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ORIGINAL ARTICLE

Incidence and treatment of delayed symptoms of CSF leak following lumbar spinal surgery

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Abstract
Purpose Dural tear (DT) resulting in cerebrospinal fluid (CSF) leak is a common complication of spinal surgery. Most cases of DT are recognised and addressed intraoperatively; however, a small percentage of cases may present at a later stage with delayed symptoms of CSF leak, either due to an unrecognised intraoperative DT or as a result of a de novo delayed DT. Apart from few reports describing delayed symptomatic CSF leaks, most studies tend not to separate intraoperatively recognised DTs from delayed symptomatic CSF leaks. To our knowledge, there are no long-term studies describing specifically the incidence and management of this complication. The aim of this study is to determine the incidence of late presentation of dural tear (LPDT) following lumbar spinal surgery, its treatment, associated complications and clinical outcomes from long-term follow-up in a consecutive series of patients.
Methods A retrospective review was conducted on 2052 consecutive patients who underwent spinal surgery by two spinal surgeons from 2000 to 2005 and 2007 to 2013 at two institutions.
Results A total of 2052 patient records were reviewed. Seventeen patients (0.83 %) were found to have LPDT, unrecognised intraoperatively. Fifteen patients required surgical intervention, one patient was treated with insertion of a subarachnoid drain and only one patient settled with conservative measures. Out of the 15 patients who underwent surgery, two patients required another operation and 2 patients were treated with a subarachnoid drain. At 9 months mean follow-up, there was no significant difference in outcome in cases with LPDT compared to those without.
Conclusion A delayed symptomatic presentation of DT unrecognised intraoperatively is a specific complication that needs to be recognised and treated appropriately. A high suspicion and vigilance can help discover and address delayed CSF leaks with no long-term sequelae.

Keywords Dural tear · CSF leak · Spinal surgery · Complications

Introduction

Dural tear is a relatively common complication of lumbar spinal surgery ranging from 1 to 17 % [1–4]. The vast majority of dural tears is recognised intraoperatively and treated successfully using primary repair, fibrin glue or tissue grafting. However, a small percentage of dural tears may go unrecognised and present with symptoms of cerebrospinal fluid (CSF) leak in the immediate postoperative period (≤5 days). Alternatively, there are cases, which go undetected intraoperatively and remain asymptomatic within the immediate postoperative period, but develop delayed symptoms of CSF leak (>5 days) following surgery.

The spine literature is relatively sparse of reports on late presentation of dural tears (LPDTs), as probably most studies reporting on dural tears include intraoperative and LPDTs in a single perioperative group. LPDTs or unrepaired durotomies can lead to the formation of CSF fistulas with predisposition to meningitis as well as pseudomeningoceles with headaches, back pain and root entrapment [5–8].

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To our knowledge, apart from an unrecognised intraoperative dural tear incidence of 0.28 % reported by Cammisa [9] and few case reports describing delayed presentation of dural tear [10–12], there are no specific studies demonstrating the incidence, management and outcome of symptomatic LPDTs unrecognised during lumbar spinal surgery. The aim of this study is to review the incidence and management of LPDTs presenting >5 days after the index surgical procedure in a consecutive series of 2052 cases.

Materials and methods

Our study population consisted of patients undergoing lumbar spine surgery between 2000 and 2013 by two surgeons. Patients treated between 2005 and 2007 were not included because of logistical difficulty in tracking the records. A total of 2052 lumbar spine procedures were included in this series. Patients with a minimum follow-up of 90 days were included to ensure inclusion of delayed CSF leaks, with an average follow-up of 9 months.

Patients with dural tears recognised intraoperatively or within 5 days after surgery accounted for 5.90 % of cases and were excluded from this study. Although there is no universal definition of LPDT, we considered that a patient had LPDT if symptoms of Low CSF pressure, such as postural headache, photophobia and nausea with definite evidence of extravasated collection of extradural CSF, confirmed on MRI scan ± beta-2-transferrin protein on an aspirated sample, developed after 5 days from surgery [5].

