

## Clinical Quiz

# Vitamin D deficiency resulting to a subsequent vertebral fracture after kyphoplasty

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## Case

A 76-year-old white female was admitted as an urgent case in the orthopaedic department suffering from substantial back pain and severe muscle weakness. Lateral X-rays of the spine revealed compression fractures of the T<sub>10</sub> and T<sub>11</sub> and L<sub>1</sub> vertebrae. Medical history included total hysterectomy due to fibromyoma at the age of 40, hypertension, atrial fibrillation, gastroesophageal reflux, and thyroidectomy. The diagnosis of osteoporosis was done many years ago and since then she had received several treatments such as calcium and vitamin D supplements, calcitonin, bisphosphonates, and for the last 12 months teriparatide subcutaneous injections. Magnetic resonance imaging and bone scintigraphy (Figure 1) showed recent lesions consistent with recent osteoporotic fractures. The patient underwent percutaneous kyphoplasty (Figure 2) in order to restore the vertebral deformities and to reduce pain. Postoperatively the patient did not report improvement in pain intensity. A follow up X-ray revealed a fresh compression fracture in L<sub>2</sub> vertebrae while a recent-biochemical investigation of bone metabolism showed hypocalcemia (Ca=8.2 mg/ml), elevated levels of immune-reactive parathyroid hormone (iPTH) [77 ng/ml, normal values up to 65] and very low levels of serum 25(OH)D<sub>3</sub>=9 ng/ml [normal range: 20-76 ng/ml]. The diagnosis of vitamin D deficiency and osteomalacic myopathy was established and the patient received treatment accordingly (vitamin D capsules 2200 units daily) with an impressive clinical improvement of muscle strength and a significant decrease of back pain.

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## Commentary

Vertebral compression fracture is a common complication of osteoporosis with serious socio-economic consequences. It is estimated that 1.5 million fragility fractures are diagnosed in the United States while approximately 750.000 of these fractures occur in the spine, every year<sup>1</sup>. Vertebral fractures affect overall the health of the patient because of their direct and indirect effects on quality of life with increased morbidity and mortality. The therapeutic goals of treatment target on pain reduction and the prevention of consequent spinal fractures. The conservative treatment of these fractures includes bed rest, analgesics, bracing and antiosteoporotic treatment. The prolongation of post fracture incapacity leads to inactivity and further loss of bone and muscle mass. About one third of the patients with past osteoporotic vertebral fractures have been reported to suffer from severe and persistent pain that can lead to further disability which requires long-term medical care and hospitalization. Balloon kyphoplasty and vertebroplasty are two methods of minimally invasive surgery developed for the management of symptomatic vertebral compression fractures. The technique of vertebroplasty consists of fluoroscopically guided percutaneous insertion of a needle into the fractured vertebra and injection of polymethylmethacrylate (PMMA) cement. Kyphoplasty is differentiated from vertebroplasty and involves the insertion of a balloon tamp<sup>2</sup>. The balloon tamps intent to reduce the deformity, restore the vertebral body height while they create a cavity to be filled with PMMA. Although there were improvements in pain after kyphoplasty, several complications have been reported. The main complications of these techniques are pulmonary embolism, bleeding, infection and spinal cord compression from the leakage of the cement. Balloon kyphoplasty and vertebroplasty are also associated with a recurrent fracture risk in the adjacent levels as a result of the surgical procedure.

Lindsay et al. found that within the first year following an initial fracture the risk of sustaining a subsequent fracture was 19.2% and the risk for patients with more than one initial vertebral fracture was 24%<sup>3</sup>. Subsequent fractures after kyphoplasty



Figure 1. Pre-operative bone scan of the patient.

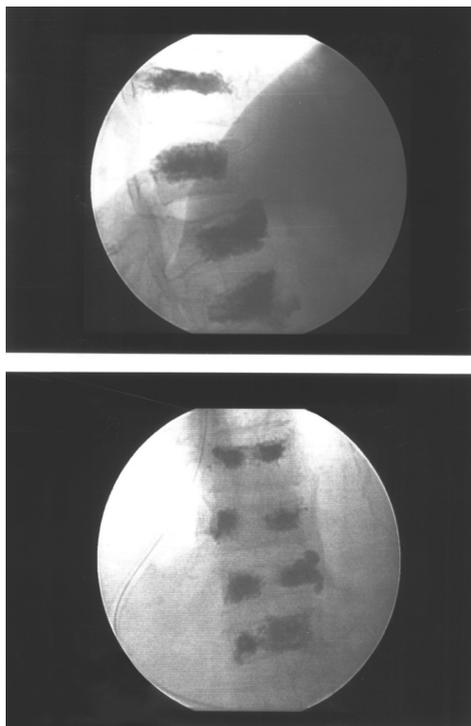


Figure 2. Fluoroscopically guided percutaneous kyphoplasty.

