12 Management of Intraoperative Dural Tear in Anterior Cervical Surgery

Satish Verma and Sachin Anil Borkar

Learning Objectives

The learning objectives of this chapter are:

- To anticipate and avoid intraoperative dural tear in degenerative cervical spine surgeries.
- To learn the technique to manage intraoperative dural tear in degenerative cervical spine surgeries.

Introduction

Dural tear following anterior cervical surgery is a rare, but frequently troublesome complication to manage. In this chapter, we discuss the risk factors for developing intraoperative dural tear and its management.

Case History and Examination Findings

A 45-year-old male presented with progressive weakness of all four limbs and stiffness of 1 year duration. He did not have any significant comorbidities. Examination revealed spastic quadriparesis with a power of 4/5 (Medical Research Council grade) in bilateral upper limbs and 4-/5 in bilateral lower limbs. There was no evidence of muscle atrophy in upper limb. Tone was slightly increased in all the muscle groups below C5 with a modified Ashworth grade of 1/5. His modified Japanese Orthopedic Association (mJOA) score was 12/18. Clinical diagnosis of cervical compressive myelopathy was made.

Imaging

Radiological investigations revealed degenerative changes in the cervical spine with severe canal compromise at C5 and C6 vertebral levels due to ventral compression from ossified posterior longitudinal ligament (OPLL) and osteophyte complex. There was no evidence of double layer sign on CT. Axial MRI revealed a canal occupancy ratio (the ratio denotes the canal diameter occupied by the OPLL) of 80% at the level of maximum canal stenosis at C5–C6 intervertebral disk level. There was cord hyperintensity on T2-weighed

image (T2WI) at C5–C6 level where there was significant radiological compression (**Fig. 12.1** and **Fig. 12.2**). Plain radiograph showed reversal of cervical curvature resulting in cervical kyphosis. K-line (K-line is a straight line connecting the midpoints of the cervical spinal canal at C2 and C7 mid body levels) based on neutral lateral radiograph was negative. A negative K-line means that the OPLL is extending posterior to the K-line.

Diagnosis

Cervical compressive myelopathy due to OPLL.

Management

The patient was kept in Philadelphia cervical collar. No cervical traction was applied in the preoperative period.

In view of clinical evidence of myelopathy and severe canal compromise causing cervical spinal cord compression, decompression of the spinal cord was warranted. Anterior approach was considered because of the following reasons:

- The compression was primarily from ventral aspect,
- Canal occupancy ratio was 80%,
- Negative K-line, and

