Eur Spine J (2018) 27 (Suppl 3):S264–S269
https://doi.org/10.1007/s00586-017-5117-4

CASE REPORT

Delayed chance fracture pattern injury in a case of skeletal fluorosis

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Received: 2 January 2017 / Revised: 10 April 2017 / Accepted: 30 April 2017 / Published online: 8 May 2017

Abstract
Purpose To document a rare complication of a delayed 'chance fracture pattern'-type injury through the proximal end of a pedicle screw construct in the clinical scenario of skeletal fluorosis.
Methods A 72-year-old man with fluorosis presented following a fall which resulted in a T12–L1 fracture. Investigations revealed an unstable three-column injury, so the patient was treated with surgical stabilisation using pedicle screw fixation from T11 to L2. He presented 1 month following surgery with worsening back pain. Investigations revealed a fracture through T11 in a 'chance fracture pattern' along the pedicle screw tracts at the proximal end of the construct. An extension of fixation was performed proximally to T8 and he made an uneventful recovery showing fusion at 20-month follow-up.
Results Complication of delayed pedicle fractures, in a 'chance fracture pattern' at the ends of a pedicle screw fixation constructs are a rarely reported in the literature. The occurrence of such a complication in a hyperostotic spine associated with fluorosis makes this a unique clinical scenario which is previously unreported to the best of our knowledge.
Conclusions This report highlights a very rare complication of chance fracture pattern injury in the clinical scenario of fluorosis. A hyperostotic stiff spine, poor quality of bone and extension of pedicle screw tracts to anterior cortex during primary surgery may have resulted in the occurrence of this rare complication.

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Keywords Skeletal fluorosis · Hyperostosis · Chance fracture · Pedicle screw fixation · Complication

Introduction

Pedicle fractures are seen often as an intra-operative complication or as a delayed stress fracture following pedicle screw instrumentation and posterolateral fusion procedures [1]. Chance fracture occurring through the upper or lower instrumented spine is very rare and has been reported in patients with cerebral palsy and osteoporotic spine. We present a unique case of a chance fracture pattern injury occurring through the upper instrumented vertebra following pedicle screw fixation in a case of skeletal fluorosis.

Case report

A 72-year-old gentleman presented to our emergency department following an accidental fall at home with severe back pain and difficulty in ambulation. Patient was a known case of fluorosis which was diagnosed following an intertrochanteric fracture 2 years prior to current presentation. Patient had severe tenderness over the thoracolumbar junction with intact neurology. Radiographs revealed a hyperostotic stiff spine, diffuse ligament calcification and break in continuity in anterior syndesmophytes (Fig. 1).

Computed tomography (CT) showed an undisplaced carrot stick-type fracture at T12–L1 extending along the disc end plate junction (Fig. 2). Surgical stabilisation was planned in view of three-column injury and fused spinal segments above and below the fracture level. Posterior instrumented stabilisation and fusion from T11 to L2 was

