Research article

Post-operative spinal epidural hematoma causing American Spinal Injury Association B spinal cord injury in patients with suction wound drains

Peter Chimenti, Robert Molinari

University of Rochester, Rochester, NY, USA

Background: Subfascial wound suction drains are commonly used after spinal surgery to decrease the incidence of post-operative hematoma. However, there is a paucity of literature regarding their effectiveness.

Objective: To report four cases of post-operative spinal epidural hematoma causing massive neurological deficit in patients who had subfascial suction wound drains.

Methods: During an 8-year period, a retrospective review of 1750 consecutive adult spinal surgery cases was performed to determine the incidence, commonalities, and outcomes of catastrophic neurological deficit caused by post-operative spinal epidural hematoma.

Findings: Epidural hematoma causing major neurological deficit (American Spinal Injury Association B) was identified in 4 out of 1750 patients (0.23%). All four patients in this series had subfascial wound suction drains placed prophylactically at the conclusion of their initial procedure.

Results: Three patients developed massive neurological deficits with the drain in place; one patient had the drain removed at 24 hours and subsequently developed neurological symptoms during the following post-operative day. Significant risk factors for the development of hematoma were identified in two of the four patients. Average time to return to the operating room for hematoma evacuation was 6 hours (range 3–12 hours). Neurological status significantly improved in all four patients after hematoma evacuation.

Conclusions: Post-operative epidural hematoma causing catastrophic neurological deficit is a rare complication after spinal surgery. The presence of suction wound drains does not appear to prevent the occurrence of this devastating complication.

Keywords: Epidural hematoma, Suction drainage, Spinal cord injuries, Laminectomy, Spinal decompression

Introduction

Catastrophic neurological deficit due to symptomatic post-operative spinal epidural hematoma is among the most feared complications of spinal surgery. Although the exact incidence is unknown, it has been estimated to affect 0.2% of patients undergoing all types of spinal surgeries.^{1–4} Placement of a subfascial wound suction drain is thought to decrease the incidence of this complication through drainage of the epidural space. Nonetheless, it remains unclear as to what the role of suction drains is

in reducing the incidence of post-operative epidural hematoma. The purpose of our study is to identify the incidence of post-operative spinal hematoma causing catastrophic neurological deficit in patients who had subfascial wound drains, and to identify potential risk factors associated with this devastating post-operative complication. We reviewed 1750 consecutive cases from the senior author from 2003 through 2011 and identified four patients who suffered a major neurological deficit due to epidural hematoma post-operatively. In each case, documentation was made of a functional wound suction drain present despite the patients' symptomatic presentation.

Correspondence to: Peter Chimenti, University of Rochester Medical Center, 601 Elmwood Avenue, Box 665, Rochester, NY 14642, USA.
Email: Peter_chimenti@urmc.rochester.edu

Methods

A total of 1750 consecutive open spinal surgical cases were performed during the years 2003–2011 by the same surgeon at a single level-one university medical center. A retrospective review of a surgical database was performed for inclusion in this case series. Descriptive statistics were used to calculate the incidence of post-operative epidural hematoma causing catastrophic neurological deficit. An analysis of the risk factors for post-operative hematoma formation was performed among the identified patients.

Results

Four out of 1750 spinal surgery patients in this case series were identified as having a post-operative epidural hematoma causing major neurological deficit American Spinal Injury Association (ASIA B). The overall incidence is 0.23% in this study. The mean age of the four patients was 73 years, range 63–83 years (Table 1). Two patients were male and two were female. Pre-operative risk factors included age >60 years in all patients, use of non-steroidal anti-inflammatories (NSAIDs) in two, and the presence of metastatic renal cell carcinoma (RCC) at the operative site in another. All four patients in the study had medium-sized Jackson-Pratt® (Cardinal Health, Dublin, OH, USA) closed-wound suction drains placed prophylactically prior to the closure of the wound. All drains were noted to have functional suction with blood present in the drainage container post-operatively, and all but one was noted to be holding functional wound suction at the onset of neurological symptoms. All patients experienced a neurological injury consistent with the American Spinal Cord Injury classification of ASIA B.⁵ Mean time to return to the operating room from symptom onset was 6 hours, range 3–12 hours. Post-operatively all patients experienced complete neurological recovery at the time of latest follow-up with the exception of one patient who had persistent bowel and bladder impairment.

