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Incidence & management of inadvertent dural injury in lumbar spine surgery

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Abstract
Inadvertent dural tears are not uncommon events. Dural tears should be identified during surgery and should be proactively tackled to avoid postoperative complications. The consequences can range from mild and benign headache to tonsillar herniation, infection and even death. Early diagnosis is essential and MRI is the investigation of choice. Certain factors like the degree of stenosis, surgeon experience, ossification of the ligamentum flavum and compromised dural integrity are discussed. The authors discuss the various treatment options available for intraoperative dural tears depending on the stage of diagnosis and extent of the lesion.

Keywords: incidental durotomy, incidence, management

Introduction
Incidental durotomy is defined as an unintended dural laceration or tear [1]. Incidental dural tears are among the most commonly seen complications in spine surgery [2, 3] The incidence reported in the literature ranges from 1.7% to 16% [4]. A number of studies have studied the factors associated with dural tears. Weakened strength of the dural layer may be seen in the elderly and infections. Epstein reported ossification of the yellow ligament as the most significant cause of unintentional dural leaks in the elderly [5]. Similarly, an adhered and thinned out dura is often encountered in revision surgeries. Severe (very tight) spinal stenosis leads to folding of the redundant dura under the ligamentum flavum predisposing it to be caught in the Kerrison punch. Level of surgeon experience/expertise is understandably associated with higher incidence, although no surgeon is immune from it [6]. Kerrison is the most common instrument causing the CSF leak [7]. Instrumentation malposition is also associated with CSF leaks. Failure to preoperatively recognize spina bifida occulta and other defects of the posterior elements also increase the risk. CSF leaks following anterior cervical durotomies are also reported, though not well defined [8].

A CSF leak requires a high level of patient care as the consequences can be serious. A spinal headache is not only a telltale sign of CSF leak but also leads to significant disability to the patient and creates panic. A persistent CSF collection impedes the wound healing and acts as a direct entry for the organisms to the meninges. Superficial infections can spread deep and lead to subfascial infections, epidural abscesses and rarely meningitis. A long term continuous CSF leak may lead to pseudomeningocoele which can cause cord compression and even trap the nerve rootlets causing symptoms. Severe leaks can affect the blood-CSF flow dynamics and lead to cerebellar tonsillar herniation, intracranial haemorrhages, cranial nerve palsies and cerebral vasospasm. The CSF erodes the bone graft and hinders fusion. CSF leaks are a common cause of Medico-legal malpractice suits against surgeons [9]. Most of the dural tears are noticed intra-operatively as clear fluid. Only some are diagnosed post-operatively as clear fluid in drain or through the wound. Patients often complain of postural headache which is pathognomic. Other patients with recent surgery may develop wound swelling that may increase with Valsalva's maneauver. MRI is the investigation of choice, although all patients do not need it. Those with neurological symptoms and CSF leak, suspicion of infection/meningitis undergo an MRI. A pseudomeningocoele with its 'stalk' directed towards the dura helps to differentiate from a seroma apart from the signal characteristics. CT myelography is an alternative when MRI is not feasible or when instrumentation is suspected to be the cause of CSF leak.

Methods
Patients' records, operative notes, and radiographic images of all consecutive patients who underwent spine surgery performed by the two senior surgeons between February2020-December 2020 were retrospectively reviewed by a single independent observer. Patients treated for durotomies sustained during surgery at other institutions were excluded. Data reviewed included demographic data, diagnoses, details of surgery, mechanism of durotomy, treatment, and clinical evolution. A total of 30 cases were included during the study period.