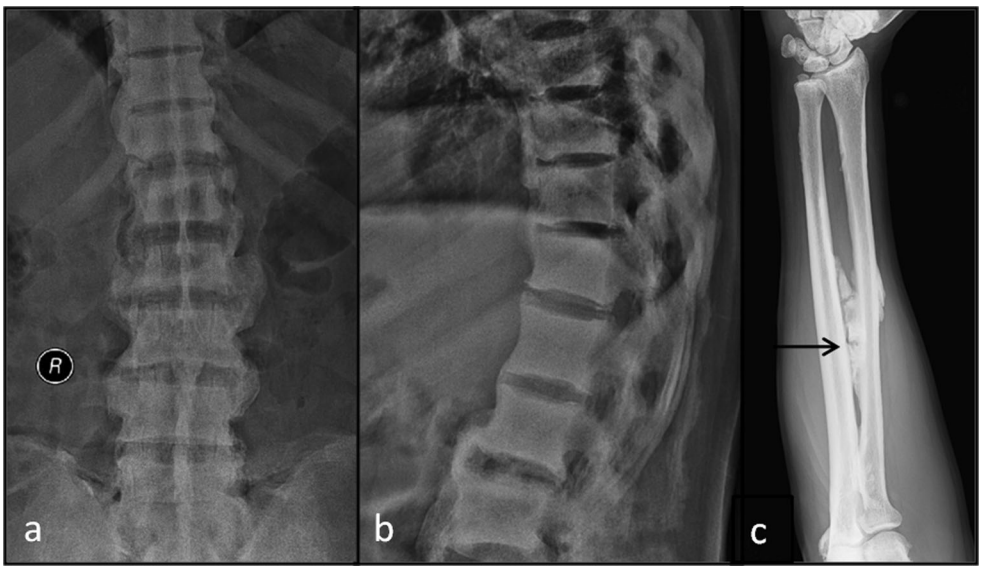

Fig. 1 Pre-operative radiograph of thoracolumbar spine **a**, **b** showing a break in the anterior syndesmophyte at T12–L1 and **c** forearm with interosseous calcification marked by a *black arrow*

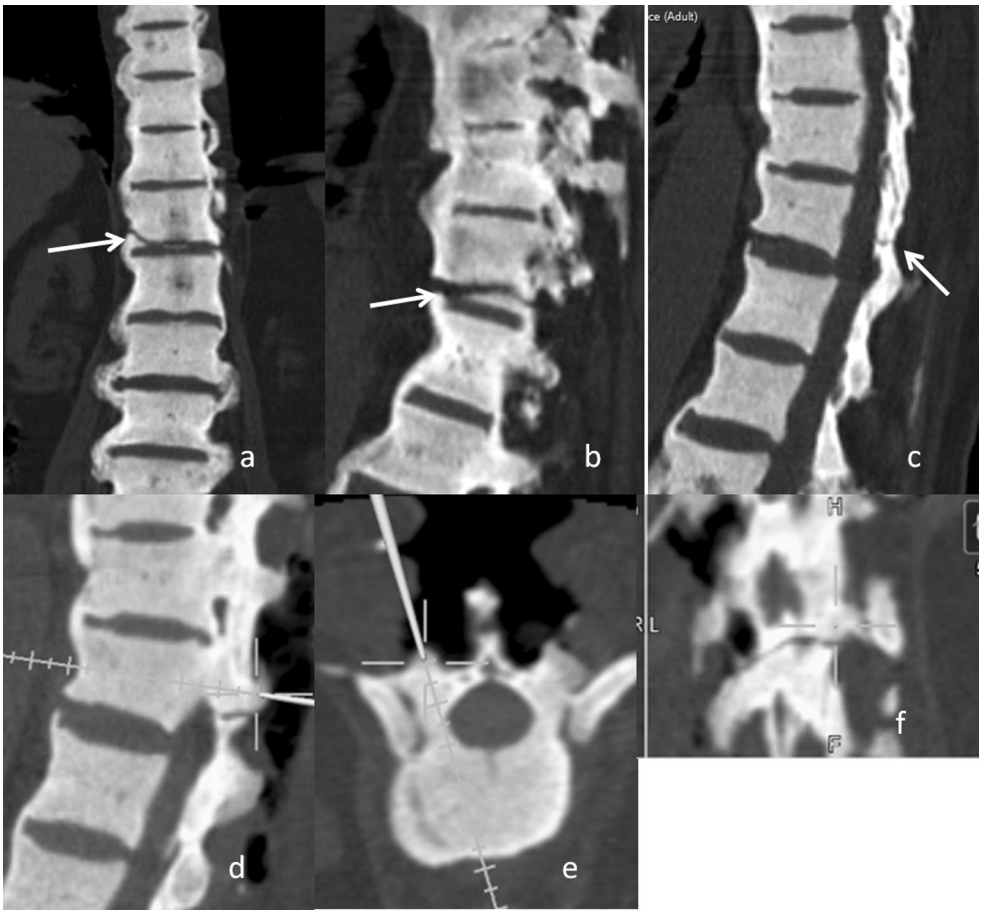

Fig. 2 Preoperative CT scan **a–c** showing fracture line passing through all three columns marked by *arrow* and **d–f** intra-operative CT navigation images showing fracture line and pedicle tract preparation

done with pedicle screw fixation under intra-operative CT navigation (Fig. 2).