Case 1

A 63-year-old man with no significant history presented with 3 months of neck pain radiating to the right

shoulder and arm that was refractory to treatment with both NSAIDs and gabapentin. He exhibited a positive Hoffman's reflex on the right at initial evaluation but was otherwise neurologically intact. Plain radiographs showed severe cervical spondylosis at multiple levels including C3–C4 and C6–C7. Magnetic resonance imaging (MRI) showed C3–C4 stenosis without significant myelomalacia. At 1-year follow-up he was noted to have increasing difficulty with balance during ambulation, as well as weakness in his upper extremities bilaterally, and was indicated for operative intervention at that time.

He was taken to the operating room for C3–C5 posterior cervical decompression with C4 laminectomy. Blood loss was estimated at 100 ml, and two medium subfascial wound suction drains were placed prophylactically. Two hours post-operatively the patient was neurologically intact with full strength in his bilateral upper and lower extremities. At 3 hours post-operatively, the patient began to complain of inability to move the arms or legs and physical examination confirmed flaccid paralysis in bilateral upper and lower extremities including 0/5 deltoid strength bilaterally with intact sensation to light touch throughout. The wound drains were noted to be functional and holding suction with serosanguineous fluid present. He was in transport to the operating room for emergent surgical decompression when he spontaneously regained some movement in his arms (3/5 deltoid/bicep strength) at which time he was diverted to the MRI scanner for cervical spine imaging.

The MRI demonstrated a 4 cm ×4 cm collection of epidural hematoma causing severe compression at the level of C3–C4; the surgical drain was seen within the hematoma (Fig. 1). He was taken back to the operating room within 4 hours of the development of neurological deficit for evacuation of the hematoma; surgical findings included hemorrhagic tissue within the wound bed. Coagulation was performed with bipolar electrocautery and the wound was noted to be dry at the conclusion of the procedure. Two medium subfascial wound suction drains were placed before closure.

Post-operatively he was transferred to the Intensive Care Unit (ICU) and was noted to have 5/5 strength

Table 1 Patient demographics and pre-operative risk factors for epidural hematoma formation

Patient	Age	Procedure	Estimated blood loss (ml)	Identified risk factors
1	63	C3–C5 decompression, C4 laminectomy	100	Pre-operative NSAID use, age >60
2	78	L2–L3 decompression	50	Age >60
3	83	Bilateral T9 transpedicular decompression, PLIF T6–T11 with local bone graft	850	Age >60, metastatic renal cell carcinoma at T9
4	67	L2–S1 lumbar decompression	200	Age >60, NSAID use

Figure 1 Sagittal T2-weighted MRI of the cervical spine showing an epidural fluid collection causing compression of the cord at the level of C3–C4.

in his bilateral lower extremities and 4/5 strength in bilateral shoulder abduction, elbow flexion, and wrist extension but 5/5 strength in intrinsic hand muscles. Drains were continued until post-operative day 5 and were removed without complication. At his 6-week and 4-month follow-up visits, he demonstrated 5/5 strength throughout his bilateral upper and lower extremities, as well as normal gait.

Case 2

A 78-year-old woman presented with complaints of back pain, difficulty with standing, and pain with ambulation worsening during the past year. She had a surgical history of L3–L4 and L4–L5 decompression with L4–L5 instrumented posterolateral fusion 7 years prior for degenerative spondylolisthesis. MRI showed severe spinal stenosis at L2–L3. Given her poor quality-of-life and difficulty with activities of daily living, operative intervention was pursued. Pre-operatively, she was not on any anticoagulation and had a pre-operative hemoglobin of 12.7 g/dl.

She was taken to the operating room for L2–L3 bilateral lumbar decompression. Blood loss was estimated at 50 ml, the wound was noted to be dry at the conclusion of the procedure and one medium wound suction drain was placed prophylactically. One-hour post-operatively, the patient began to complain of severe bilateral lower-extremity pain rated at 10/10 along with pressure and a sensation of heaviness in her legs. Physical examination revealed 1–2/5 strength in all muscle groups of her bilateral lower extremities, weak rectal tone with no volitional control but intact sensation to light touch. Note was made of a functional suction drain in place with 75 ml of serosanguineous fluid present. MRI of the

Figure 2 Sagittal T2-weighted contrast-enhanced MRI of the lumbar spine showing compression of the cord at L2–L3 and an epidural fluid collection extending from T11 to L3.

thoracic and lumbar spine was immediately obtained demonstrating an epidural hematoma extending from T11 to L3 with anterior displacement of the cord (Fig. 2).

