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CASE REPORT

# A bony Chance fracture through L1 following posterior spinal fusion for adolescent idiopathic scoliosis: a case report

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## Abstract

**Study design** Case report.

**Introduction** Instrumented posterior fusion using pedicle screws has been the mainstay of the surgical correction of adolescent idiopathic scoliosis since it was popularised by Roy-Camille in the 1970s. The aim of this case report is to describe the occurrence and salvage of an L1 chance fracture occurring through the lower instrumented vertebra following pedicle screw placement for posterior spinal instrumented fusion in the treatment of adolescent idiopathic scoliosis (AIS).

**Case report** A 15-year-old female patient underwent T2–L1 posterior instrumented fusion for a Lenke 1b deformity. The selection of fusion levels was made based upon standing and bending radiographs which showed a non-structural lumbar curve. Early recovery was uneventful. At 6 months post-operatively, the patient reported new deformity and pain. A chance fracture at L1 was diagnosed and subsequent extension of instrumentation to L3 was carried out. Final post-operative recovery was uneventful and the patient returned to an active lifestyle.

**Conclusion** Several factors can contribute to the occurrence of a fracture through an instrumented pedicle. This case shows that there must be due consideration of the small pedicle at L1 when it is chosen as the LIV.

**Keywords** Scoliosis · Deformity · Correction · Adolescent idiopathic scoliosis

## Introduction

Instrumented posterior spinal fusion with pedicle screws is the most commonly employed surgical treatment for adolescent idiopathic scoliosis (AIS) [1–7]. In Lenke type 1 or 2 curves, L1 is commonly the lowest instrumented vertebra (LIV); however, the L1 vertebra has small pedicles which challenges its safe instrumentation [8–13]. Fractures following pedicle screw placement have been described in up to 14% of cases [14–16]. If the distal anchor point of a construct is compromised, the consequences can necessitate revision surgery. Here we present the case of a patient treated with posterior spinal fusion for AIS who sustained a Chance fracture at L1 following T2–L1 posterior instrumented fusion for AIS.

## Case report

A 17-year-old female patient presented with a 56° Lenke 1b deformity complaining of back pain and a feeling of leaning to the right (Fig. 1a–d). Examination showed an elevated right shoulder, right trunk shift and normal neurology. A diagnosis of AIS and a recommendation for posterior spinal fusion of T2–L1 was made based upon bending radiographs. No pre-operative CT scan was carried out. The patient was advised of the risks of construct failure and the potential for revision surgery.

Legacy titanium (Medtronic Minneapolis, MN) instrumentation was used with fixed angle screws placed at T3–L1, and polyaxial screws placed at T2. The L1 pedicle measured 5 mm by 12 mm in the coronal plane on plain radiographs and was instrumented with a 5.0 mm by 35 mm pedicle screw. The location of each screw was confirmed with

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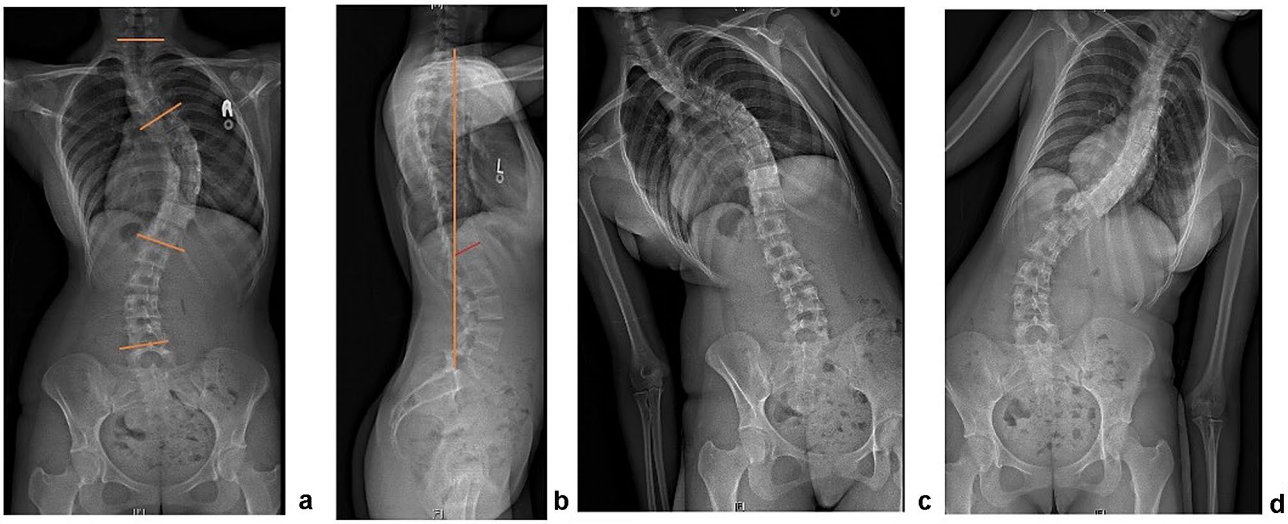