As bone was hard and sclerotic, pedicle screw tracts were prepared in the following manner. The pedicle screw insertion and tract were appropriately visualised with the reference tool with the help of CT navigation (Fig. 2). The entry point for pedicle screw was prepared with a high-speed cutting burr. The screw tract was then prepared with a power drill using a 3.2-mm drill-bit. The screw tract was frequently probed and trajectory was confirmed with the reference tool intermittently to ensure accurate screw placement. Once the screw tract was prepared it was further tapped with a 5.5-mm hand-held tap. After tapping the pedicle, 6.5 mm size titanium screws of length 45 mm were inserted at T12-L2 and 40 mm screws were inserted at T11 in both pedicles.

The intra-operative course was uneventful and the patient made excellent post-operative recovery. The implant position was satisfactory in the immediate post-operative radiograph with no evidence of a fracture line at the proximal instrumented vertebra at T11 (Fig. 3a, b). The patient was mobilised with independent ambulation on day 2 after surgery and was discharged after a period of 6 days.

One month following the surgery the patient reported with progressive pain over the operative site limiting his activities. The surgical wound had healed well with no local signs of inflammation and normal neurology. The radiograph showed a faint fracture line extending along the pedicle screw tract up to the anterior cortex and was well appreciated in the anterior–posterior projection of the plain radiograph at T11 (Fig. 3c, d). A CT scan confirmed a fracture extending along the upper instrumented level along the pedicle screw tract of T11 in the configuration of a chance fracture (Fig. 4). The fracture line was clearly seen extending through all columns. Though no translation was noted, the presence of the fracture line involving the anterior, middle and posterior column prompted an extension of stabilisation up to T8 (Fig. 5).

The patient had good pain relief and made an excellent recovery. At 20-month follow-up, the fracture had healed well with good functional outcome (Fig. 5).

Discussion

Pedicle screw instrumentation has been associated with complications like malpositioning of the screw, neurological injury, screw loosening and back out, loss of curve correction, intra-operative pedicle fracture and pseudoarthrosis [1]. Robertson and Macdessi reported stress fractures of the proximal pedicles following instrumented posterolateral fusion of L4–S1 [2, 3]. The cause of such fractures has been postulated to be the cantilever motion at the junction of the posterolateral fusion mass and persisting movement anteriorly at the disc level. As the moment arm of the pedicle is shorter than the pars, they are less frequently involved than the more common spondylolysis aquisita [2, 3]. These pedicle fractures occur at the junction of the pedicle with the body and not along the long axis of the pedicle [2, 3].

Chance fracture occurring through proximal or distal end of instrumented segment in spine is a rare complication. Coscia [4] first reported occurrence of chance fracture in a 15-year-old girl who suffered a T12–L1 fracture dislocation with paraplegia, which was treated with a T11–L3 posterior instrumented fusion. Patient presented 10 weeks