She was taken back to the operating room within 3 hours of the onset of neurological symptoms. Intraoperatively a large expansile hematoma was encountered at the level of the prior laminotomy. Prophylactic laminectomy of L1–L2 was performed with the placement of two medium drains into the thoracic epidural space and one large subfascial wound drain. Immediate post-operative examination in the Post-Anesthesia Care Unit (PACU) demonstrated 4/5 strength throughout her bilateral lower extremities with no sensory loss and good rectal tone. On post-operative day 1, she had recovered full strength in her legs with the exception of 3/5 hip flexion on the left. At her 2-month follow-up visit, she had recovered to her baseline, reported overall improvement in her back pain, and was ambulating with a walker. Examination showed full strength in all muscle groups and no sensory deficit.

Case 3

An 83-year-old woman presented to the emergency department with a complaint of mid-thoracic back pain worsening over several months. The patient had a history of metastatic RCC and had previously been on chemotherapy but stopped due to the development of pancreatitis and congestive heart failure. MRI revealed a pathologic fracture of T9 with over 50% loss of vertebral body height and retropulsion of the fracture fragments with severe canal stenosis at T9. Physical examination on admission showed intact bilateral

upper-extremity strength, 3/5 right hip flexion, and 4/5 strength in the remaining muscle groups. Sensation to both light touch and pinprick was diminished from the T9 to S4 dermatomes. Her pre-operative hemoglobin was 11.4 g/dl and she was not on anticoagulant medication.

She was taken to the operating room for bilateral T9 transpedicular decompression and instrumented posterolateral fusion of T6 through T11 with local bone graft. During the case, severe bleeding was encountered with the transpedicular decompression in the region of the tumor. This was controlled with Gelfoam and bipolar electrocautery. The wound was irrigated and noted to be dry. Blood loss was estimated at 850 ml. One subfascial medium wound drain was placed. As the patient left the operating room she was noted to be able to move her lower extremities bilaterally and have intact light-touch sensation.

Thirty minutes after arrival in the PACU she lost all motor and sensory function below the level of T9. At this point there was serosanguineous fluid in the suction drain. An immediate MRI showed a posterior

epidural hematoma at T8 and T9 causing anterior displacement of the cord and cord compression (Fig. 3). The patient was brought back to the operating room within 90 minutes of neurological decline for evacuation of a coagulated hematoma and additional coagulation with bipolar electrocautery. On second return to the PACU, she regained full motor and sensory function and was monitored for several days in the ICU. More than 1-year post-operatively, she was ambulating with a walker and had full strength in her lower extremities.

Case 4

This case has been reported previously by the senior author.⁶ Briefly, a 67-year-old man had experienced several months of disabling neurogenic claudication and had an MRI that demonstrated multilevel degenerative lumbar stenosis from L2 to the sacrum. He was not on anticoagulant medication pre-operatively and was evaluated by his cardiologist prior to operative intervention. He was taken to the operating room for four-level lumbar decompression from L2–3 to L5–S1. Blood loss was estimated at 200 ml. A medium subfascial drain was placed prophylactically and was noted to be functional post-operatively with a small amount of serosanguineous fluid present. Thirteen hours after surgery the patient developed evidence of myocardial ischemia and he was begun on a heparin drip. At 24 hours after surgery, the drain was noted to have 50 ml of fluid present and the patient denied neurological symptoms, therefore the drain was removed. At 48 hours post-operatively, he began to develop sharp, severe pain in his bilateral lower extremities and physical examination revealed decreased rectal tone, a T7 sensory level, and bilateral lower extremity paralysis.

Decompression of the surgical site was performed at bedside by removal of the sutures from the incision and drainage of an extensive amount of hematoma. The symptoms did not resolve with this, and the patient was taken for an emergent MRI that revealed an extensive epidural hematoma from C4 to the lumbosacral spine (Fig. 4). Fresh-frozen plasma and vitamin K were given for reversal of anticoagulation and he was emergently taken to the operating room for evacuation of a consolidated hematoma. Primary laminectomy in the cervical and thoracic spine was necessary to drain the hematoma; revision laminectomy was necessary in the lumbosacral spine. One epidural and two subfascial drains were placed at the conclusion of the case. Post-operatively, he remained off anticoagulation and had a prophylactic inferior vena cava filter placed for thromboprophylaxis. Two-week post-operatively, he exhibited complete neurological recovery with the exception of

Figure 3 T2-weighted sagittal MRI of the lumbar spine of showing posterior fluid collection at T8–T9 displacing the spinal cord anteriorly.