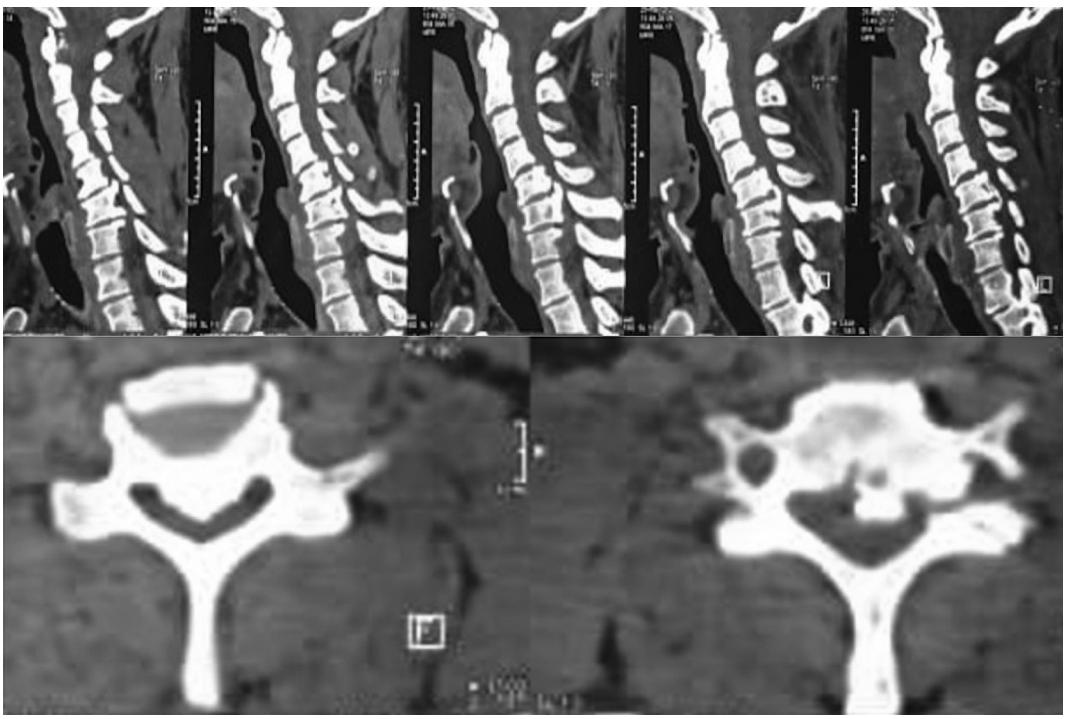

Fig. 12.1 Preoperative computed tomography (CT). Upper panel shows sagittal reconstruction images with ossified posterior longitudinal ligament (OPLL) at the level of C5 and C6 vertebrae. Lower panel shows axial images at C5–C6 disk level (left) and C6 (right), showing a sessile central OPLL at C5–C6 intervertebral disk level with a canal occupancy of >80% and eccentric OPLL at C6 level. (Reproduced with permission from Department of Neurosurgery, AIIMS, Delhi).

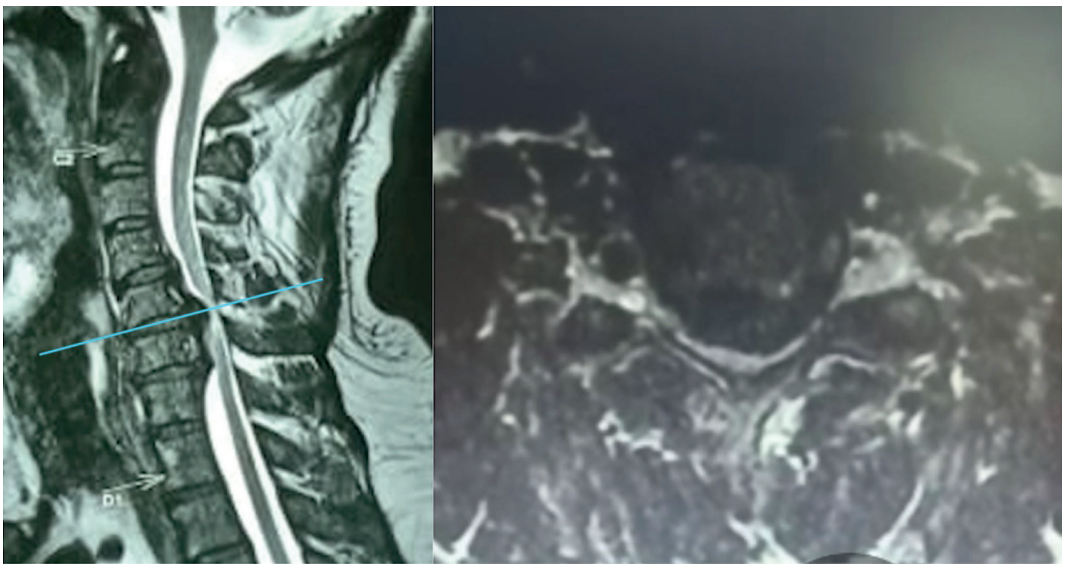

Fig. 12.2 Preoperative T2-weighted magnetic resonance imaging (MRI) images. Sagittal (left) and axial (right) images showing severe canal compromise with cord compression and T2 hyperintense signal at C5–C6 level. (Reproduced with permission from Department of Neurosurgery, AIIMS, Delhi).

