



Atypical lumbar pedicle fractures. A case report and comparative review of the literature: Bisphosphonate-related? Possible matching with diagnostic criteria of atypical fractures of the femur

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ARTICLE INFO

Handling Editor: Prof F Kandziora

Keywords:

Lumbar fracture
Atypical
Bisphosphonate
Percutaneous fixation

ABSTRACT

Introduction: Bisphosphonates are commonly used to prevent osteoporotic fractures. Many randomized controlled trials have proved the efficacy of bisphosphonates, showing their ability to increase bone mineral density and decrease the risk of hip and vertebral fractures. Atypical, bisphosphonate-related fractures concerning the femur have been widely described and a list of primary and secondary clinical and radiographic criteria are used in order to achieve diagnosis.

Research question: To identify clinical and radiographic findings for a possible association of vertebral fractures to prolonged bisphosphonate therapy.

Material and methods: In this paper we present a case of an atraumatic bilateral pedicle lumbar fracture, assuming the hypothesis of an insufficiency atypical fracture due to prolonged Alendronate therapy for osteoporosis. We highlight the various aspects for diagnosis, treatment and a review of the existing literature was carried out.

Discussion and conclusion: Atypical fractures in the spine are rarely reported in the literature. Pedicle anatomy is partially similar to a long bone, described as a strong bridge between the posterior arch and the vertebral body composed of a cortical bone and a cancellous core. Stress fractures are reported as a result of an underlying bone disease, trauma, post-surgery and stress fractures. In our opinion, the criteria described for atypical femoral fractures are a useful tool to also classify these rare pedicle lesions as insufficiency, bisphosphonate-correlated fractures.

1. Introduction

Bisphosphonates are commonly used to prevent osteoporotic fractures. The mechanism consists in inhibition of the osteoclast-mediated resorption and remodelling of bone. Many randomized controlled trials have proved the efficacy of bisphosphonates, showing their ability to increase bone mineral density and decrease the risk of hip and vertebral fractures (Eastell et al., 2019). Despite these benefits, both skeletal and extra-skeletal complications are described (Reyes et al., 2015): among those that are related to the skeleton, osteonecrosis of the jaw and atraumatic femoral fractures have been reported in patients taking bisphosphonates for a prolonged time (Reyes et al., 2015). Atypical, bisphosphonate-related fractures of the femur have been widely described (Donnelly et al.) and a list of primary and secondary clinical

and radiographic criteria are used to achieve a specific diagnosis (Epidemiology and Etiology, 2012). The recommended treatment of these atypical fractures is surgical, and the choice of the surgical technique depends on location and fracture pattern.

On the other hand, atypical spinal fractures have been scarcely reported. Although the vertebral body presents different characteristics in comparison to long bones, the pedicle's anatomy may be compared to that of a long bone, described as a strong bridge between the posterior arch and the vertebral body composed of a cortical bone and a cancellous core (Edwards et al., 2013). Stress fractures are due to an underlying bone disease, trauma, or surgery. To date, only three cases of atraumatic bilateral pedicle insufficiency fracture in osteoporotic patients with prolonged bisphosphonate medications have been reported as a diagnostic hypothesis (Maillot and Wolfram-Gabel, 1993). The aim

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<https://doi.org/10.1016/j.bas.2024.102786>

Received 6 January 2024; Received in revised form 29 February 2024; Accepted 11 March 2024

Available online 16 March 2024

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of this paper is to describe a case of atypical, bilateral isthmic fracture of the lumbar spine with its outcome, on the background of an accurate literature review on the subject.

2. Case report

A 71-year-old woman presented to the outpatient department of tertiary referral spinal centre complaining of increasing non-mechanical low back pain. Symptoms had been lasting for four months and had worsened in the last two. Physical examination showed disabling pain at rest aggravated by active movement of the trunk in all directions. There were no associated neurological abnormalities. The patient's unique comorbidity was osteoporosis with a lumbar spine DXA (bone density measurement) T-score of -2.9 with an history of treatment with 70 mg oral Alendronic acid weekly, for the last five years.