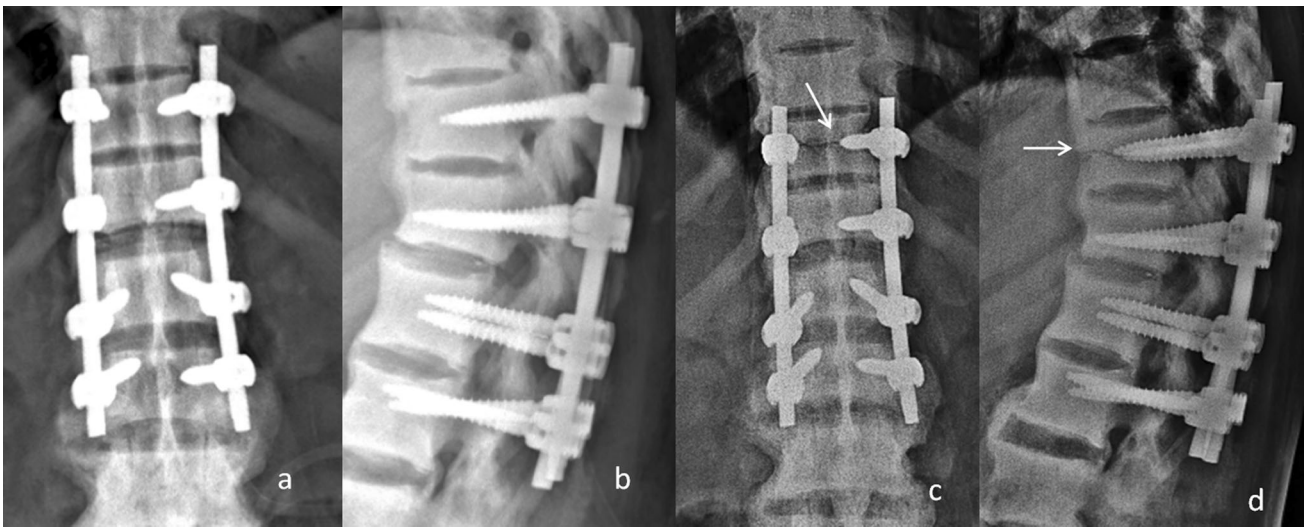

Fig. 3 Post-operative radiograph after first surgery. **a**, **b** Immediate post-operative radiograph showing satisfactory screw positions with no clear evidence of a fracture line in T11. **c**, **d** Radiograph at 1 month showing a faint fracture line at level of upper pedicle screw marked by *white arrow*

Fig. 4 Post-operative CT scan performed at 4 weeks clearly shows **a**, **b** the fracture line extending along the screw tracts up to the anterior vertebral cortex marked by a *white arrow* at the upper instrumented level, **c**, **d** para-sagittal sections showing a fracture line in the lamina and pars region, **e** mid-sagittal section showing fracture line involving the middle column and a extension along the length of the spinous process

later with L3 chance fracture which was augmented by laminar hooks [4]. Levine et al. described chance fracture occurring through the distal end of construct at L4 following T1–L4 fixation and L1 decancellation osteotomy for a deformity correction procedure in a case of cerebral palsy [5]. This complication was treated by the authors with an extension of fusion to the pelvis. They postulated rigid spinal implants, rigid spinal deformity, non-ambulatory weight-bearing status, decreased bone mineral density and trauma to be the contributing factors [5]. Hu et al. reported a complication of proximal vertebral body chance fracture after pedicle screw instrumentation and fusion in an osteoporotic kyphosis patient which required proximal extension of fixation [6]. They attributed the occurrence of fracture to rigid kyphotic spinal deformity, ending the construct in a junctional area and cortical pedicle breech during instrumentation [6]. We present a different scenario with similar type of chance fracture pattern occurring through the proximal instrumented vertebra in a stiff spine due to skeletal fluorosis.

By definition a chance fracture is not an iatrogenic injury and this fracture includes injury to the posterior osteoligamentous structures such as lamina, spinous process and posterior ligamentous complex. The fracture pattern seen in this case may not be considered as a true chance fracture but the pattern of the fracture in the vertebral body and pedicle resembles the chance fracture pattern of injury.

Hyperostotic lesions such as ankylosing spondylitis and fluorosis can predispose to development of a stiff spine, which may be prone to fractures. Though the radiological appearance in fluorosis is hyperostotic the quality of the bone is poor due to incorporation of fluoride into the hydroxyapatite making the bone prone to fractures. Skeletal fluorosis is often associated with osteomalacia further compromising the quality of bone [7–10].