Late presentation dural tear (LPDT) was documented in 17 patients (0.83 %). Data recorded from these 17 cases included; demographic data, diagnosis, surgical details, time to diagnosis, treatment and outcome. Clinical outcome was defined as:

- excellent: totally asymptomatic
- good: symptoms improved significantly, full daily activities resumed, not taking any medication
- fair: partial symptom relief, limited daily activities
- poor: as compared to or worse than preoperative symptoms.

Results

There were 1027 males (50.0 %) and 1025 females (50.0 %). The average age at the time of surgery was 53.8 years (range 15–92 years). Primary surgery was performed in 1662 patients. Of the 2052 cases, 1780 had decompression and/or discectomy as sole or part of their procedure such as in combination with stabilisation, instrumented or non-instrumented fusion. The remaining 272 patients underwent lumbar surgery without decompression or discectomy. The distribution of cases by levels of decompression and preoperative diagnosis by LPDT are noted in Tables 1 and 2, respectively.

Of 2052 cases, 17 (0.83 %) sustained a LPDT ("Appendix"). The average age of patients with and without LPDT was 48.1 and 53.9 years, respectively. There were no cases of delayed CSF leak in patients who did not undergo decompression or discectomy. Similarly, there were no cases of LPDT in patients who underwent decompression ± discectomy with stabilisation, instrumented or non-instrumented fusion. The incidence of LPDT in primary cases was 0.90 % compared to 0.51 % in revision cases.

Clinical outcomes at follow-up were considered as: excellent, good, fair or poor. Our follow-up results showed that nearly 88.24 % of our cases with LPDT reported fair to excellent outcomes (Table 3). These results were not dissimilar to our patients without LPDT, with 89.75 % reporting fair to excellent outcomes.

Diagnosis of LPDT

Seventeen LPDT with postoperative symptomatic onset beyond 5 days were diagnosed at an average of 23 days (range 8–52 days). All seventeen patients complained of headache (100.00 %). Photophobia was reported in 6 patients (35 %), 7 patients (41 %) experienced nausea ± vomiting and 9 patients (53 %) had soft tissue swelling at the surgical site. Fifteen patients had a contained CSF leak and 2 had fistula with CSF leak through the skin.

Treatment

Patients with LPDT were either treated conservatively (Bed rest, Increased intake of fluids and Caffeine), surgically or by inserting a subarachnoid drain. Out of six patients initially treated conservatively, only one case was successfully treated after 1 month of bed rest. Conservative treatment was abandoned in the other five patients after an average 20.2 days of bed rest (range 4–60 days). Surgery was successful in all those five patients. One patient was successfully treated primarily with a subarachnoid drain and 6 days of bed rest. Of the remaining ten patients treated with surgery, six were successfully treated with one surgical procedure, two patients required further surgery,

Table 1 Incidence of LPDT as distributed by levels of decompression

Index surgery decompression	Postoperative CSF leak (LPDT) (%)	No postoperative CSF leak (%)	Total
No decompression	0 (0)	185 (100)	185
1 level, 1-sided discectomy/decompression	10 (1.18)	840 (98.82)	850
2 Level, 1-sided discectomy/decompression	1 (0.67)	148 (99.33)	149
1 level, bilateral discectomy/decompression	3 (0.77)	385 (99.23)	388
2 level, bilateral discectomy/decompression	3 (1.06)	281 (98.94)	284
3 or more levels discectomy/decompression	0 (0)	109 (100)	109
Other lumbar surgery (IDET, anterior)	0 (0)	87 (100)	87
Total	17 (0.83)	2035 (99.17)	2052 (100 %)