Fig 1: Post-op MRI showing Pseudomeningocele formation opposite L4-L5

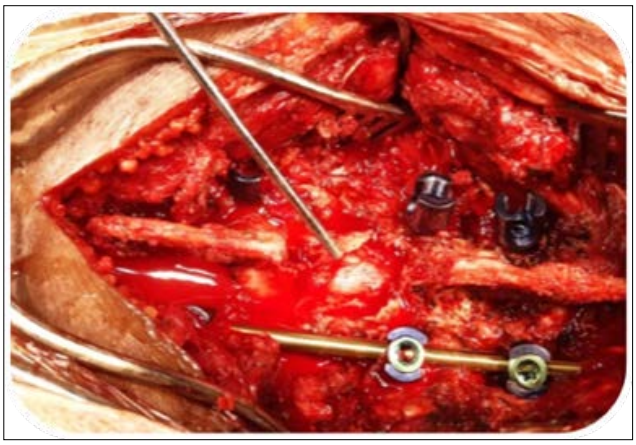


Fig 2: Dural tear in lumbar spine surgery

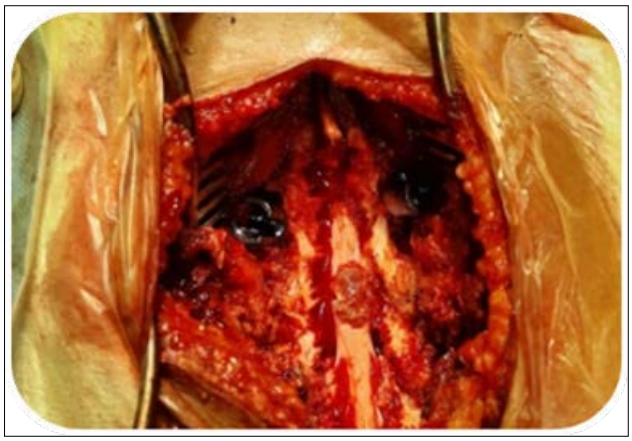


Fig 3: Dural tear repaired with mersilk 4-0 with muscle patch

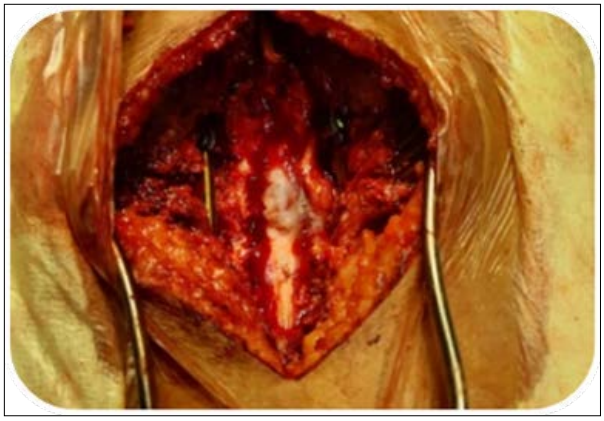


Fig 4: Dural tear repaired with mersilk 4-0 & fibrin glue & Post-op MRI of the same.

Management

Dural tears have to be closed primarily whenever possible. CSF outflow releases the tamponade effect on the epidural veins leading to brisk epidural bleeding. Blood in the CSF is a risk factor for late arachnoiditis and hence all efforts should be taken to reduce bleeding.

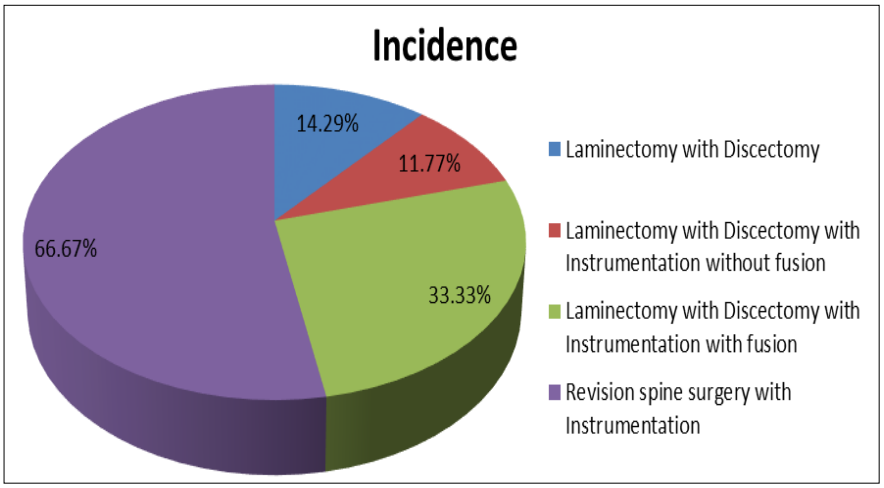
Great care should be taken to avoid rootlets being sucked into the suction system. It helps to reduce the suction pressure and having the assistant pinch kink the suction tubing to block the suction immediately in case of entrapment. At times the rent margins are ragged and may not approximate. Pulling up the margins to approximate may lead to iatrogenic stenosis and should be avoided. Not uncommonly, there is a breach in the dural layer with pouting of the intact CSF filled arachnoid layer. These rents must be repaired to avoid root entrapment. Full thickness dural tears with CSF outflow are best addressed by primary suturing. A round body needle is preferred to prevent CSF leak from the needle entry point. For the same reason, the needle diameter should be smaller than the suture diameter. Monofilament sutures should be avoided as they are difficult to handle due to filament memory and the knot tends to slide and unfurl. Both interrupted and continuous techniques with non-absorbable suture material are recommended. We prefer to use simple continuous suturing technique with 5-0 silk with a muscle patch. Incorporation of the muscle patch is easier with interrupted suturing technique. Additional sealing can be done with the help of fibrin glue over the dural repair, although not necessary if water tight closure of the dural layer has been achieved. In a literature review Epstein compared four different types of spinal sealants and found Tisseel (fibrin glue) to be the safe [10]. A Valslava's maneuver should be done to check for integrity of the repair. In the event that the dural margins are ragged and cannot be approximated, then dural patch may be used to substitute the defect. Alternatively, the dura can be left un-repaired making sure that the CSF is diverted away from the wound though a drain or a sub arachnoid lumbar CSF drain. The wound drain may be tunneled through the subcutaneous layer rather than direct 'head on' puncture, to allow it to self-collapse when removed. In principle, the diversion has to be maintained till the surgical wound has healed adequately, usually 4 to 7 days, to contain the CSF. In the ward the patient should be kept supine, preferably in head low position (not well tolerated by patients), for 24 to 72 hours and the CSF output in the drain should be monitored every 24 hours. It is safe to remove the drain when the CSF output is less than 100ml in 24 hours. In case of CSF leak from the drain site/wound site, additional stitch may be taken in the ward to achieve water tight closure. Use of anti-secretory drugs (Acetazolamide) is controversial.