- Reversal of cervical curvature to kyphosis. Posterior decompression procedures result in displacement of the spinal cord posteriorly for which a lordotic curvature and canal occupancy ratio of <50 to 60% are the criteria. In this case, spinal cord was already displaced posteriorly, and no further significant displacement was expected by posterior decompression.

Surgical Management

The patient was planned for a standard right-sided anterior cervical approach with spinal cord decompression and reconstruction with a mesh cage and anterior cervical plate under general anesthesia in supine position. A vertical linear incision was made along the medial border of sternocleidomastoid muscle in view of the long segment exposure required spanning the vertebral bodies. Further dissection was done under microscope. Platysma was incised and subplatysmal plane was dissected. Deep cervical fascia was sharply divided and blunt dissection done in the avascular plane between the carotid sheath structures laterally and the visceral structures (trachea and esophagus) medially to reach prevertebral fascia. At this point the vertebral level of interest (C5 and C6) is confirmed under fluoroscope. Prevertebral fascia was incised in midline, and longus colli muscles were elevated bilaterally off the C4, C5, C6, and C7 vertebral bodies. Self-retaining retractors were placed beneath longus colli to expose the uncovertebral joints bilaterally from C4–C5 to C6–C7 intervertebral disk space. Next, annulus fibrosus of C4–C5, C5–C6, and C6–C7 intervertebral disks were incised and diskectomies were performed at each of these three levels. Further steps were corpectomy of C5 and C6 vertebrae. Under high magnification, corpectomy was performed with a cutting drill (M8 Midas Rex, Medtronics pneumatic drills). As soon

as the body is drilled out and OPLL is reached, cutting drill was changed to a diamond drill (M8D, Midas Rex, Medtronics). Meticulous drilling of the OPLL was performed, and all efforts were made to preserve the integrity of thecal sac. A thin layer of OPLL was left attached to the ventral dura which was dissected with microsurgical technique. However, removing that part created a dural defect, as the dura was probably ossified. However, the arachnoid mater was intact, and no cerebrospinal fluid (CSF) leak was observed (**Fig. 12.3**). Thecal sac pulsations were observed, and good thecal sac decompression was achieved. Dural defect was considered not amenable to repair. Right thigh was prepped and tensor fascia lata and fat harvested. A layer of tensor fascia lata was placed over the dural defect and reinforced with tissue glue. It was further reinforced with a layer of fat and tissue glue. After this, a mesh cage of appropriate size filled with autologous bone chips harvested from right iliac crest was placed between the inferior endplate of C4 and superior endplate of C7 vertebra. An anterior cervical plate was applied from C4 to C7. An intraoperative radiograph was done to confirm the correct position of implants. Standard layered closure was performed. To reduce the chances of CSF leak further, a lumbar CSF drain was placed. The patient was extubated on table with no change in the neurological status. Lumbar CSF drain was allowed to drain 150 to 200 mL of CSF per day for 3 days. No surgical site CSF leak or meningitis was observed. Postoperative course was uneventful, and the patient was discharged on postoperative day (POD) 7. The patient was kept in Philadelphia cervical collar for 6 weeks.

Tips and Tricks in Management

- Anticipation: Identify red flags in preoperative imaging like double-layer sign that signifies underlying dural ossification.
- Prevention: Leave behind the thinned down posterior wall of the vertebral body and the OPLL but decompress laterally around it, so that the OPLL becomes a “free-floating” mass on the dura. A few isolated islands of OPLL tightly adherent to the dura can be left in place to reduce the chance of dural tears and CSF leak.
- Management options: (1) Primary repair; (2) fat, fascia, and tissue glue; (3) lumbar CSF drainage (4–5 days); (4) adjuncts—bed rest, head end elevation, acetazolamide.

