# Simultaneous Ventral and Dorsal Decompression of OPLL and OLF

Jong Won Yoon and Junseok Bae

## Introduction

Ossification of the posterior longitudinal ligament (OPLL) is a well-known cause of cervical myelopathy. However, the disease also occurs in the thoracic spine and produces myelopathy through anterior compression of the spinal cord [1]. Ossification of the ligamentum flavum (OLF), also known as ossification of the yellow ligament, is a condition that causes myelopathy by compressing the spinal cord from the posterior and lateral side.

Although each of these two diseases is major causes of thoracic myelopathy, since thoracic OPLL usually occurs at the upper or middle thoracic spine while the most common site of OLF is the lower thoracic spine [2, 3], concurrent OPLL and OLF at the same thoracic level are not common. However, if these conditions happened, because they pinch the spinal cord from anterior and posterior, mostly leads to severe thoracic myelopathy and requires surgical decompression.

To date, several cases with concurrent OPLL and OLF at the same thoracic level have been reported and surgical methods to treat these conditions: (1) posterior only decompression without OPLL removal [4–7]; (2) single-staged circumferential decompression through posterior approach [2, 4, 5, 7, 8], and (3) decompression over two stages for OPLL and OLF respectively through trans-thoracic and posterior approaches have been described in the previous literatures [9–11].

Posterior only decompression without OPLL removal is relatively simple with fewer complications related operation and posterior approach provides a familiar surgical vision to spinal surgeons [12]. Thus, this surgical method is maybe one of the better ways to eliminate only the OLF alone or to treat the OPLL at cervical with lordotic curvature or upper thoracic spine with relatively mild kyphotic curvature than that of the middle or lower thoracic spine. However, the results of this method are not always satisfactory in middle or lower thoracic OPLL. Because the ventral compression of the cord by OPLL remaining is constantly sustained and posterior shifting of spinal cord is restricted due to physiologic kyphosis even after posterior decompression, tethering phenomenon which may cause damage of the cord around OPLL may be produced by posterior traction of spinal cord [1, 6, 12, 13]. Therefore, many surgeons agree that direct decompression through removal of the thoracic OPLL should be the ultimate goal of the surgery in treating thoracic myelopathy caused by thoracic OPLL and anterior decompression is the most ideal surgical method for this purpose [9, 14–18].

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Single-staged circumferential decompression through posterior approach which removes the OPLL directly after approaching from posterior of the spinal cord have been reported at several literatures since being developed by Ohtsuka in 1986 [19]. In brief, this surgery is performed by exposing of the bilateral and dorsal side of the spinal cord through extensive laminectomy with removal of both facet joints, pedicles, and pars interarticularis after posterior midlind incision, then digging into vertebral body from both lateral side of spinal cord and extirpating the OPLL. This method aims at direct anterior decompression of OPLL through posterior approach, so it has been considered as one of the effective and efficient surgical treatment for concurrent OPLL and OLF at the same thoracic level because it is possible to decompress completely the ventral and dorsal side of the spinal cord at the same time through single posterior approach providing a familiar surgical vision to spinal surgeons [2, 4, 5, 7, 8]. However, it has been also reported the high incidence of complications such as spinal cord damage associated with repetitive traction of the spinal cord for manipulation and removal of the OPLL under indirect visualization caused by posterior approach [2, 20, 21]. And because posterior elements such as facet joint, lamina, posterior ligamentous complex cannot preserved, which can induce postoperative kyphosis and instability, both bone graft and instrumentation should be performed.

Another possible surgical method for concurrent OPLL and OLF at the same thoracic level is to remove OPLL and OLF respectively over two stages through each trans-thoracic and posterior approaches. The anterior decompression through trans-thoracic approach for OPLL removal has advantages in terms of making it possible to look directly the OPLL lesion and the boundary between OPLL and dura under the microscope, which result in reducing the risk of spinal cord damage by repetitive traction of the spinal cord as well as allowing direct decompression for thoracic OPLL [22]. And posterior decompression is one of the best ways of surgical methods for OLF removal. Therefore, decompression over two stages for OPLL and OLF respectively through trans-thoracic and posterior approaches has been considered a suitable surgical method for concurrent OPLL and OLF at the same thoracic level. However, this surgical method also has some disadvantages such as increased operation time, surgical stress, and anesthesia risk due to two-staged operation. Moreover, this surgical method requires bone graft and instrumentation.