Results

Table 1 shows the incidence of inadvertent dural tear according to procedure. Overall incidence of inadvertent dural tear was 20%. Inadvertent dural tear was found to be 14.29%, 11.77%, 33.33% and 66.67% of the subjects who underwent laminectomy with discectomy, laminectomy with discectomy with instrumentation without fusion, laminectomy with discectomy with instrumentation with fusion and revision spine surgery with instrumentation surgery respectively (graph 1).

Table 1: Incidence of inadvertent dural tear according to procedure

Surgical Procedure	Number of cases	Inadverdent Dural Tear	Incidence (%)
Laminectomy with Discectomy	7	1	14.29
Laminectomy with Discectomy with Instrumentation without fusion	17	2	11.77
Laminectomy with Discectomy with Instrumentation with fusion	3	1	33.33
Revision spine surgery with Instrumentation	3	2	66.67
Total	30	6	20



Graph 1: Incidence of inadvertent dural tear according to procedure

Complication was reported only in one case who underwent conservative approach with postoperative bed rest & without drain (table 2).

Table 2: Different forms of repair of dural tear vs post-op outcomes

Form of Repair	Number of cases	Symptomatic	Asymptomatic	Complication
Non Absorbable Suture with Muscle patch/Dural graft with Fibrin Glue	2	0	2	0
Non Absorbable Suture with Muscle patch/Dural graft without Fibrin Glue	1	0	1	0
Non Absorbable Suture without Muscle patch/Dural graft without Fibrin Glue	1	1	0	0
Conservative approach with Postoperative Bed Rest & without Drain	2	1	1	**1**

Discussions

The overall incidence of incidental durotomy varies from 1.7%-16% in the literature [7, 11-14]. The incidence is variable according to the indications and to the type of procedures (table 3). In our study, the incidence was 20%.

Table 3: Incidence of incidental durotomy

Author	Overall
Sin et al [7]	16
Guerin et al [11]	3.84
Camissa et al [12]	3.1
Wolff et al [13]	1.7
Kalevski et al [14]	12.66
Present Study	20

Dural tears are commonly associated with complex spinal surgeries and revision procedures. High speed drills and Kerrison's Ronguer are the most common tools associated with incidental durotomies and it must be used with caution while decompression procedures [11, 12]. Epstein [10] found three factors that contributed to dural tears: marked ossification of yellow ligament, high frequency of synovial cysts and prior surgery. Sin et al [7] concluded that patients' age and level of surgeons training were factors contributing to the incidence of dural tears. The most effective way to minimize the incidence of incidental durotomy is to prevent it. Pre-operative planning and meticulous surgical technique are necessary to reduce the incidence of durotomies. Non operative treatment of durotomies is unsuccessful and must be treated perioperatively. Ideally primary repair of dural tears should be done and is successful in most cases. Different studies have compared different treatment approaches to dural tears. Tafazel & Snell [15] in a study done in United Kingdom reported that 58% of surgeons used Prolene, 30% used a different suture material and 125 did not repair the dural tear. It is also possible to use muscle graft, fat graft, fibrin patch, fibrin glue and gelatin matrix if necessary [16, 17].

Limitations of the study

Since the number of dural tears was very low and the numbers were too low for a statistical analysis.

Conclusion

Incidental durotomy following thoracic and lumbar spinal surgeries is a common occurrence. The incidence increases significantly with revision surgeries and among surgeries performed by fellows in training. It is important to identify a dural tear intra-operatively and repair it primarily or seal it with surgicel and Gel foam or fat graft, so that complications like wound infection, pseudomeningocele and meningitis can be minimized.

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