On X-Rays, no evidence of bony lesions was reported (Fig. 1 a, b). As a second level investigation, MRI STIR (short tau inversion recovery) sequences gave evidence of bilateral pedicle fractures at L3 (Fig. 2). For higher accuracy, a CT-scan was performed confirming the MRI diagnosis and evidenced totally corticalised pedicles of the L3 vertebra (Fig. 3). Due to the above radiological features and the history of prolonged medication with bisphosphonates, the hypothesis of an atypical drug induced fracture was raised. The patient was supported with a lumbar back brace for the next months. At the fourth month of follow-up, no improvement in reported lumbar pain was found (visual analogue scale – VAS 8\10) and a follow up MRI-scan showed no evidence of healing, with STIR sequences unchanged. Therefore, the patient was offered and accepted surgical intervention, which took place in the form of a short segment, L3 to L4 pedicle screw fixation. The operation was carried out under general anaesthesia and a 2gr second-generation Cephalosporin was administered for prophylaxis. Lumbar instrumentation was performed via a minimally invasive percutaneous technique. 7mm diameter, titanium cannulated L4 pedicle screws were placed within the “core” of the pedicles in a standard manner. At the L3 fracture level, because of the corticalised bone and to avoid crossing the fracture site, an out-in technique was used for 7mm titanium cannulated screw placement. Considering the known bone fragility, screws were augmented at the L3 level with cement. A standard post-operative plain radiograph (Fig. 4 a, b) was performed to confirm both position of



Fig. 2. MRN (STIR sequence) with evidence of bilateral pedicle fractures at L3 with intact vertebral body.

implants and cement distribution.

The patient started ambulation on the day after surgery and two weeks later reported a significant improvement in her low back pain intensity (visual analogue scale - VAS of 2 out of 10). At four weeks, the VAS scale was 1 out of 10 with a full return to daily-life activities. At 6 months follow-up, the Patient underwent a control CT that showed features of bone healing of the fractured pedicles (Fig. 5 a, b, c).

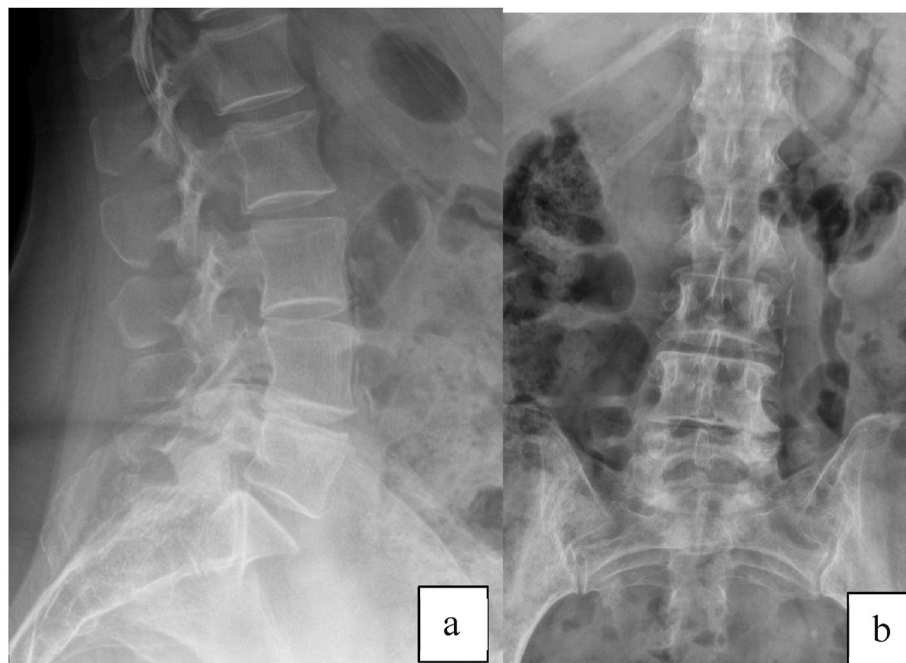


Fig. 1. Preoperative X-rays.