**Fig. 1** **a** Anteroposterior and **b** lateral pre-operative standing radiographs showing a proximal thoracic curve of 29.4°, main thoracic of 56.3° and thoracolumbar curve of 32.1° with normal sagittal balance. The pelvic incidence is 48° with an inflection point at T12/L1 (indicated by the red line). **c** the Left bending radiograph showing a proximal thoracic curve of 47.2°, main thoracic curve of 59.6° and thoracolumbar curve of 10.6°. **d** the right bending radiograph showing proximal thoracic curve of 34.4°, main thoracic curve of 48.1° and thoracolumbar curve of 63.5°

electromyography. Periapical osteotomy was not deemed necessary. A 5.5-mm cobalt-chrome rod was secured to the proximal and distal anchors and the apical screws were then reduced with a translational manoeuvre. There were no intra-operative concerns with pedicle screw position or size, and no fracture or perforation of the pedicle was noted.

Post-operative radiographs showed a residual main thoracic coronal curve of 20° and satisfactory sagittal alignment (Fig. 2a, b). The rod contour was considered to be optimal in restoring the patient's sagittal contour and inflexion point based upon their pelvic incidence of 48°. There were no immediate or early complications.

At 6 months post-operatively, the patient complained of pain in the lower back and an associated bump. Radiographs showed new lumbar kyphosis between T12 and L2 consistent with a Chance fracture at L1 (Fig. 2c, d). The patient recalled no trauma or antecedent symptoms.

The patient underwent extension of fusion to L3 and made an uneventful recovery (Fig. 2e, f). At 5-year follow-up, the patient is well and participating in unrestricted sports.

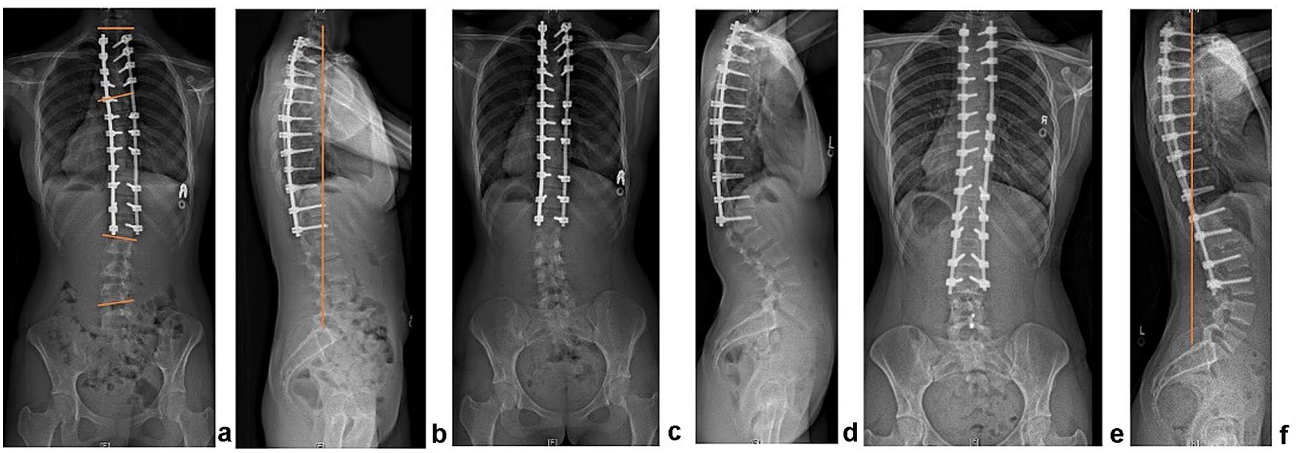

**Fig. 2** **a** Anteroposterior and **b** lateral post-operative standing radiographs showing a residual proximal thoracic curve of 8.0°, main thoracic of 19.6° and thoracolumbar curve of 9.8° with normal sagittal balance. **c** Anteroposterior and **d** lateral standing radiographs showing acute kyphosis at L1 indicating a Chance fracture (**e**) anteroposterior and (**f**) lateral post-operative standing radiographs showing the extension of fusion to L3 with a C7-sagittal vertical distance of 14 mm