Difficulties Encountered

OPLL poses a fair degree of challenge to the surgeon. After majority of the OPLL is drilled

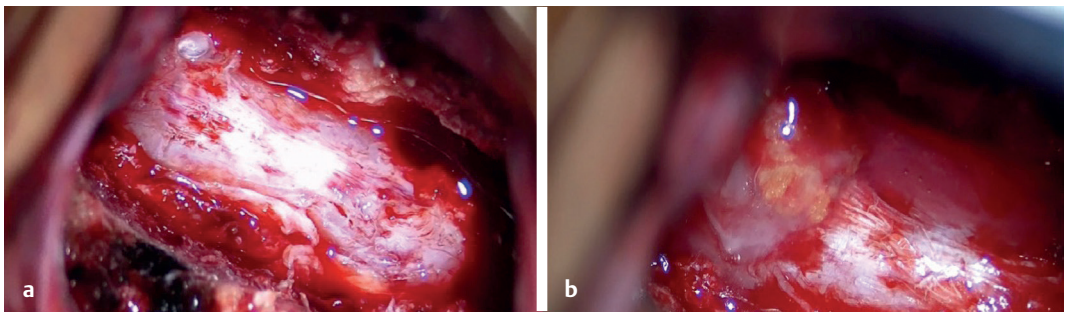

Fig. 12.3 **(a, b)** Intraoperative image showing dural tear with arachnoid herniation. Intraoperative image showing repair of the dural tear with an overlay free fat graft and reinforced with tissue glue. (Reproduced with permission from Department of Neurosurgery, AIIMS, Delhi).

out, the underlying calcified dura mater is difficult to drill because of two reasons: (1) thin layer of dural ossification offer no counter-resistance to facilitate drilling and (2) the end-point of drilling is not usually guarded by another distinct layer and abrupt disruption of arachnoid layer can lead to CSF leak. In this particular case, all precautions were taken not to expose the arachnoid but there was inadvertent dural tear. Fortunately, CSF leak was not encountered.

Postoperative Follow-Up

The patient gradually improved neurologically and was independent and able to carry out his routine works at 7 months follow-up. Cervical spine radiographs showed implants in situ without any evidence of failure or breakage or cage subsidence (**Fig. 12.4**).

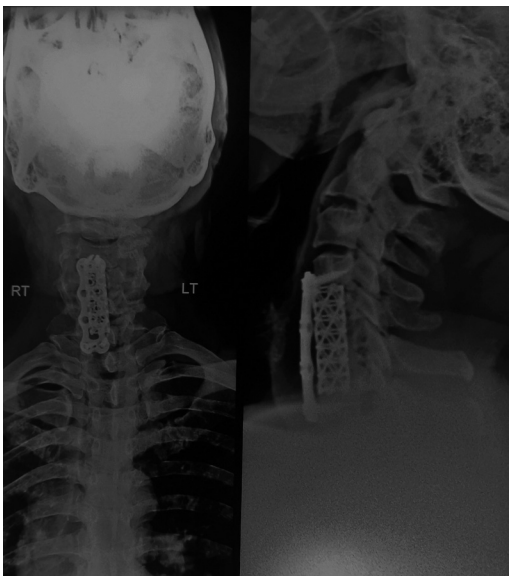

Fig. 12.4 Postoperative imaging—(postoperative day 1) anteroposterior (AP) and lateral radiograph showing implant construct in situ with restoration of cervical lordosis. (Reproduced with permission from Department of Neurosurgery, AIIMS, Delhi).

Discussion

Dural tear in cervical degenerative disease surgeries is infrequent and it is less common (average 1.3%) than in thoracolumbar surgeries (average 5.1%). Incidence of dural tear in anterior cervical approaches varies from 0.45 to 32% depending on the type and indication of surgery: for anterior cervical diskectomy and fusion (ACDF), 1.3%; for anterior cervical corpectomy and fusion (ACCF), 4.3%. For OPLL, anterior approach carries a 5.6% chance of dural tear (in one of the largest series), and it varies from 4.3 to 32%.

Certain etiologies carry a high risk for dural tear in degenerative cervical spine surgery. OPLL being the most prominent etiology involving dural tears with a relative risk (RR) of 19.2 (95% CI = 10.4–35.6) followed by cervical deformity (RR = 3.3, 95% CI = 1.6–6.6). Procedures involving a standard single-level corpectomy carries an RR of 2.1 (95% CI = 1.1–4.0). Revision surgeries also increase the risk of dural tear. In OPLL, dural tears are more frequently observed in those with a canal occupancy ratio (≥50%) and underlying dural ossification (63.6%) as compared to those without dural ossification (3.5%).