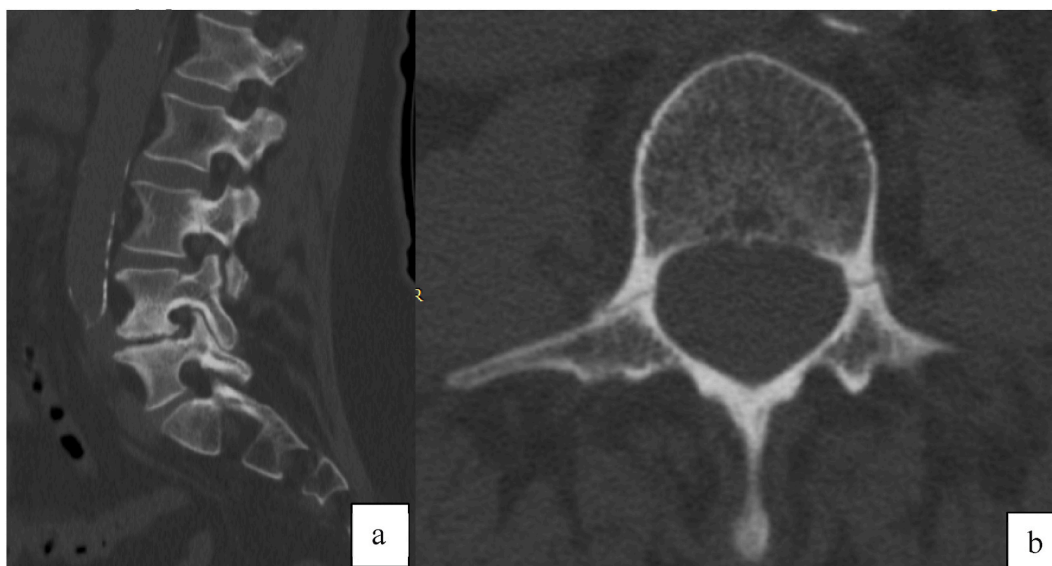


Fig. 3. a, b: CT scan with fracture line on both L3 pedicles. Pedicles are characterised as narrow and “corticalised”. These radiographic features are resumed in [Table 1](#).

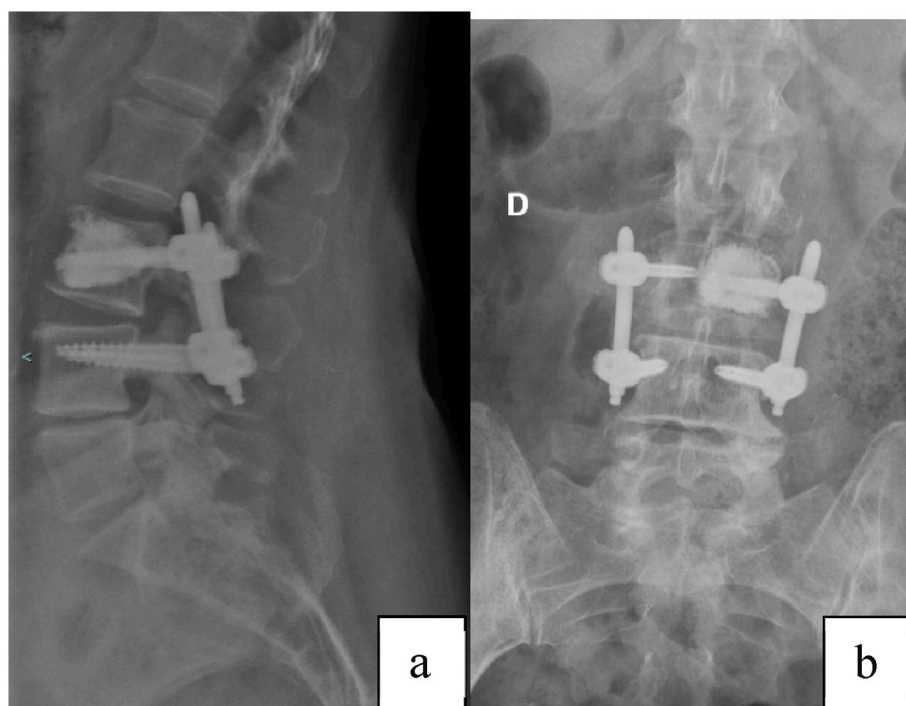


Fig. 4. a, b: Post-operative X-rays.

