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Case Report

Postoperative loss of correction after combined posterior and anterior spinal fusion surgeries in a lumbar burst fracture patient with Class II obesity

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ABSTRACT

Background: When treating thoracolumbar fractures with severe cranial endplate injury but no or slight caudal endplate injury, it is debatable whether anterior fusion should be performed only for the injured cranial level, or for both cranial and caudal levels. We report an unexpected postoperative correction loss after combined multilevel posterior and single-level anterior fusion surgery in a patient with obesity.

Case Description: A 28-year-old male with Class II obesity was brought to the emergency room with an L1 burst fracture with spinal canal involvement. Cranial endplate injury was severe, whereas caudal endplate injury was mild. The first surgery with 1-above 1-below posterior fixation failed to achieve sufficient stability; thus, additional surgeries (3-above 3-below posterior fixation and single-level T12-L1 anterior fusion) were performed. Postoperatively, the local kyphosis angle (LKA) between T12 and L2 was 22° in the lateral lying position and 29° in the standing position. Twenty-one-month post surgery, bony fusion between T12 and L1 was observed, and the LKA was 28° in both the lateral lying and standing positions. After posterior implants were removed 24 months after the surgery, significant correction loss both at the T12-L1 segment (6°) and L1-L2 segment (6°) occurred, and LKA was 40° at the final follow-up.

Conclusion: In this patient, an intense axial load due to excessive body weight was at least one of the causes of postoperative correction loss. Postural differences in LKA may be useful to evaluate the stability of thoracolumbar fractures after fusion surgery and to predict postoperative correction loss.

Keywords: Anterior fusion, Correction loss, Kyphosis, Obesity, Thoracolumbar fracture

INTRODUCTION

Thoracolumbar fractures and dislocations, particularly those with spinal cord or cauda equina injuries, are often treated with spinal decompression and fusion surgery. Recently, the safety and efficacy of posterior short-segment instrumentation for the treatment of thoracolumbar fractures have been reported; thus, posterior pedicle screw fixation is recommended by many

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surgeons.[20,22,29] However, when the anterior part of the thoracolumbar spine (vertebral body and intervertebral disc) is severely damaged, anterior fusion or combined anterior and posterior decompression and fusion are generally recommended.[1,11,23,25,27] Clinically, we often experience thoracolumbar fracture in patients with severe cranial endplate injury but no or slight injury at the caudal endplate and adjacent intervertebral disc.

When treating such patients with spinal fusion surgery, it is debatable whether anterior fusion should be performed only for the injured cranial level (single-level) or for cranial and caudal levels (two levels).[10,12,17,24,28] Surgeons should make an effort to reduce surgical risks; thus, the number of fusion levels should be carefully considered before surgery. On the other hand, sufficient stability with an adequate number of fixation levels is important to avoid postoperative loss of segmental kyphosis correction.

The increase of patients with obesity, which is associated with adverse health consequences throughout the life course, is a common problem in countries worldwide.[14] The body mass index (BMI) is generally used to classify patients into overweight (BMI ≥ 25.0 kg/m^2) and obesity (≥30.0 kg/m^2). Furthermore, the World Health Organization (Geneva) defines three subclasses of obesity severity (Class I: BMI 30.0–34.9 kg/m^2, Class II: 35.0–39.9 kg/m^2, and Class III: ≥40.0 kg/m^2).[26]

Previously, it was reported that obesity is a risk factor for correction loss after spinal fusion surgery for thoracolumbar fractures.[7] In this case report, we present a case of lumbar (L1) burst fracture in a patient with Class II obesity who was treated with combined multi-level posterior and single-level anterior fusion surgery but failed to maintain favorable local thoracolumbar sagittal alignment.

CASE REPORT

History, examination, and first surgery

A 28-year-old man who worked as a steeplejack was brought to the emergency room with a lumbar burst fracture at the L1 level caused by a fall from a 6-m height. He had no comorbidities except Class II obesity (height, 178 cm; weight, 117 kg; and BMI, 36.9 kg/m^2). On arrival, the patient was alert and oriented, but complained of severe back pain, bilateral lower-extremity pain, and numbness. Although accurate neurological evaluation was difficult because of severe back and lower extremity pain, the weakness of the bilateral lower extremities (Medical Research Council grade 3–4) and no sensory decline by the pin-prick test was observed.