The thoracic cavity enclosed by the ribs, the vertebral column, and the sternum is not elliptical completely and dorsal parts of each rib on both sides are curved inwards, making articulation with thoracic vertebra, so the thoracic spinal cord is located about one-third of the posterior on the midline of the thorax, not on the surface of the thorax. Considering this anatomical location of the vertebral body and the spinal cord in the thoracic cavity, it is possible to access the ventral part of the cord for OPLL removal and the dorsal part of the cord for OLF removal simultaneously through single-staged mini-thoracotomy (Fig. 1).

The surgery of simultaneous decompression through mini-thoracotomy for concurrent OPLL and OLF at same thoracic level has several advantages over previously reported methods for removing concurrent OPLL and OLF at same thoracic level.

One is that direct decompression simultaneously for both OPLL and OLF is possible in single-staged operation.

If the OPLL is not removed after posterior decompression for the OLF removal, cord damage around OPLL may be caused by tethering phenomenon which occurs when the ventral compression of the cord by OPLL is sustained and posterior shifting of spinal cord is restricted due to physiologic kyphosis of thoracic spine even after posterior decompression [1, 6, 12, 13]. And if only OPLL is removed while the dorsal compression continues due to remaining OLF, the antero-displacement of the cord may occur due to the OLF, which can also cause cord damage. Therefore, this surgical technique that can remove concurrent OPLL and OLF simultaneously at the same level is considered to be able to reduce the incidence of postoperative neurological deterioration.

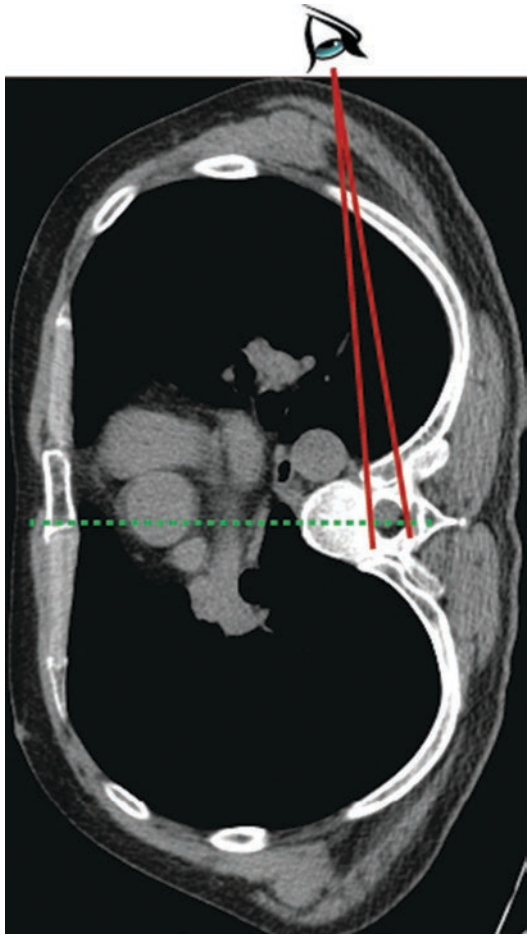

**Fig. 1** Considering the shape of the thoracic cavity and the anatomical locations of the vertebral body and spinal cord in the thoracic cavity, it is possible to access both ventral and dorsal parts of the thoracic cord simultaneously through single-staged thoracotomy. MAL, mid-axillary line

Another advantage is that because OPLL and OLF lesions are not obscured by cord and the boundary between the ossified lesion and the dura can be visualized and confirmed directly, which can minimize the traction of the cord for manipulation and removal of the lesions. Less manipulation of the cord due to direct visualization is a significant advantage in reducing the incidence of postoperative neurological deterioration in surgery of thoracic spine where has the watershed zone that is relatively vulnerable to traction or manipulation.

The other advantage is that both bone graft and instrumentation are not required. In this surgical technique, a small part of vertebral body, intervertebral disc and of unilateral lamina, and unilateral rib head is only resected, but posterior elements such as facet joint, lamina, posterior ligamentous complex are preserved. The intervertebral disc is regarded as the most important stabilizer in the spine, but because the resected portion of the intervertebral disc is small and posterior elements known as affecting postoperative kyphosis and instability are preserved in this surgical technique [23, 24], it is not expected to affect stabilization like three cases to be described later that show postoperative kyphosis or instability were not observed in the follow-up period for more than a year, even though both bone graft and instrumentation were not performed.

## Indications

Concurrent OPLL and OLF at the same thoracic level.

## Limitations

Technically demanding procedure.
The OLF lesion located on the opposite side of the approach side for OPLL removal.
Significant preexisting pulmonary problem.