3. Discussion

We herewith report the case of a non-traumatic, bilateral L3 pedicle fracture, assuming the hypothesis of an insufficiency atypical fracture due to prolonged bisphosphonate (Alendronate) therapy for osteoporosis.

A review of the existing literature was carried out to shed light on this nosological entity. A systematic review of the FDA (Food and Drug Administration) adverse event reporting system (FAERS) and international safety efforts between 2006 and 2011 underlines the correlation of prolonged bisphosphonate medication to the so called “atypical fractures” of the femur and a delayed healing for femoral fractures in

patients assuming these medicines. Among this class of medicines, alendronate users seem to be more likely implicated by these side effects due to a severely suppressed bone turnover ([Epidemiology and Etiology, 2012](#)). However, atypical fractures of the spine have not been included among this class of adverse effects. On the other side, bilateral pedicle fractures have been described in case reports, resulting from a mechanical load that exceeds the biological capacity of the bone. As a consequence, such a fracture could be classified as a fatigue or an insufficiency lesion. Following this reasoning, a fatigue atraumatic fracture can occur after a repeated stress more frequently in cases of post-operative instrumented spine procedures ([Surur et al., 2018a; Hajjioui et al., 2011; Pedro Jorge and Carvalho, 2019; Karabay et al.,](#)

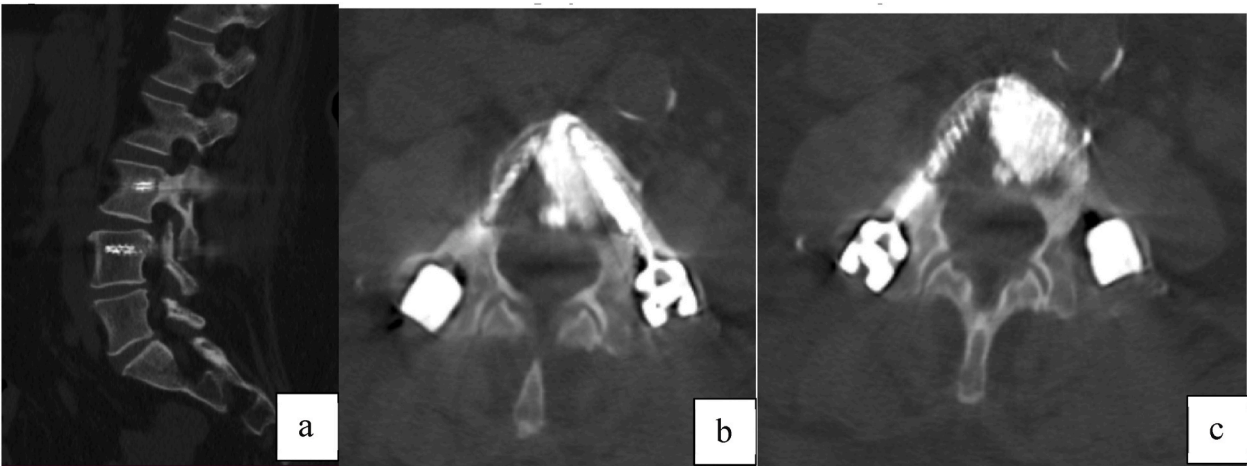


Fig. 5. a, b, c: CT scan at 6 months from surgery. Callus formation on the pedicles is evident.

2015a; Lattig et al., 2010) or spontaneously in athletes (Sadiq, 2006; Parvataneni et al., 2004). On the other hand, an underlying bone disease classifies these rare cases as insufficiency fractures. Metabolic changes underline these atraumatic events. In this pattern, pedicle fractures have been correlated to osteoporosis (Amari et al., 2009), ankylosing spondylitis (Tabrizi and Bouchard, 2001) and in patients under prolonged bisphosphonate therapy for osteoporosis (Kim et al., 2010; El Rachkidi et al., 2011; Karabay et al., 2015b).