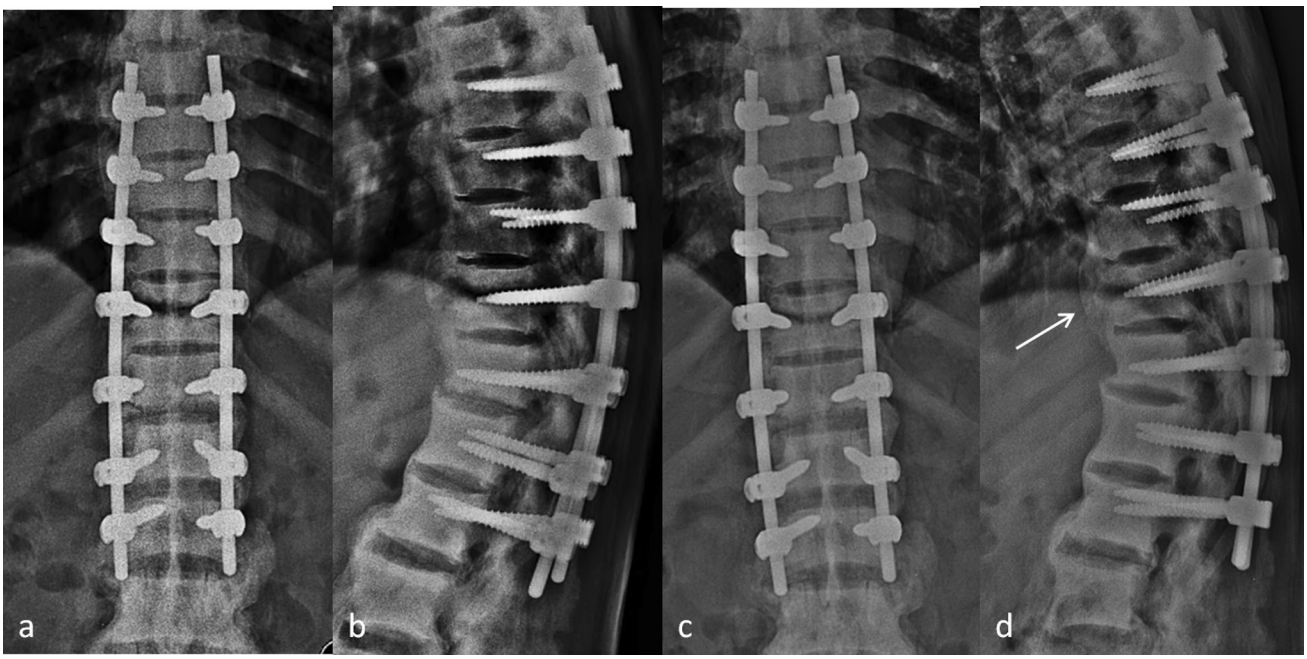

Fig. 5 Postoperative radiograph after revision surgery. **a**, **b** Immediate post-operative radiograph after extension of fixation. **c**, **d** Final follow-up radiograph showing fracture union (*arrow*)

Lattig et al. reported three cases of pedicle fractures occurring through the lower instrumented fusion without extension into the vertebral body and these pedicle fractures occur at the junction of the pedicle with the body. They proposed technique for osteosynthesis using cerclage-wire fixation for a fractured instrumented pedicle as a means of restoring stability without need to extend the fusion to the adjacent level [11]. But fracture of the pedicle with extension into the vertebral body can compromise the stability of the instrumentation, and extension of the fusion is the conventional and easiest way to address this problem and the same has been done in our case.

In our case we postulate that multiple factors played a possible role in the causation of this pedicle fracture which includes poor quality of bone and surgical technical factors. Factors compromising bone quality in this case include age and fluorosis. Surgical technical factors include parallel tracts with breach of anterior vertebral wall and hubbing of the pedicle screws. Hubbing might have initiated the pedicle fracture which was further propagated by parallel tracts into the anterior vertebral wall and through all columns resulting in the "chance"-type fracture pattern [6, 12]. The clinical scenario of fluorosis gives rise to dense, osteosclerotic bone; however, it remains brittle. The screw tracts prepared with the power drill leads to a stress riser zone in the instrument construct. In this scenario, undertapping the pedicle tract could have led to possible extension of the fracture line through the pedicle screw tract. Cyclical loading in the post-operative period could have propagated the fracture line resulting in symptoms of instability, back pain with radiological evidence of the fracture line on the 4-week follow-up radiograph. There was no evidence to suggest that the fracture line was present in the immediate post-operative period. However, the screw tracts prepared in such fluorosis-associated bone are likely to progress to overt fractures and bony discontinuity which is highlighted in this case report.

Multiple fixation points, avoidance of parallel pedicle screw tracts, maintaining the anterior cortex and adequate sequential tapping prior to final screw placement could have avoided such a complication. Contouring the rod to the deformity correction achieved by positioning of patient could have decreased translational stress at the bone–implant interface and could have possibly prevented this complication.

This report highlights the fact that a high index of suspicion must be maintained when evaluating a stiff spine presenting with post-operative pain. Use of CT scan is essential in the evaluation of such a stiff spine to detect any fractures. Early recognition and intervention in fractures associated with fluorosis or stiff spines is advisable as this prevents displacement of the fracture segments and any resulting neurological complications.

Conclusion

This report highlights a very rare complication of 'chance fracture pattern' in the unique clinical scenario of fluorosis. A hyperostotic stiff spine, poor quality of bone and

extension of pedicle screw tracts to anterior cortex during primary surgery may have resulted in the occurrence of this rare complication.

Compliance with ethical standards

Funding The project was funded by Ganga Orthopaedic Research & Education Foundation, Coimbatore.

Conflict of interest The authors declare that they have no conflict of interest.

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