## Surgical Technique

### Position and Anesthesia

Under general anesthesia with a double lumen endotracheal tube, the patient is positioned on the operating table in the lateral decubitus position with the OPLL and OLF lesion facing upwards. The use of a double lumen endotracheal tube makes possible one lung ventilation, which provides operation space in thoracic cavity by allowing ipsilateral controlled atelectasis.

## Thoracotomy

An oblique 8–10 cm skin incision is performed parallel to the rib direction in mid-axillary line. The musculature is sequentially divided to expose the superficial surface of the rib and the periosteum of rib and contiguous underlying parietal pleura are incised along the upper border of the rib for intercostal approach without rib resection. After deflation and retraction of the lung are performed, parietal pleura overlying rib head and vertebra is incised and taken off to expose the costo–vertebral junction and the lateral aspect of the vertebral bodies and the intervertebral disc. Ligating and sacrificing segmental vessels help prevent intraoperative bleeding. Target level is verified fluoroscopically. The microscope is used for complete visualization of the operative field (Fig. 2).

## OPLL Removal

The rib head is partially resected using a diamond burr to expose the posterior margin of the intervertebral disc and cephalo-lateral surface of pedicle of the lower vertebral body, and exfoliating the soft tissue along the pedicle surface of the lower vertebral body to expose the superior articular process (SAP) of the lower vertebra. After this, the exposed cephalo-lateral surface of pedicle of the lower vertebral body is drilled to expose the lateral surface of the dura, avoiding the exiting nerve root and vessels running through the foramen. Once the lateral surface of the dura is exposed, drilling the posterior margin of the intervertebral disc and the posterior edges of the adjacent vertebral bodies with leaving the OPLL, working space is created along the ventral side of dura and the OPLL (Figs. 3 and 4a). The width and depth of the working space depend on the vertical (cranial to caudal) and horizontal (right and left) distribution of the OPLL and should be such extent that the normal dura is exposed enough to release the adhesion from the OPLL. After normal dura surrounding the OPLL is exposed and the OPLL is released from the dura carefully by epidural dissection under direct visualization, the OPLL can be removed.

## OLF Removal

Confirming the boundary between dorsal side of dura and the OLF through the exposed lateral dura, the ventral side of SAP of the lower vertebra should be drilled with the part of the OLF to make working space to handle the OLF. Since

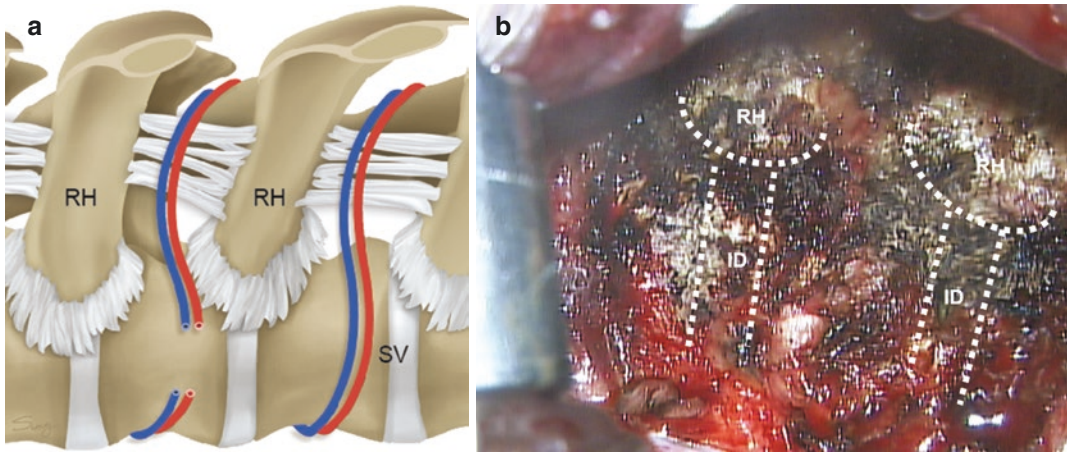


**Fig. 2** Illustration (**a**) and intraoperative photograph (**b**) showing exposure of the rib head, the intervertebral disc, and the lateral aspect of the vertebral body. Rib head is the key anatomical landmark for identifying intervertebral disc. Note that the segmental vessels across the middle concave portion of each vertebra. RH, rib head; SV, segmental vessels; ID, intervertebral disc