El Rachkidi et al. first advanced the hypothesis of a bilateral L5 pedicle fracture correlated to a long term Risedronate therapy (Kim et al., 2010). They concluded that long-term riseridronate therapy was the only remaining suspect after a detailed medical history investigation of the patient. Previously, other cases of pedicle fractures in patients under medication for osteoporosis have been reported but with associated vertebral body compression fractures (Surur et al., 2018b; Smith et al., 2006). Nuri Karabay et al. reported a case of a bilateral multilevel pedicle involvement (L1 to L4) in a patient with bisphosphonate therapy (El Rachkidi et al., 2011). However, in this case the patient presented with a previous history of Grade 1 compression fractures that could have influenced mechanical load on the posterior vertebral elements. Surur et al. presented a case of an atraumatic bilateral pedicle lumbar fracture in a patient suffering from osteoporosis that had been taking bisphosphonate drugs. In this case no other comorbidities were mentioned and the patient was treated conservatively. Most recently, Karasawa et al. (2023) also reported a bilateral pedicle vertebral fracture in a patient under bisphosphonate therapy, suggesting the use of criteria for atypical femoral fractures. In our patient, medical history didn't reveal any comorbidities, previous vertebral fractures or metabolic disorders except osteoporosis. Based on clinical presentation, type of lesion and specific radiological findings, we assumed the hypothesis of an atypical insufficiency bilateral pedicle L3 fracture.

In the patient herewith reported, medical history did not highlight any comorbidities, previous vertebral fractures, or me tabolic disorders except osteoporosis. Based on the clinical presentation, type of lesion and specific radiological findings, we assumed the hypothesis of an atypical insufficiency bilateral pedicle L3 fracture. Driven by our experience with bisphosphonate induced atypical femoral fractures we assumed major and minor criteria as widely described (Larsen and Schmal, 2018) to apply to our patient to validate the diagnostic hypothesis (Table 1). In this effort, most of these criteria were found matching with our diagnosis for an atypical vertebral fracture.

Despite the adverse effects mentioned, bisphosphonates remain an effective prophylaxis for patients suffering from osteoporosis and at increased risk of fragility fractures of both the axial and appendicular skeleton. The occurrence of an atypical vertebral fracture involving the pedicles in patients with prolonged therapy must be taken under

Table 1
Atypical pedicular fractures: possible matching with diagnostic criteria of atypical fractures of the femur.

Major criteria ^a	Atypical pedicular fracture ^b
Absence of Trauma or minimal Trauma	Applicable: atraumatic
Femoral fracture in any diaphyseal part	Not applicable
Transverse or short oblique fracture	Applicable: transverse and short oblique pedicle
Non-comminuted fracture	Applicable: both pedicles non comminuted
Complete fractures extend through both cortices, incomplete only the lateral cortex	Applicable: complete fracture of both cortices
Minor criteria ^a	Atypical pedicular fracture ^b
Localized periosteal reaction	Applicable: present in the medial pedicle cortex
Increase in the thickness of the cortex	Applicable: present for both pedicles
Prodromal symptoms	Applicable: pain for a 4-month period
Bilateral fractures	Applicable: bilateral pedicle fracture
Delayed healing	Applicable: delayed union underwent to surgery

^a Criteria applied to identify atypical fractures.
^b L3 bilateral pedicle fracture in our case report.

consideration (Donnelly et al.; Epidemiology and Etiology, 2012). Understanding the mechanisms through which bisphosphonates can lead to skeletal and extra-skeletal side effects could help in their prevention. In our opinion, the criteria described for atypical femoral fractures are a useful tool to also classify these rare pedicle lesions as insufficiency, bisphosphonate-correlated fractures. For this purpose, multicentre case studies would be useful to test the reliability of the criteria we proposed in order to aid with diagnosis and to clarify the pathogenesis of these fractures.

4. Structured review

A review of the existing literature was carried out to shed light on this nosological entity. A systematic review of the FDA (Food and Drug Administration) adverse event reporting system (FAERS) and international safety efforts between 2006 and 2011 underlines the correlation of prolonged bisphosphonate medication to the so called “atypical fractures” of the femur and a delayed healing for femoral fractures in patients assuming these medicines. Among this class of medicines, alendronate users seem to be more likely implicated by these side effects

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Conflict of interest

On behalf of all authors, the corresponding author (Emmanouil Theodorakis) declares absence of any conflict of interest regarding this manuscript.

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