## Discussion

This case highlights the importance of understanding the variable anatomy of the pedicle when instrumenting the spine, and a potential consequence of anchor failure [15]. In this case, we have observed that the size of the pedicle screw relative to the pedicle may have led to an unnoticed intraoperative fracture or later fatigue of the pedicle leading to failure of the construct.

Previous case reports describing fracture through pedicles following instrumentation have focussed on adults, with the exception of Kato and Lewis who described a Chance fracture through L4 in the paediatric population [17]. Both Lattig and Levine describe fractures through the LIV following deformity correction, each with mitigating comorbidities [18, 19]. Despite its small dimensions, the selection of L1 as the LIV in Lenke 1b curves is supported by long-term follow-up from Lonstein, and Takashi et al. explained that the selection of L1 as the LIV is acceptable when this is either the end or stable vertebra as in this case [20, 21]. Lowe et al. showed that ending the construct at the end vertebra or failing to restore normal sagittal contour at the thoracolumbar junction contributed to distal junctional failure; however, we do not believe that either was the case here [22].

In our experience of similar curves, the technique of screw insertion has not previously led to fracture, and the principles used in rod contouring have not led to similar failures. It may be that an undetected pedicle perforation or fracture occurred, and as such the patient may have been left vulnerable to a complication that could have been avoided if a narrower screw or alternative anchor was placed. This is supported by the patient not recalling any activity that may have caused the Chance fracture. The evidence does not support the use of further distal anchors in preventing this outcome, and this strategy would have led to an excessively long construct [22]. The use of a cobalt-chrome rod is standard in our practice and we have not observed fractures before. Although stiffer than alternative materials, the cobalt-chrome rods were appropriately contoured and we suggest were unlikely to contribute to the subsequent fracture. Similarly, there has been an increased prevalence of osteopenia in patients with AIS which may have a role in the aetiology of fractures [23, 24]. This patient did not undergo investigation for bone density; however, no abnormal bone consistency was noted intraoperatively and no fracture following revision has been seen.

This report is limited by the absence of 3-dimensional imaging to confirm an intact pedicle post-operatively; however, it does show that instrumentation of the L1 can be associated with fracture in the medium term following deformity correction despite meeting the requirements of sagittal alignment. Careful consideration of the anatomy of the LIV is essential to prevent this unusual outcome.

**Author contributions** BR: acquisition and analysis of data, drafted the manuscript, and approved the manuscript. SK: acquisition of data, critically revised the manuscript, and approved the manuscript. DL: critically revised the manuscript, and approved the manuscript. SL: conceived study, critically revised the manuscript, and approved the manuscript.

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### Compliance with ethical standards

**Conflict of interest** BR: none, SK: none, DL: none, and SL: none.

**Ethical approval (IRB)** No copyrighted material was included in this study. Patient's identity has not been revealed. Being a single-case study, it is exempt from institutional review board approval.

**Informed consent** All identifiable details have been removed from the report. Informed consent is, therefore, not required.