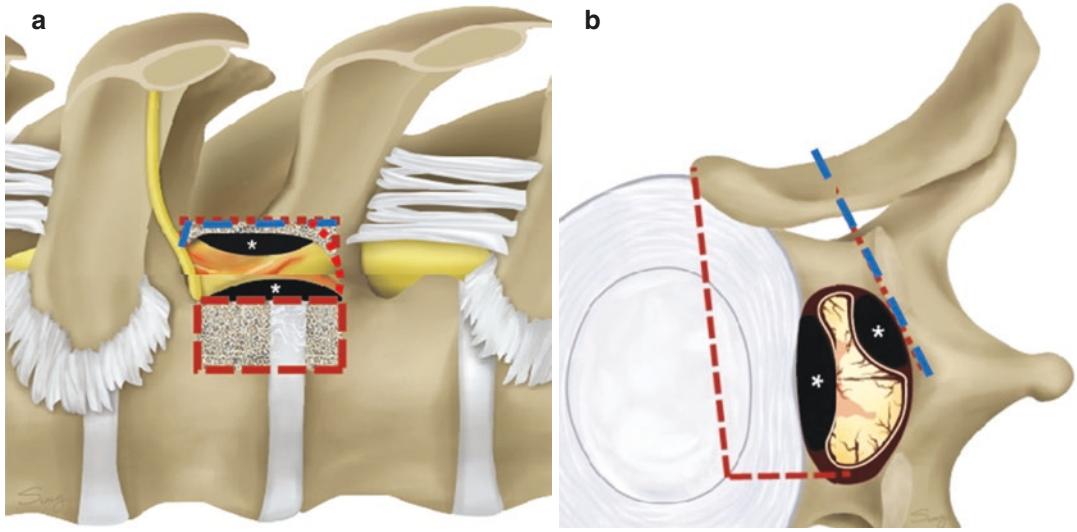


**Fig. 3** Illustration showing the drilling of the vertebra for removal of OPLL and OLF. The cephalo-lateral surface of pedicle of the lower vertebral body should be drilled to expose the lateral surface of the dura (red dotted line). The posterior margin of the intervertebral disc and the posterior edges of the adjacent vertebral bodies should be drilled to make working space along the ventral side of dura and OPLL for OPLL removal (red dash line). And the ventral side of SAP of the lower vertebra and the inner cortex of upper vertebral lamina should be drilled with the part of the OLF to make working space to handle the OLF (blue dash line)

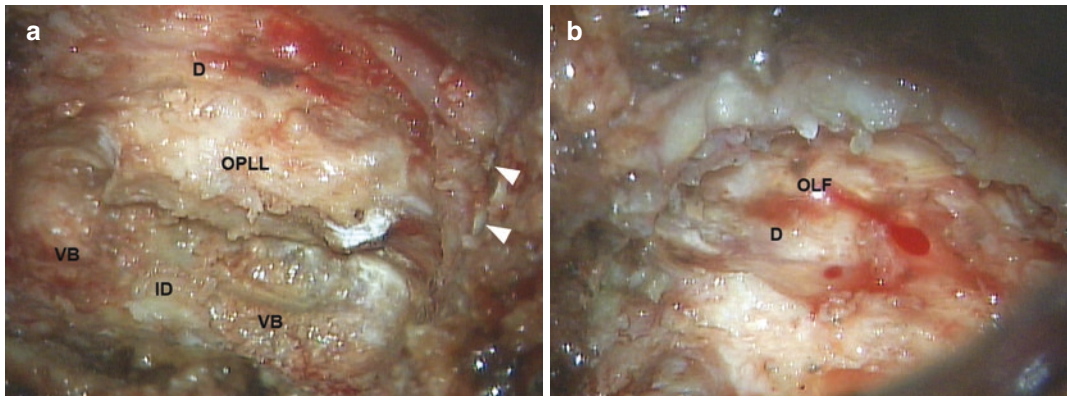


**Fig. 4** (**a**) Intraoperative photograph after creating working space for OPLL removal. Segmental vessels are transected (arrowhead). (**b**) Intraoperative photograph after drilling the ventral side of SAP with the part of OLF. OPLL has not been removed yet. VB, vertebral body; ID, intervertebral disc; D, dura

the OLF is present in the cranial and caudal portions of the tip of the SAP, it may be necessary to drill the inner cortex of upper vertebral lamina to remove the OLF located in the cranial portion of the tip of SAP (Figs. 3 and 4b). At this point, be careful not to injure the exiting root running along the lower surface of the upper vertebral pedicle. After floating the OLF from the lamina and the SAP and releasing the adhesion from dura carefully by epidural dissection under direct visualization, the OLF can be removed.