Anticipation and planning are important to prevent or reduce such complications. CT scan should be a part of imaging protocol in all cervical spine cases. In OPLL one should look for canal occupancy ratio and "double-layer sign." Choosing proper intraoperative strategies to manage dural tears is of paramount importance. Management strategies include primary repair or overlay fascia/fat/dural substitute. Primary repair is conceivably the best management option but approximately only 25% of the cases are amenable to primary repair. A potential risk

of using primary suture closure for small incidental dural tears is conversion of a low-pressure defect to high pressure pinholes from suture needles. Lumbar CSF drainage (3–5 days) creates a diversion for CSF with reported success rates of 83 to 100%. Care should be taken to prevent infection (up to 5% risk). Adjunctive measures like bed rest and head end elevation may be tried. Acetazolamide trial may be given. Approximately 80 to 88% patients post these interventions for dural tear remain asymptomatic and do not require any further intervention.

Take Home Message

- Intraoperative dural tears in anterior cervical spine surgeries are rare.
- Higher chances of dural tears are reported with OPLL, more so with additional underlying dural ossification.
- Primary repair of the dural tear is frequently not possible as the surrounding dura mater is also ossified and it is not pliable enough to get sutured.
- Fat/fascia and tissue glue supplemented by lumbar CSF drainage for few days remains the preferred practical solution.

Suggested Readings

Cerecedo-Lopez CD, Tafel I, Lak AM, et al. Surgical management of ossification of the posterior longitudinal ligament in the cervical spine. J Clin Neurosci 2020;72:191–197

Dave BR, Degulmadi D, Dahibhate S, Krishnan A, Patel D. Ultrasonic bone scalpel: utility in cervical corpectomy. A technical note. Eur Spine J 2019;28(2):380–385

Durand WM, DePasse JM, Kuris EO, Yang J, Daniels AH. Late-presenting dural tear: incidence, risk factors, and associated complications. Spine J 2018;18(11):2043–2050

Horn SR, Ayres EW, Segreto FA, et al. Ossification of the posterior longitudinal ligament in cervical spine cases trends in surgical treatments and outcomes in the US from 2005 to 2013. Bull Hosp Jt Dis 2020;78(2): 108–114

Kimura A, Shiraishi Y, Sugawara R, Inoue H, Endo T, Takeshita K. Impact of K-line (-) in the neck-flexion position on patient-reported outcomes after cervical laminoplasty for patients with ossification of the posterior longitudinal ligament. Clin Spine Surg 2019;32(9):382–386

Kuo CH, Kuo YH, Chang CC, et al. Combined anterior and posterior decompression with fusion for cervical ossification of the posterior longitudinal ligament. Front Surg 2022;8:730133

Le HV, Wick JB, Van BW, Klineberg EO. Ossification of the posterior longitudinal ligament: pathophysiology, diagnosis, and management. J Am Acad Orthop Surg 2022; 30(17):820–830

Lofrese G, Visani J, Cultrera F, De Bonis P, Tosatto L, Scerrati A. Anterior dural tear in thoracic and lumbar spinal fractures: single-center experience with coating technique and literature review of the available strategies. Life (Basel) 2021;11(9):875

O'Neill KR, Fehlings MG, Mroz TE, et al. A multicenter study of the presentation, treatment, and outcomes of cervical dural tears. Global Spine J 2017;7(1, Suppl):58S–63S

Phan A, Shah S, Joo P, Mesfin A. Can cervical and lumbar epidural blood patches help avoid revision surgery for symptomatic postoperative dural tears? World Neurosurg 2022;164:e877–e883

Yoshii T, Egawa S, Sakai K, et al. Perioperative complications in posterior surgeries for cervical ossification of the posterior longitudinal ligament: a prospective nationwide investigation. Clin Spine Surg 2021;34(10): E594–E600