Table 2 Distribution of LPDT by diagnosis and preoperative symptoms

Diagnosis and symptoms	Delayed postoperative CSF leak (LPDT)	No CSF leak	Total cases
Lumbar stenosis without instability	5 (1.18)	418 (98.82)	423 (100.00)
Lumbar stenosis with instability	0 (0.00)	278 (100.00)	278 (100.00)
Predominantly leg pain due to disc prolapse	10 (1.74)	564 (98.26)	574 (100.00)
Combined lower back and leg pain due to disc prolapse/ degeneration	1 (0.19)	520 (99.81)	521 (100.00)
Pure lower back pain due to disc prolapse/facet joint arthropathy	0 (0.00)	68 (100.00)	68 (100.00)
Deformity/infection/fracture/spondylolytic spondylolisthesis	1 (0.53)	187 (99.47)	188 (100.00)
All	17 (0.83)	2035 (99.17)	2052 (100.00)

Table 3 Clinical outcomes at final follow-up comparing LPDT with no dural tear

Excellent–good–fair	Poor	All
Delayed postoperative CSF leak (LPDT)		
15 (88.24)	2 (11.76)	17 (100.00)
No delayed postoperative CSF leak (LPDT)		
1826 (89.73)	209 (10.27)	2035 (100.00)
All		
1841 (89.73)	211 (10.27)	2052 (100.00)

one patient required a subarachnoid drain and another one needed further surgery and a subarachnoid drain. One patient had confirmed preoperative infection and 2 had postoperative infection, which caused severe low back pain in the first 3 weeks but resolved with long course of antibiotics.

In total, 15 patients had surgery. A sharp bone spicule emanating from underneath the distal lamina edge or from the superior articular facet was found to have eroded through the dura in six patients. In five patients, no bony spicule was found to be in close contact with the thecal sac. In the remaining four patients, the cause of the dural tear was not recorded. Where a bony spicule was eroding through the dura, the spike was excised and Tisseel glue was applied over the dura in all cases treated surgically. All patients who underwent surgical exploration had tension sutures over a suction free drain. The drain was removed at 48–72 h. Patients were mobilised on the third postoperative day. All patients were given perioperative intra-venous antibiotics at induction with two further postoperative doses. Sutures were removed after 14 days. At 6 weeks follow-up, only three patients continued to report intermittent headaches, which eventually resolved in about 3 months.

Discussion

Incidental or inadvertent dural tear is a common complication of lumbar spine surgery. The majority of these dural tears are detected and addressed intraoperatively; however,

a small percentage of dural tears is not identified intraoperatively and may present in the immediate postoperative period with headache and photophobia when they assume an upright posture due to CSF leak [9, 13, 14]. Alternatively, there are even fewer cases of dural tears which go unnoticed in the immediate postoperative period and may present after many days, weeks or months with symptoms of CSF leak. Reports of pseudomeningocele development presenting as localised back pain or radiculopathy several weeks or even months after surgery exist [15–18], but there are only few case reports, each detailing 1–4 cases who had no recognised dural tear at the time of surgery but had sudden onset headache between 8 days to 3 months after surgery [10–12, 19]. Hershman and coworkers [11] reported an annual incidence of 2 cases per every 400 lumbar surgeries (0.5 %). Brookfield and colleagues reported two cases of delayed presentation of dural tear after lumbar spinal decompression presenting at 5 days and 5 weeks postoperatively. Cammisa et al. [9] reported the incidence of clinically significant durotomies undetected during spinal surgery at 0.28 % (6/2144 cases) with an average time to diagnosis of 20.8 days (range 5–45 days). Gerardi et al. reported a 6.8 % incidence of unrecognised dural tears [20]. In reality, the true incidence of unrecognised durotomies is difficult to obtain because the majority of patients are asymptomatic.