## Case Illustration

### Case 1

A 51-year-old female patient suffered from gait disturbance and upper back and frank pain. She also complained of hypoesthesia below the nipples level of trunk. Motor power of both lower extremities was grade 4 and more generally, but she showed severe ataxic gait. The patient showed hyperactive knee and ankle jerk response and had a positive Babinski sign and ankle clonus on both lower extremities. Radiologic examinations with computer tomography (CT) and magnetic resonance imaging (MRI) showed a T1 to T10 OPLL and T4-5 OLF and severe compression of the spinal cord at T4-5 and T6-7-8 levels. In particular, the cord at T4-5 level was heavily compressed between ventral OPLL and dorsal OLF and showed signal change on MRI (Fig. 5).

Thoracotomy was performed in the left lateral decubitus position and simultaneous removal of both OPLL and OLF at T4-5 level with the removal of T6-7-8 OPLL was performed. Postoperative CT and MRI revealed complete decompression of the operated level (Fig. 6). During a 2-years follow-up after surgery, the preoperative symptoms were gradually improved and there was no kyphotic change or instability in thoracic spine despite not performing both bone graft and instrumentation.

### Case 2

A 47-year-old man visited our clinic with weakness, dysesthesia, hypoesthesia of both lower extremities. The patient also complained of bladder and bowel dysfunction. Motor power of both lower extremities was grade 3 and the patient was unable to walk. The patient showed hyperactive knee and ankle jerk response and had a positive Babinski sign and ankle clonus on both lower extremities. Radiologic examinations with CT and MRI showed severe cord compression and signal change of cord due to OPLL at T6-7 level and concurrent OPLL and OLF at T7-8 level (Fig. 7).

Because OPLL and OLF lesion was prominent on the right side on the cord, thoracotomy was performed in the right lateral decubitus position, and simultaneous removal of both OPLL and OLF at T7-8 level with the removal of T6-7 OPLL was performed. In this case, because there were dural ossification and severe epidural adhesion between dura and OPLL lesion, despite dissecting as carefully as possible, intraoperative cerebrospinal fluid (CSF) leakage occurred. The defect portion of the dura was sealed with TachoComb and fibrin glue. To prevent postoperative atelectasis and pleural effusion caused by CSF leakage into the pleural cavity, chest tube was inserted, and the complete expansion of deflated lung was confirmed at the last stage of the operation and the patient was encouraged to take deep breaths exercise and to ambulate as early as possible. Postoperative CT and MRI revealed complete decompression of the operated level (Fig. 8). CSF pleural effusion was observed postoperative images, but it gradually decreased over time on a follow-up chest image. Immediately after surgery, the patient's symptoms did not improve significantly. However, a month after surgery, bladder and defecation symptoms improved, and a year after surgery, although the patient still had a mild gait disturbance, he can walk alone without assistive device for ambulation. There was no kyphotic change or instability in thoracic spine despite not performing both bone graft and instrumentation.

## Summary

Concurrent OPLL and OLF at the same thoracic level are not common, but if these conditions happened, because they pinch the spinal cord from anterior and posterior, mostly leads to severe thoracic myelopathy and require surgical decompression. The surgical technique described in this chapter has some advantages, which make it possible to decrease operation time, surgical stress and anesthesia risk and to reduce the incidence of postoperative neurological deterioration In addition, because structures known as affecting postoperative kyphosis and instability are preserved