## References

1. Harrington P (1962) Treatment of scoliosis. Correction and internal fixation by spine instrumentation. J Bone Joint Surg Am 44:591–634
2. Kuklo TR, Potter BK, Lenke LG et al (2007) Surgical revision rates of hooks versus hybrid versus screws versus combined anteroposterior spinal fusion for adolescent idiopathic scoliosis. Spine 32:2258–2264
3. Mac-Thiong JM, Remondino R, Joncas J et al (2019) Long-term follow-up after surgical treatment of adolescent idiopathic scoliosis using high-density pedicle screw constructs: Is 5-year routine visit required? Eur Spine J 28:1296–1300
4. Yilmaz G, Borkhuu B, Dhawale AA et al (2012) Comparative analysis of hook, hybrid, and pedicle screw instrumentation in the posterior treatment of adolescent idiopathic scoliosis. J Pediatr Orthop 32:490–499
5. de Kleuver M, Lewis SJ, Germscheid NM et al (2014) Optimal surgical care for adolescent idiopathic scoliosis: an international consensus. Eur Spine J 23:2603–2618
6. Kim YJ, Lenke LG, Kim J et al (2006) Comparative analysis of pedicle screw versus hybrid instrumentation in posterior spinal fusion of adolescent idiopathic scoliosis. Spine 31:291–298
7. Roy-Camille R, Saillant G, Mazel C (1986) Internal fixation of the lumbar spine with pedicle screw plating. Clin Orthop Relat Res 203:7–17
8. Trobisch PD, Ducoffe AR, Lonner BS et al (2013) Choosing fusion levels in adolescent idiopathic scoliosis. J Am Acad Orthop Surg 21:519–528
9. Sanchez-Raya J, Bago J, Pellise F et al (2012) Does the lower instrumented vertebra have an effect on lumbar mobility, subjective perception of trunk flexibility, and quality of life in patients with idiopathic scoliosis treated by spinal fusion? J Spinal Disord Tech 25:437–442

10. Kepler CK, Meredith DS, Green DW et al (2012) Long-term outcomes after posterior spine fusion for adolescent idiopathic scoliosis. Curr Opin Pediatr 24:68–75
11. Lee CS, Hwang CJ, Lee DH et al (2017) Five major controversial issues about fusion level selection in corrective surgery for adolescent idiopathic scoliosis: a narrative review. Spine J 17:1033–1044
12. Fischer CR, Kim Y (2011) Selective fusion for adolescent idiopathic scoliosis: a review of current operative strategy. Eur Spine J 20:1048–1057
13. Lien S-B, Liou N-H, Wu S-S (2007) Analysis of anatomic morphometry of the pedicles and the safe zone for through-pedicle procedures in the thoracic and lumbar spine. Eur Spine J 16:1215–1222
14. Hicks JM, Singla A, Shen FH et al (2010) Complications of pedicle screw fixation in scoliosis surgery: a systematic review. Spine 35:E465–E470
15. Suk SI, Kim WJ, Lee SM et al (2001) Thoracic pedicle screw fixation in spinal deformities: are they really safe? Spine 26:2049–2057
16. Di Silvestre M, Bakaloudis G, Lolli F et al (2008) Posterior fusion only for thoracic adolescent idiopathic scoliosis of more than 80 degrees: pedicle screws versus hybrid instrumentation. Eur Spine J 17:1336–1349
17. Kato S, Lewis SJ (2017) Temporary iliac fixation to salvage an acute L4 Chance fracture: following pedicle screw fixation for adolescent idiopathic scoliosis. Spine 42:E313–E316
18. Lattig F, Fekete TF, Jeszenszky D (2010) Management of fractures of the pedicle after instrumentation with transpedicular screws: a report of three patients. J Bone Jt Surg Br 92:98–102
19. Levine DS, Dugas JR, Tarantino SJ et al (1998) Chance fracture after pedicle screw fixation. A case report. Spine 23:382–385
20. Fujii T, Daimon K, Fujita N et al (2020) Risk factors for postoperative distal adding-on in lenke type 1B and 1C and its influence on residual lumbar curve. J Pediatr Orthop 40:e77–e93
21. Lonstein JE (2018) Selective thoracic fusion for adolescent idiopathic scoliosis: long-term radiographic and functional outcomes. Spine Deform 6:669–675
22. Lowe TG, Lenke LG, Betz R et al (2006) Distal junctional kyphosis of adolescent idiopathic thoracic curves following anterior or posterior instrumented fusion: incidence, risk factors, and prevention. Spine 31:299–302
23. Tanabe H, Aota Y, Nakamura N, Saito T (2017) A histomorphometric study of the cancellous spinal process bone in adolescent idiopathic scoliosis. Eur Spine J 26(6):1600–1609
24. Cheung CS, Lee WT, Tse YK et al (2006) Generalized osteopenia in adolescent idiopathic scoliosis–association with abnormal pubertal growth, bone turnover, and calcium intake? Spine 31(3):330–338

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