Initial radiographic examination including computed tomography (CT) scan and magnetic resonance imaging showed burst fracture at the L1 level with spinal cord and cauda equina compression, which was classified as AO type B2 with spinous process fracture at L1 and L2 [Figure 1]. In this patient, cranial endplate injury was severe; however, caudal endplate injury was mild [Figure 1]. In addition, left pubic fracture, left 12th rib fracture, and left transverse process fractures at the L1, L2, and L3 levels were observed.

The patient was temporarily immobilized with a bedrest and the first surgery was performed 2 days after the trauma. During the surgery, pedicle screws (Universal Spine System II, Depuy Synthes, Zuchwil, Switzerland) were inserted bilaterally to the T12 and L2 levels after partial laminectomy at the T12 and L1 vertebrae for decompression were performed [Figure 2]. Intraoperatively, we tried to fill the vacant space inside the fractured vertebra with hydroxyapatite blocks (Pentax, Tokyo, Japan). The angle between the cranial endplate of T12 and the caudal endplate of L2 (local kyphosis angle: LKA) was 18° preoperatively (supine position) and improved to 16° intraoperatively (prone position, [Figure 2]).

Postoperatively, the patient's back and lower extremity symptoms improved when compared with preoperatively; however, the patient was unable to stand because of severe back pain in the standing position. Eight days after surgery, the patient was able to stand; thus, radiographs of the thoracolumbar spine were taken in the standing position 14 days after the surgery. LKA was 32° in the standing position [Figure 2], while it was 24° in the lateral lying position. Sufficient stability could not be achieved by 1-above 1-below posterior fusion. Therefore, we conducted additional surgery to achieve better stability of the unstable T12-L2 segments.

Second and third surgery

Twenty-two days after the first surgery, a second surgery was performed. All implants, including pedicle screws inserted at the first surgery, were removed, and pedicle screws of other systems (Expedium Spine System, Depuy Synthes, Zuchwil, Switzerland) were inserted at the T10, T11, T12, L2, L3, and L4 levels. On each side, the pedicle screws from T10 to L4 levels were connected by two rods to reinforce the stability of the screw-rod system [Figure 3]. Ten days after the second surgery, the patient could stand and walk by himself with a hard thoracolumbar orthosis in the horizontal bars with mild back pain and slight bilateral foot numbness. The LKA was 22° in the lateral lying position and 27° in the standing position.

Forty-four days after the second surgery, a third surgery was performed. At the third surgery, the left eleventh rib was harvested, and the left lateral aspect of the T12-L1 vertebra was exposed through the retropleural approach. Subsequently, the T12-L1 disc and a part of the injured L1 vertebra were removed, and autologous rib strut grafts were inserted [Figure 4]. After the third surgery, the LKA was 22° in the lateral lying position and 29° in the standing position [Figure 5].

Figure 1: Preoperative CT images: sagittal view (a) and axial views (b and c). Lines (b) and (c) indicate axial slices shown in b and c, respectively (a). Preoperative magnetic resonance images: sagittal view (d) and axial views (e and f). Lines (e) and (f) indicate axial slices shown in (e) and (f), respectively (d).

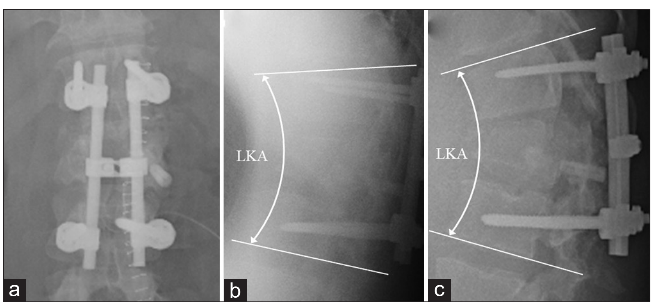

Figure 2: Postoperative radiographs taken in operating theatre in lying position (anteroposterior view in supine position: a, and lateral view in prone position: b), and taken in standing position 14 days after the first surgery (c). Local kyphosis angle (LKA) between T12 and L2 was 16° in prone position (b) and 32° in standing position (c).