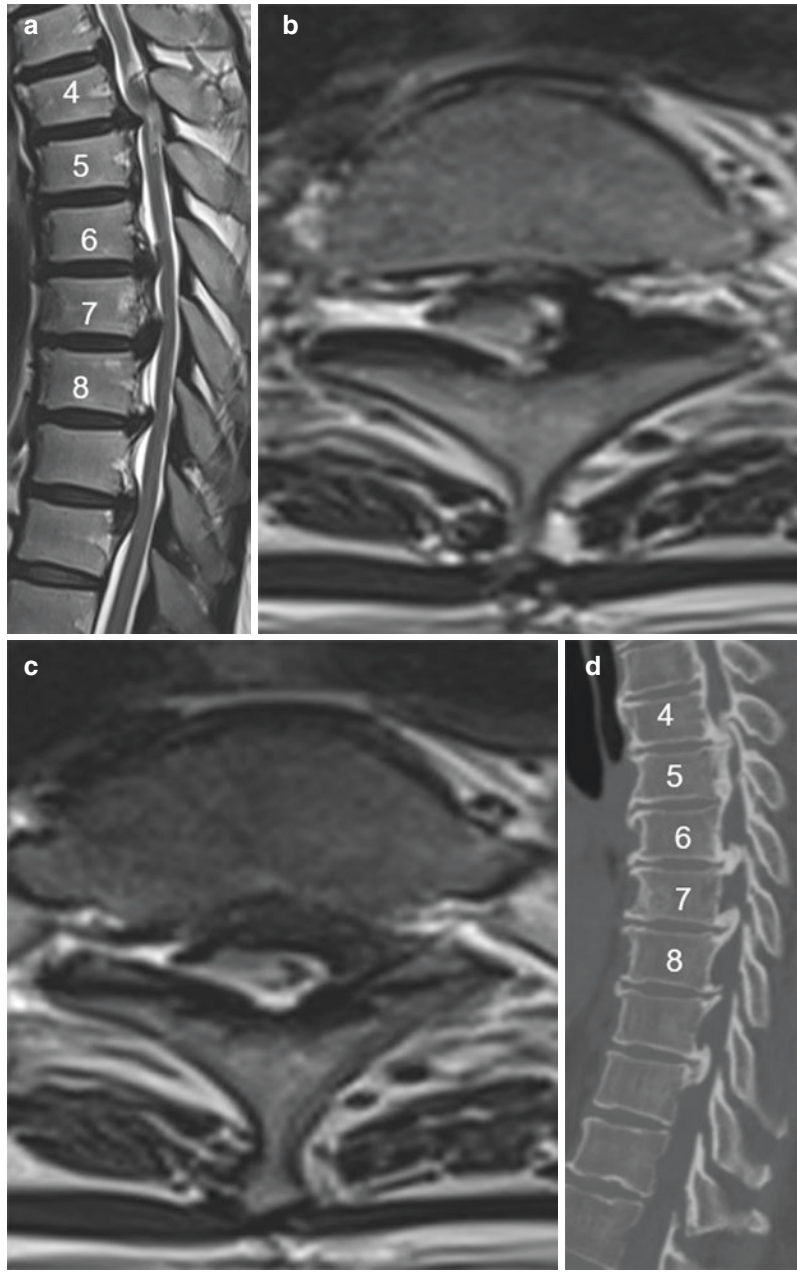


**Fig. 5** Preoperative thoracic MRI (**a**) and CT (**d**) show OPLL and OLF lesions at multi-thoracic level. Among them, the cord at T4-5 level is heavily compressed by concurrent OPLL (**c**, **f**) and OLF (**b**, **e**)