We believe that symptomatic delayed presentation of dural tears (LPDT) have unique features and deserve independent evaluation separate from intraoperatively recognised dural tears. Although patients with dural tear recognised intraoperatively are likely to have longer operating time and delay in discharge from hospital, they are overall managed successfully without long-term adverse sequelae [1, 4, 5]. In contrast, LPDT patients are typically satisfied with the surgical outcome in the early postoperative period; however, their recovery is halted when they develop symptoms of low CSF pressure. Most of these patients need further hospital admissions, bed rest and further surgical procedures to treat not their original symptoms of low back or leg pain but the new and different severe symptoms of postural headaches [18].

There are different possible explanations for the duration before the development of the delayed presentation of CSF leak. LPDT patients, by definition, are patients who had no intraoperatively recognised dural tear and had no symptoms of postural headache, photophobia and dizziness in the immediate postoperative period to suggest that a dural tear had already occurred at the time of surgery. All patients with LPDT developed sudden acute symptoms rather than gradual insidious onset of symptoms which would suggest that a late postoperative durotomy occurred at the same time of symptoms onset. One assumption for the development of LPDT is a weak dura or an incomplete dural tear that became complete with CSF leak at the time of severe headaches onset. An alternative possibility is that there was already a CSF leak at the time of surgery but the leak was contained in the sub-fascial layer, therefore a certain form of homeostasis between CSF production, which occurs at a rate of 0.3–0.6 ml/min, and CSF leak is maintained to keep the CSF pressure at approximately 100 mm H_2O [21, 22]. However, it may be possible that at the time of headaches onset, the CSF leaked into the subcutaneous layer through a rent in the fascia resulting in homeostasis disruption.

Different theories could explain the occurrence of late dural tears. An increased CSF pressure from Valsalva-inducing manoeuvres or physical activity may expand a weakened dura against a spicule of bone at the edge of the decompression site. This could result in erosion of the dura and CSF leakage. In our series, a bone spike was confirmed in six cases; therefore, we now routinely inspect the dura for leakage and the margins of the spinal canal for bone spicules prior to wound closure. An increased intra-abdominal pressure from violent movement early at the time of extubation or later as a result of sneezing or straining could also lead to LPDT. This is particularly illustrated in one of our patients who, 52 days postoperatively, developed symptoms of CSF leak following sexual intercourse [23].

In our routine practice, we perform lumbar spinal decompression with the operating table in a flexed position. Consequently, a residual bone spike could be away from the thecal sac intraoperatively, but after levelling and extending the table following wound closure, the bone spike may come into contact with the dural sac and potentially erode through the dura. We, therefore, advocate that the table is levelled and the margins of the laminotomies are inspected to ensure no sharp bony spikes are in contact with the dura.

Diagnosis of a dural tear postoperatively usually requires a combination of clinical history, physical examination, and imaging studies. The cases reported in our series had no visible subcutaneous fluid collection or wound drainage on physical examination in the immediate postoperative period; however, they had delayed onset of severe postural headaches, suspicious of CSF leak. Headaches are believed to occur secondary to cerebrospinal fluid leakage and decrease in intracranial pressure, which results in traction on

the meninges, blood vessels and subsequently pain. A clear, watery fluid discharge, augmented by the Valsalva manoeuvre and associated with headache, is a common sign of a fistula. A very sensitive and specific test to confirm the diagnosis of CSF is to determine the presence of beta-2-transferrin in a fluid sample. Magnetic resonance imaging is the diagnostic study of choice as it localises the CSF fistula tract or pseudomeningocele and may demonstrate the level of communication with the dural sac as well as spinal cord compression or nerve root entrapment.

We are not aware of any cases of delayed symptoms of CSF leak after lumbar spine surgery that have been reported beyond 3 months from surgery; therefore, any such symptoms after 3 months would in our opinion be very unlikely related to a CSF leak. We elected to use 5 days delay in symptoms of CSF leak as most case reports in the literature have onset of symptoms after 1 week and it is likely that those cases presenting in the immediate postoperative period are included with other cases recognised intraoperatively. This paper is not addressing the situation of asymptomatic pseudomeningocele that presents with a wound fluid lump, the treatment of which is most commonly observation and commonly the collection will resolve [24].