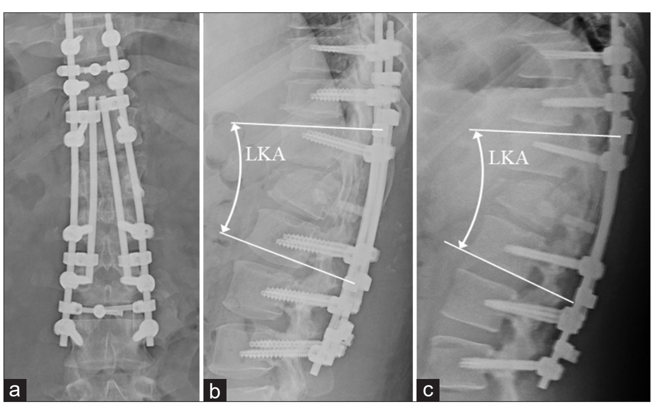

Figure 3: Anteroposterior (a) and lateral radiographs taken in lateral lying position (b) and in standing position (c) after second surgery (3-above 3-below posterior fixation). Local kyphosis angle (LKA) between T12 and L2 was 22° in lateral lying position (b) and 27° in standing position (c).

Postoperative course after the third surgery

The postoperative course after the third surgery was favorable, with no postoperative complications. Back pain gradually decreased postoperatively, and the muscle weakness of the lower extremities returned to normal; however, slight residual back pain and foot numbness remained after the third surgery.

Bony fusion was evaluated on reconstructed sagittal and coronal CT images. The full integration of a bone graft at both adjacent levels was considered as complete bony fusion.[2,10] Twenty-one months after the third surgery, complete bony fusion at the T12-L1 segment was confirmed by CT images [Figure 4]; thus, 24 months after the third surgery, all posterior implants were surgically removed. The LKA in the standing position was 28° before removal and 30° 11 days after removal [Figure 6]. Before implant removal, no correction loss in the LKA in the standing position occurred after the third surgery. However, an increase of 6° in LKA in the lateral lying position was observed after the third surgery; thus, LKA in the lateral lying position was the same as that in the standing position when bony fusion between T12 and L1 was achieved. After implant removal, obvious loss of lordosis at the T12-L2 segments was observed. Six months after the removal, LKA in the standing position was 37°, and increased up to 40° at the final follow-up (27 months after removal, [Figure 6]). Complete bony fusion between the L1 and L2 vertebrae was observed, as well as between T12 and L1. Loss of lordosis occurred both at the T12-L1 segment (6°) and L1-L2 segment (6°), although continuous trabecular bone formation between the T12 and L1 vertebrae was observed before implant removal [Figure 4].