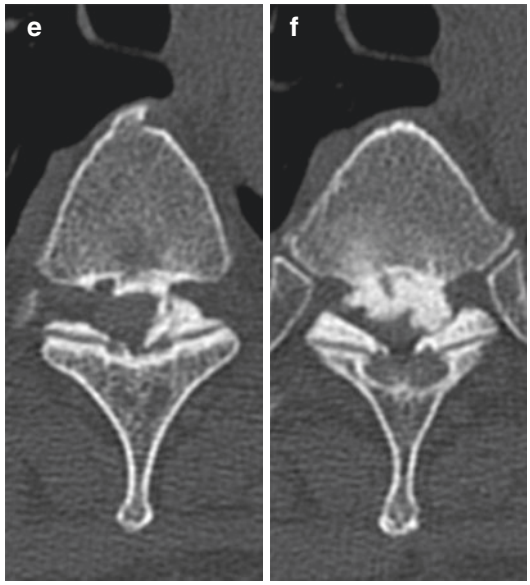


**Fig. 5** (continued)

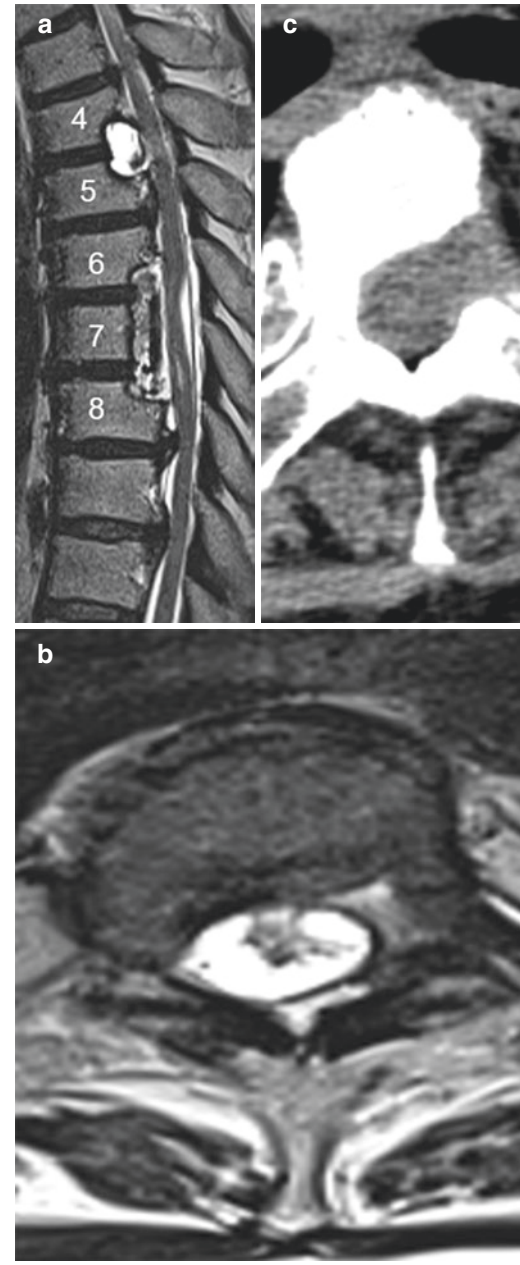


**Fig. 6** Postoperative MRI (**a**, **b**) and CT (**c**) reveal the findings of decompression from concurrent OPLL and OLF at T4-5 level. OPLL removal at T6-7-8 level is also performed (**a**)