Most cases of LPDT reported in the literature [9, 17, 19] failed non-surgical treatment although there are some cases which were successfully treated conservatively. Hershman et al. [11] reported successful outcomes with epidural patch in two cases whose symptoms started 8 days and 3 weeks after surgery. We have not used the blood patch technique but used an intrathecal drain combined with bed rest for 5–7 days and was successful in all three cases (one primary and two as a salvage procedure after failed surgery). However, of the six cases treated with bed rest and increased fluid and caffeine intake, only one had their symptoms resolved.

We had no specific algorithm for management of delayed symptoms of CSF leak after lumbar spine surgery. Currently, as soon as a patient has symptoms of CSF leak within 3 months after lumbar surgery, blood tests including Full blood count, CRP and ESR and an MRI of Lumbar spine are carried out. Patients are kept on bed rest with increased fluid intake and Caffeine. If there is leakage of CSF through the skin, we recommend immediate specimen for culture and immediate surgical treatment with exploration and closure of CSF leak. Although few cases in the literature and in our series were treated non-surgically, we now have a low threshold to recommend immediate surgical treatment as significant percentage of cases in our series were found to have a bony spike directly digging into the dural tear which, in our opinion, would not heal conservatively, particularly if the tear was already present for weeks after surgery. We would recommend that the dural tear is identified and the overlying bony spike is removed with further laminotomy as needed. If possible, we recommend suture repair of the dural tear and application of a dural sealant and an additional 24–48 h period of bed rest prior to assuming an upright posture.

As far as we are aware, there are no reported cases of delayed symptoms of CSF leak following cervical or thoracic spinal surgery, anterior lumbar or posterior lumbar surgery that does not include decompression or discectomy. Cammisa et al. [9] reported an incidence of unrecognised intraoperative dural tears of 0.28 % in a consecutive series of cases that included 338 anterior cervical surgical cases. The incidence of LPDT in our case series of 0.83 % (17/2052) is certainly higher than that reported in the literature but our series is the only study reporting on the specific delayed symptoms of CSF leak following lumbar spinal surgery.

To decrease the incidence of LPDT, we recommend a meticulous spinal decompression ensuring good visualisation and haemostasis throughout the procedure. We advocate levelling the table before checking for spicules. In addition, we advocate the use of operating microscope for discectomy procedures and having an experienced assistant for these cases.

We also recommend that the consent form for a spinal procedure should not only include the complication of an intraoperative incidental durotomy but also that of a LPDT, with its associated symptoms of headache, dizziness and photophobia and the need for a delayed wound exploration and dural repair.

The important message is to be prudent about a late development of orthostatic headache following spinal surgery which may be the only symptom of late spinal fluid leak. Prompt investigations and adequate treatment address LPDT without long-term problems.

Conflict of interest None of the authors has any potential conflict of interest.

Appendix

See Table 4.