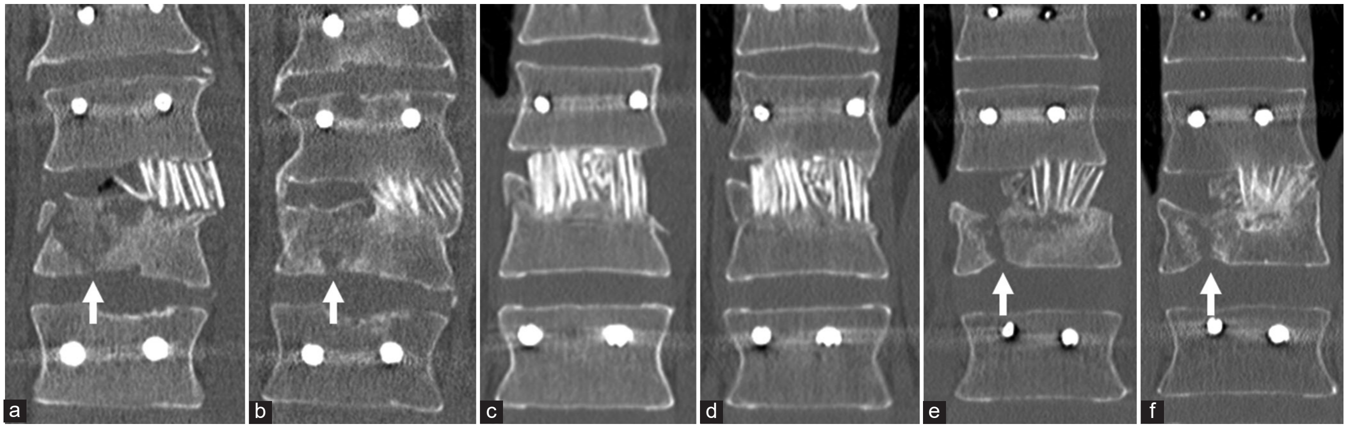

Figure 4: Coronal reconstruction CT images showing location of rib graft bone and caudal endplate injury. CT images of this patients (Case 1) taken a week (a) and 21 months (b) after anterior fusion surgery, showing mild caudal endplate injury (white arrows in a and b) and unilaterally located graft bones (a, b). The continuity of trabecular bone between T12 and L1 vertebrae were observed 21 months after the surgery (b). CT images of Case 2 in Table 1 taken a week (a) and 14 months (b) after anterior fusion surgery, showing no injury at the caudal endplate and graft bones widely located at the fractured site (c, d), and bony fusion was observed 14 months after the surgery (d). CT images of Case 3 in Table 1 taken a week (e) and 21 months (f) after anterior fusion surgery, showing radiologic findings similar to Case 1 (mild caudal endplate injury [white arrows in e and f] and unilaterally located graft bones). The continuity of trabecular bone at the fractured site was observed 21 months after the surgery (f).

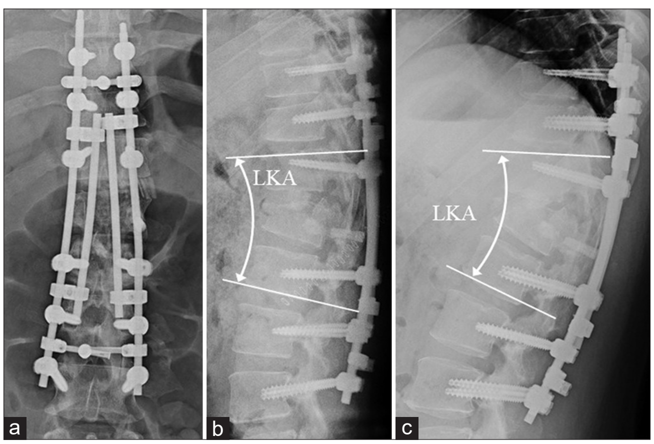

Figure 5: Anteroposterior (a) and lateral radiographs taken in lateral lying position (b) and in standing position (c) after third surgery (single-level anterior fusion). Local kyphosis angle (LKA) between T12 and L2 was 22° in lateral lying position (b) and 29° in standing position (c).

At the final follow-up (27 months after the removal), the patient was able to walk and jog without any support; however, slight back pain and slight left foot numbness were reported. He did not return to work as a steeplejack as he was hesitant to work from heights again; however, his activities of daily life had returned to normal and started work in the construction industry.

DISCUSSION

A favorable surgical outcome of single-level anterior fusion was reported in patients with thoracolumbar burst fracture in which the cranial endplate is mainly involved and the caudal endplate has no or slight injury.[12,15,21] A previous study showed that postoperative correction loss was not significantly different between single-level and two-level anterior fusion surgery in such patients.[17] Miyakoshi *et al.* reported that correction loss could be reduced using spinal instrumentation.[12] The recent development of pedicle screws, including percutaneous screw systems, has enabled surgeons to treat patients with thoracolumbar fractures through the posterior approach easier than ever.[6,20,28]

In our institution, thoracolumbar fracture patients requiring surgical intervention are usually treated with posterior fusion surgery using pedicle screws at an early post trauma period, particularly when they have multiple traumas. After the first surgery, additional anterior fusion surgery can be considered as an elective surgery. In cases where the caudal endplate has no or slight injury, we usually performed single-level anterior fusion at the cranial level. However, it is still debatable whether single-level or two-level anterior fusion is better when treating such patients.[10,12,17,24,27] Even after posterior fusion without anterior support, favorable postoperative radiological results have been reported for thoracolumbar burst fractures.[6,28] However, in this case, we experienced an unexpected significant postoperative correction loss after combined posterior and anterior fusion surgery. Because the patient had Class II obesity (BMI: 36.9 kg/m^2), it is suggested that obesity is a factors influencing postoperative correction loss. Formica *et al.* studied the risk factors for correction loss after short-segment posterior fusion in thoracolumbar fracture patients and found that obesity (BMI > 30) was significantly correlated with postoperative correction loss.[7]