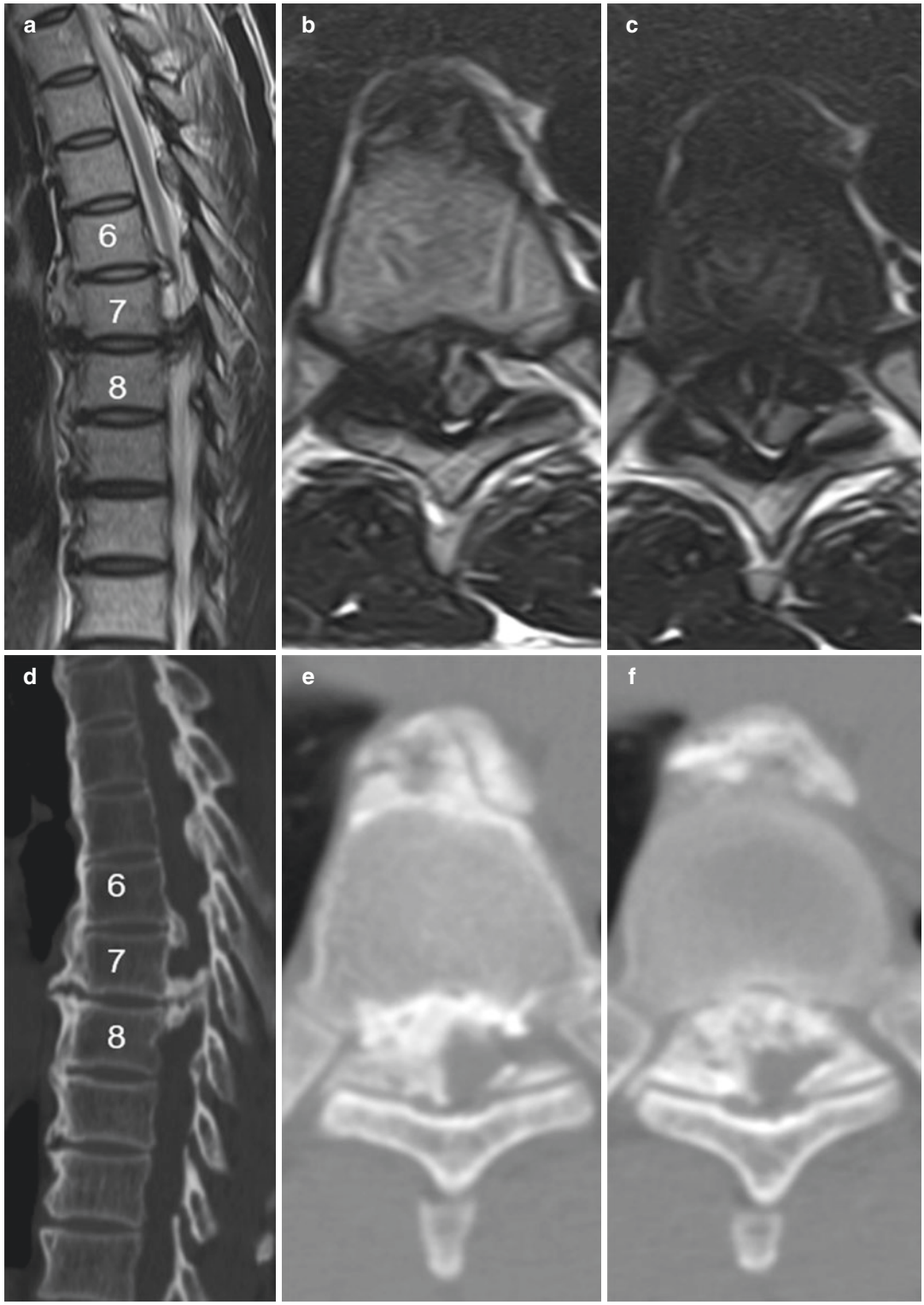


**Fig. 7** Preoperative thoracic MRI (**a**) and CT (**d**) show the cord compression caused by OPLL at T6-7 level and concurrent OPLL and OLF at T7-8 level. In particular, OPLL (**c**, **f**) and OLF (**b**, **e**) at T7-8 level cause severe core compression

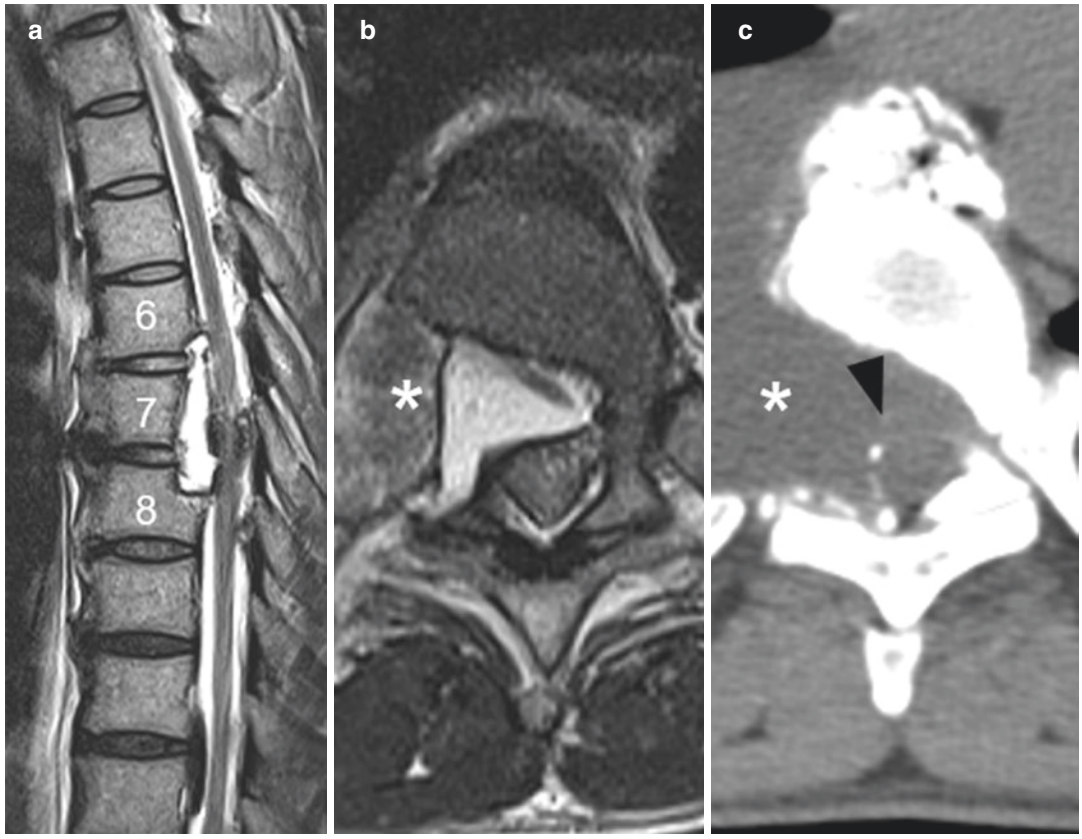


**Fig. 8** Postoperative MRI (**a**, **b**) and CT (**c**) reveal the findings of decompression from concurrent OPLL and OLF at T7-8 level. OPLL removal at T6-7 level is also performed (**a**). Cerebrospinal fluid pleural effusion (asterisk) and dural ossification (arrowhead) are observed

mostly, additional bone graft and instrumentation are not required.

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