels, and renal or liver function** were within the normal range (Table 1).

The patient was diagnosed with a **fragility** fracture of the bilateral supra-condylar area of the femur, based on clinical and imaging findings. As the serum test showed low vitamin D levels and worsened **bone strength**, self-restraint during the pandemic and lack of exposure to sunlight were determined as the causes of the fracture [6]. Accordingly, the patient underwent active vitamin D3 (Eldecalcitol) supplementation and partial weight-bearing of the lower limbs were allowed. Three months after the injury, the fractures healed and the patient recovered fully from pain (Fig. 1G–H). However, active vitamin D3 was administered continuously up to one year. The blood test on Day 380 showed that 25OH vitamin D had slightly improved to 19.2 ng/mL (normal value ≥ 30.0 ng/mL) **without inducing hypercalcemia** (Table 1) [7]. Bone density improved to 118% in the lumbar spine, 121% in the right femoral neck, and 130% in the left femoral neck (Fig. 2A–G). In conclusion, the cause of our patient's bone fragility was attributed to vitamin D deficiency.

2. Discussion

Bilateral supracondylar of the femur is a relatively rare traumatic injury in adolescents. Fatigue fractures of the distal femur are usually caused by repetitive and highly intensive movements. **The repetitive movement, and the stress apply load and ground reaction forces between the attachment part of the gastrocnemius muscle and the adductor muscles in distal femur may sometimes cause fatigue injuries at this site** [8]. In contrast to this theory, bilateral supracondylar of the femur in our current case occurred during a warm-up session in a gymnastics class, implying that our patient's fractures did not result from overuse. Although this patient practices karate and has suffered two fractures in the past, this was his first **fragility** fracture. Moreover, the blood test showed low 25OH vitamin D levels, primarily caused by him being mostly homebound for almost two months. Considering all aspects, he was diagnosed with **fragility** fracture resulting from vitamin D deficiency.

As a femur fracture caused by a slight force is relatively rare, it was necessary to distinguish this case from a malignant tumor due to a bone lesion around the knee in the patient's first visit to our hospital. Although conducting a bone biopsy for a differential diagnosis was discussed, we diagnosed the patient with a **fragility** fracture based on the X-ray, MRI, BMD test, and serum vitamin D examination findings. Thus, it is important to note that **fragility** fractures can occur even in adolescents, particularly if they have been under long-term exercise restrictions with limited exposure to sunlight. Furthermore, there was a remarkable decrease in our patient's BMD compared with its average value observed among

Table 1
Overtime change of serum data after Vitamin D intake.

Serum data	At the presence	5 months after	1 year after
25OH.Vitamin D (ng/mL)	18.5	14.4	19.2
TRAP-5b (mU/dL)	1120	811	732
Total P1NP (ng/mL)	660	437	531
Ca (mg/dL)	9.3	9.7	9.1
P (mg/dL)	4.5	4.7	4.1
PTH intact (pg/ml)		21	
BUN (mg/dL)	14	13	11
Cre (mg/dL)	0.64	0.69	0.75
AST (U/L)	15	17	19
ALT (U/L)	8	11	12

individuals in the same age group in other countries [8,9]. He showed an extensive improvement in BMD after one year of active vitamin D3 supplementation, which indicates that even after a fracture heals completely, it is necessary to screen and treat **osteoporosis or osteomalacia** to prevent future fractures even in adolescents. We prescribed eldecalcitol, a biologically active form of vitamin D, for the improvement of BMD [10,11]. However, the serum 25OH vitamin D level in our current patient stayed low despite the successful improvement of the BMD, due to the fact that the half life of 1,25OH vitamin D3 being only 4–6 h and circulating level being a thousand fold less than 25OH vitamin D3 [10,11].

Although our country did not implement a COVID-19-induced lockdown, many children and adolescents were forced to stay at home for long periods. We need to consider the possibility of extensive changes occurring in children's lifestyles due to such self-restraint, such as a lack of exercise, decreased exposure to sunlight, and nutritional imbalance without school lunch [12]. Even during a short self-restraint period, children experiencing growth spurt may be highly affected, and could develop osteoporosis that may trigger **fragility** fractures [13,14]. When vitamin D deficiency is the cause of the osteoporosis, as in this case, **fragility** fractures can be avoided through active vitamin D3 supplementation in addition to dietary changes and active sunlight exposure [15].

A limitation of this case report lies in the possibility of patients having low levels of vitamin D before the self-restraint period or a hidden disease that causes **fragility** fractures, such as mild osteogenesis imperfecta. However, the strength of this case is that we confirmed the patient's decreased bone mineral density and vitamin D after the self-restraint period, followed by an improvement in bone mineral density after the administration of vitamin D3. As schools are expected to remain closed until the COVID-19 threat sufficiently recedes, children and adolescents will continue to stay indoors during their growth spurt. Even during the pandemic, it is essential to provide them with an environment conducive to exercising and expose them to sufficient amount of vitamin D for bone growth. Furthermore, it is important to spread awareness of the fact that osteoporosis occurs even in children and needs to be detected and prevented via screening through blood tests and bone density tests.

Availability of data and material

All the data supporting our findings are contained within the manuscript.

Ethics approval and consent to participate

Not applicable.

Declarations

Nothing to disclose.

Consent for publication

Written informed consent was obtained from the parent of the patient for publication of this case report and any accompanying images.

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Declaration of competing interest

The authors declare that they have no competing interests.

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