Except for this patient, we have several thoracolumbar or lumbar burst fracture patients with cranial endplate injury but no or slight injury at the caudal endplate. Among these patients, four were treated with the same surgical strategy and followed up until their posterior implants were removed. All four patients had posterior ligamentous complex injury and were classified as having an AO type B2 injury, were not obese, and showed no obvious correction loss even after implant removal [Table 1]. When compared with the four patients, this patient had several factors other than obesity which may influence his postoperative correction loss. First, regarding the local alignment (LKA) after posterior and anterior fusion surgery, this patient showed larger LKA than other patients [Table 1]. Retrospectively, we suppose that the first surgery with 1-above 1-below posterior fusion was insufficient to achieve spinal stability in this patient with Class II obesity. We could not exclude the possibility that a better local alignment was achieved with posterior fusion with longer levels at the initial surgery. Second, this patient had a slight injury at the caudal endplate, although the displacement was minimal. In other patients, one patient had no caudal endplate injury [Figure 4]; however, three, in addition to the patient reported herein, had slight caudal endplate injury [Table 1 and Figure 4] as well as the patient in this case report. Third, the graft bone was mainly placed on the less-damaged approached side in the fractured vertebra (and cranial disc) [Figure 4]. It is reasonable that Case 2, who had no caudal endplate injury and showed bilaterally placed graft bone [Figure 4], was unlikely to show postoperative correction loss. However, we experienced a case of slight injury to the caudal endplate and unilaterally placed graft bone [Figure 4] but showed no postoperative correction loss even after implant

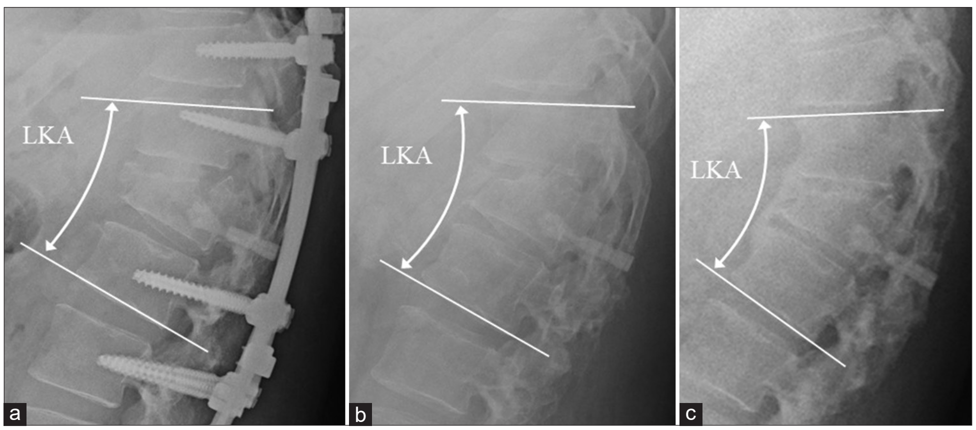

Figure 6: Lateral radiographs taken in standing position 21 months (before removal, a), 24 months (after removal, b), and 51 months (final follow-up, c) after the anterior fusion surgery. Local kyphosis angle (LKA) between T12 and L2 was 28° before removal (a), 30° after removal (b), and 40° at the final follow-up (c).

Table 1: Pre and postoperative LKA in thoracolumbar and lumbar burst fracture patients treated with two-stage posterior and single-level anterior fusion.

Case	Age (year)	Sex	BMI	Fracture level	AO type	Caudal endplate injury	Levels of posterior-fusion	LKA (degree)					IR~Final FU (Months)
								Pre-op*	Post-op	Pre-IR	Post-IR	Final FU	
1	28	M	36.9	L1	B2	Mild injury	3-above 3-below	18	29	28	33	40	27
2	39	F	20.4	T12	B2	No injury	2-above 2-below	19	4	4	4	5	6
3	39	M	21.5	L1	B2	Mild injury	3-above 2-below	22	3	4	4	5	13
4	18	F	19.5	L4	B2	Mild injury	2-above 1-below	0	−6	−3	−3	−2	7
5	42	M	21.0	L3	B2	Mild injury	1-above 1-below	2	8	9	10	10	3

LKA: Local kyphosis angle; LKA was measured on standing radiographs, except for preoperative evaluation. IR~Final FU: months from implant removal to final follow-up. BMI: Body mass index (kg/m^2), Pre-op: Before initial surgery, Post-op: after both posterior and anterior surgery were performed (≤1 month), Pre-IR: Before the implant removal surgery (≤3 months), Post-IR: after the implant removal surgery (≤1 month). *LKA in the lying position removal. From these observations, we suppose that obesity is at least one of the causes of postoperative correction loss in our patient.