or vertebroplasty are attributed to: an increased activity from the return to full social life after the surgical procedure; a continuation of bone loss from the natural progression of osteoporosis and the new biomechanical conditions of the spine, resulting from the procedure itself. According to this theory cement increases stiffness in the treated vertebrae while also produces increased loading in the adjacent levels. Most of the researchers and surgical teams attribute the occurrence of these subsequent fractures to a combination of these theories, with the biomechanical theory combined with the status of bone metabolism having the main contribution. Bone metabolism seems to play a key role in the success of the technique. In osteoporosis, besides a quantitative reduction of bone tissue, there is disruption of the quality characteristics which affect the final outcome of kyphoplasty or vertebroplasty. It has been previously reported that in subjects with impaired bone metabolism, such as patients under corticosteroid treatment<sup>2</sup> or transplant recipients, the risk of subsequent fractures after kyphoplasty is increased.

Bone remodeling is a continuous rebuilding of the bone tissue through a coordinated process of bone resorption and subsequent bone formation in the basic multicellular units (BMUs), by interacting actions of osteoblasts and osteoclasts. An increased rate of bone remodeling, which is common in many metabolic bone diseases such as osteomalacia, leads to accelerated bone loss and increased risk of fracture. High bone turnover causes a deterioration of bone tissue while produces new less mineralized bone with reduced mechanical strength and biomechanical properties. Vitamin

D deficiency and subsequent osteopathy and osteomalacia, creates an unstable, biomechanically weak, bone microenvironment as a result of the delayed mineralization and the reduced amount of mineralized tissue. Loss of trabecular bone and reductions of cortical bone thickness are observed<sup>4</sup> and therefore deformities and fracture risk are increased. Ciarelli et al. examined mineralization levels in cancellous bone of the iliac crest in individuals with and without vertebral fractures<sup>5</sup>. They reported that both groups had a similar mean bone formation rate but the distribution of mineralization differed markedly. This finding supports the great influence of bone mineralization in the aetiology of vertebral fracture and the variability of mechanical properties in the trabecular bone of individuals with vertebral fractures. The clinical manifestations of patients with osteomalacia, include muscle weakness, increased fall risk and diffuse bone pain. However, these findings are not enough to distinguish osteoporosis from osteomalacia in patients suffering from acute vertebral fracture, and it is quite difficult to diagnose vitamin D deficiency in older patients by clinical and/or radiographical means only<sup>4</sup>. The appearance of symptoms of muscle weakness are quite helpful in the clinical detection of the so called osteomalacic myopathy.

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## Questions

1. Patients with corticosteroid-induced osteoporosis suffering from vertebral compression fracture:
  - A. Should not undergo kyphoplasty / vertebroplasty
  - B. Have the same incidence of complications of the method comparing with patients with primary osteoporosis
  - C. Have an increased risk of subsequent fractures after kyphoplasty/vertebroplasty

### Critique

Corticosteroid-induced compression fractures appear to have an increased incidence of subsequent fractures after the kyphoplasty procedure.

The correct answer is C.

2. Cement leakage during the kyphoplasty procedure in the intervertebral disc
  - A. Is usually symptomatic
  - B. Does not affect the incidence of secondary fractures
  - C. Increases the risk of subsequent fractures
  - D. Occurs in 65% of patients

### Critique

Cement leakage into the intervertebral disc during kyphoplasty / vertebroplasty seems to increase the risk of subsequent fractures.

The correct answer is C.

3. The clinical manifestations of osteomalacia:
  - A. Are generalized bone pain and tenderness
  - B. Are muscle weakness, waddling gait and fractures
  - C. Are related to the biomechanical changes of the spine
  - D. All the above

### Critique

Vitamin D deficiency and/or osteomalacia presents with a variety of clinical, biochemical and radiographic manifestations mimicking other musculoskeletal disorders, including 'osteoporosis'. On the other hand this minimally invasive technique may change the biomechanical conditions of the osteoporotic spine and facilitate the development of a new fracture in the neighboring osteoporotic vertebrae. The existence of vitamin D deficiency and osteomalacic myopathy contributes in the pathophysiology of this complication. Early detection of these biochemical and clinical abnormalities must be detected as earlier as possible and treated with high doses of vitamin D.

The correct answer is D.