Table 4 Patients with late presentation of dural tear

Sex and age (years)	Diagnosis	Surgery performed	Onset of symptoms (days after surgery)	Headache	Nausea and/or vomiting	Photophobia	Other findings	Wound leak	Bone spike Cause of leak at surgery	Treatment	Surgery	Follow-up duration (months)	Outcome
Male, 47	Recurrent disc prolapse	Revision one level/one-sided discectomy	16	Headache	Yes	Yes	Meningitis due to wound infection	Open: CSF leak through skin	Not recorded	Surgery failed, complicated with infection and meningitis. Subarachnoid drain for 7 days and open wound treatment succeeded	Suture and Tisseal	14	Poor
Male, 35	Disc prolapse and stenosis	Primary two levels/bilateral decompression and discectomy	10	Headache	No	No	None	Closed	No bone spike	First surgery failed, complicated with infection. Second surgery succeeded	Tisseal. No sutures	8	Fair
Male, 66	Spinal stenosis	Primary one level/one-sided decompression	37	Headache	No	No	None	Open: CSF leak through skin	Not recorded	First surgery failed. Second surgery succeeded	Tisseal. No sutures	7	Fair
Female, 60	Spinal stenosis	Primary one level/bilateral decompression	41	Headache	Yes	Yes	MRI brain: subdural hematoma	Closed	No bone spike	Surgery succeeded	Tisseal. No sutures	5	Good
Female, 34	Disc prolapse	Primary one level/one-sided discectomy	23	Headache	Yes	Yes	MRI brain: subarachnoid hematoma	Closed	No surgery performed	Conservative succeeded	No surgery	44	Fair
Female, 60	Spinal stenosis	Primary one level/one-sided decompression	10	Headache	Yes	No	None	Closed	No bone spike	Conservative 2 months failed. Surgery succeeded	Tisseal. No sutures	4	Poor
male, 58	Spinal stenosis	Primary one level/one-sided decompression	20	Headache	No	No	None	Closed	Definite bone spike	Surgery succeeded	Tisseal. No sutures	5	Excellent
Male, 38	Disc prolapse	Primary one level/one-sided discectomy	34	Headache	No	No	None	Closed	No bone spike	Conservative 15 days failed. Surgery succeeded	Tisseal. No sutures	4	Excellent
Female, 29	Disc prolapse	Primary one level/bilateral discectomy	52	Headache	No	Yes	MRI brain: pachymeningeal enhancement	Closed.	No bone spike	Conservative 5 days failed with Preop infection confirmed with cultures. Surgery succeeded	Tisseal. No sutures	24	Good
Female, 33	Disc prolapse	Primary one level/bilateral discectomy	26	Headache	No	No	None	Closed	No surgery performed	Subarachnoid drain for 6 days succeeded	No surgery	3	Excellent

Table 4 continued

Sex and age (years)	Diagnosis	Surgery performed	Onset of symptoms (days after surgery)	Headache	Nausea and/or vomiting	Photophobia	Other findings	Wound leak	Bone spike Cause of leak at surgery	Treatment	Surgery	Follow-up duration (months)	Outcome
Female, 61	Deformity and stenosis	Revision two levels/bilateral decompression	30	Headache	No	No	None	Closed	Definite bone spike	Surgery succeeded	Tisseal. No sutures	26	Good
Male, 32	Disc prolapse	Primary one level/one-sided discectomy	21	Headache	No	No	Vertigo and dizziness	Closed	Not recorded	Surgery complicated with infection succeeded	Tisseal. No sutures	7	Fair
Male, 61	Spinal stenosis and foraminal disc prolapse	primary two levels/bilateral decompression	16	Headache	Yes	Yes	None	Closed	Not recorded	Surgery failed. Subarachnoid drain suuceeded	Tisseal. No sutures	6	Good
Female, 63	Disc prolapse	Primary one level/bilateral discectomy	13	Headache	No	No	None	Closed	Definite bone spike	Surgery succeeded	Tisseal. No sutures	2.5	Excellent
Male, 39	Disc prolapse	Primary two level/one-sided discectomy	10	Headache	Yes	Yes	None	Closed	Definite bone spike	Surgery succeeded	Tisseal. No sutures	4.5	Excellent
Female, 42	Disc prolapse	Primary one level/one-sided discectomy	8	Headache	Yes	Yes	Meningitis12 years before surgery and head concussion 2 months before surgery	Closed	Definite bone spike	Conservative 17 days failed. Surgery succeeded	Tisseal. No sutures	6	Good
Male, 59	Spinal stenosis	Primary one level/one-sided decompression	17	Headache	Yes	No	None	Closed	Definite bone spike	Conservative 4 days failed. Surgery succeeded	Tisseal. No sutures	3	Fair

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