At present, the cutoff value of a patient's BMI (or body weight) for predicting postoperative significant correction loss is unclear. Thus, to predict the possibility of postoperative correction loss, we focused on the difference in LKA between the lying and standing positions after posterior fusion surgery without anterior support. In our patient, LKA was obviously larger in the standing position than in the supine position after the first posterior fusion, suggesting that the 1-above 1-below posterior pedicle screw fixation was insufficient to stabilize the injured thoracolumbar spine in the patient. Moreover, even after 3-above 3-below posterior fixation using four rods, LKA in the standing position was considerably larger than that in the lying position. These findings suggest that sufficient stability was not obtained even by 3-above 3-below posterior fusion surgery, possibly due to the patient's body weight and severity of fracture. In this patient, such insufficient stability may cause subsidence of the graft bone to the fractured vertebra after anterior fusion surgery. In the early postoperative period after the third surgery, LKA was 22° in the lateral position and 29° in the standing position. However, the LKA was 28° both in the lateral lying and standing positions before implant removal, suggesting that the final LKA before implant removal is predicted by postoperative standing radiographs.

Moreover, correction loss occurred after implant removal at both fractured and caudal discs. As reviewed by Kweh *et al*., in younger patients with thoracolumbar burst fractures treated by posterior stabilization, planned implant removal induced superior functional outcomes without a significant difference in correction loss compared to implant retention.[9] In such cases, implant removal was usually performed approximately 12 months postoperatively. In our case, implant removal was performed 24 months after initial surgery while waiting for complete bony fusion. We did not expect obvious correction loss at the fractured site after complete bony fusion was observed. On the other hand, a similar case with no obesity showed no correction loss after implant removal. This finding suggests that bone remodeling may be induced by an intense axial load due to excessive body weight. Regarding the disc caudal to fracture vertebra, it was reported that thoracolumbar fracture leads to the degeneration of the adjacent disc, even when endplate injury was mild.[4,12,16,19] Thus, it is possible that collapse of the caudal disc occurs after implant removal, particularly in obese patients. To prevent significant correction loss, two-level fusion including cranial and caudal discs would be useful. When two-level fusion is indicated, graft bone (or fusion cage) is supported by the cranial and caudal endplate without injury; thus, subsidence of the graft and remodeling of the fused segment are less likely to occur. Furthermore, collapse of the adjacent disc never occurs after implant removal when bony fusion is achieved after two-levels fusion. Recently, Fukuda *et al*. reported favorable surgical outcomes of lateral lumbar interbody fusion using a wide footprint cage for patients with a thoracolumbar fracture.[8] Patients with a thoracolumbar fracture were successfully treated by the aforementioned procedure, even when osteoporosis was present. They concluded that the use of a wide footprint cage may be advantageous to stabilize the disc adjacent to the fractured vertebrae because the cage could span the lateral borders of the apophyseal ring. This procedure may achieve more stability than a unilaterally placed autologous bone graft, which was performed in our case.

Previously, it was reported that there is a difference in lumbar sagittal alignment depending on posture.[5,18] More recently, preoperative difference in lumbar lordosis between standing and supine positions (DiLL) was proposed as a predictive factor for postoperative lumbar alignment changes after lumbar surgery for lumbar degenerative disease.[3,13,15] From our experience, it is suggested that postural differences in LKA are useful for evaluating the stability of thoracolumbar fractures after fusion surgery and predicting postoperative loss of correction.

CONCLUSION

When treating thoracolumbar burst fracture with cranial endplate injury but no or slight injury at the caudal disc by two-stage posterior and anterior fusion surgery, comparison of local alignment between standing and lying positions after posterior fusion surgery is recommended to evaluate the postoperative stability of the injured spine, particularly in obese patients. In cases where stability is insufficient, surgeons should consider additional longer levels of posterior fixation and/or two-level anterior fusion surgery, including an intact caudal disc, to prevent postoperative correction loss.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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