Figure 4 (A) T2-weighted MRI of the cervical and thoracic spine showing extensive hematoma extending to C4 with moderate compression of the thecal sac noted. (B) T2-weighted MRI of the thoracolumbar spine demonstrating continuation of the hematoma to L4 caudally.

bowel and bladder function that remained impaired until his most recent follow-up visit 4 years post-operatively.

Discussion

Symptomatic post-operative epidural hematoma is a very rare, but potentially devastating, complication of spinal surgery. Previous reports suggest that the incidence is approximately 0.2%.¹⁻⁴ Out of 1750 consecutive patients undergoing spinal surgery between 2003 and 2011, we identified 4 patients with major neurological deficit due to post-operative epidural hematoma giving an incidence of 0.23%, consistent with the reported literature. All four patients in our study were noted to have had functional subfascial suction wound drains after surgery. Maintaining a high index of suspicion for the diagnosis of post-operative spinal epidural hematoma is critical, as neurological outcomes are inversely correlated both with the duration of maximal neurological deficit and time from symptom onset to surgical intervention.⁷ Outcomes are generally favorable assuming prompt diagnosis and treatment. Lawton *et al.*⁷ reported on 30 patients with spinal epidural hematoma and found that 87% achieved a functional level of neurological recovery. Those patients who had surgical

intervention within 6 hours of symptom onset exhibited complete recovery at a rate of 67%, whereas a delay of 24 or more hours to surgical intervention lowered the rate of complete recovery to 12%. In our series, all patients except for one achieved a complete level of recovery with full return to baseline neurological status; one patient had persistent bowel and bladder impairment. Our mean time to return to the operating room was 6 hours with a range of 3–12 hours. Although an absolute time limit for surgical intervention in patients with epidural hematoma has not been established, it is clear that early diagnosis and decompression are beneficial.

Closed-wound suction drains are commonly used in orthopedic surgery to decrease the rate of both wound infection and hematomas. A recent systematic review by Parker *et al.*⁸ looked at the use of wound suction drains across all types of orthopedic procedures and found no significant difference in the rates of post-operative infection or hematomas; however, the review did find an association between the use of drains and the need for post-operative blood transfusions. Brown and Brookfield⁹ prospectively randomized 83 patients to have a drain placed or not, and followed them for post-operative complications. No epidural hematomas, infections, or neurological deficits were seen in either

group in their study. The authors concluded that drain placement be left to the discretion of the surgeon.

Other studies looking at the placement of wound suction drains have not demonstrated their benefit conclusively. Walid *et al.*¹⁰ retrospectively looked at 402 patients who had lumbar decompression and fusion and found a drain placement rate of 70% with no difference in the rates of post-operative wound infection or hematoma between the group with and without a drain placed. There was a statistically significant increase in the rate of post-operative blood transfusion among patients with a drain from 6 to 39%; however, interpretation of this finding is limited by the retrospective nature of the study. Mirzai *et al.*¹¹ prospectively randomized 50 patients undergoing single-level lumbar discectomy into two groups, one with drains placed and one without, and performed an MRI on all patients on post-operative day 1. The group without drains developed an epidural fluid collection at a significantly higher rate of 89% compared to 36% of those with drains. There was a trend toward improved clinical outcome scores at 6 months among those with a drain but this did not reach significance.

Several studies have examined risk factors for the development of epidural hematoma and have not found drain placement to be a significant risk factor. Awad *et al.*¹² retrospectively analyzed 14 932 patients over 18 years and found an incidence of 0.2% for epidural hematoma post-operatively. Risk factors leading to the development of epidural hematoma in their study included age >60 years, pre-operative NSAID use, more than five operative levels, hemoglobin less than 10 g/dl, and intraoperative blood loss more than 1 l. Post-operative coagulopathy, international normalized ratio (INR) more than 2.0, was also a significant risk factor within the first 48 hours after surgery. Subfascial drain placement was not associated with the development of epidural hematoma.

In this review, we identified several significant risk factors among this series of patients pre-operatively (Table 1). All patients were older than age 60 years and two were taking NSAIDs pre-operatively. No patient in this series was coagulopathic with an elevated INR pre- or post-operatively with the exception of case 4 who was begun on anticoagulation post-operatively. No patient received chemoprophylaxis for deep venous thrombosis post-operatively; all patients were given intermittent pneumatic compression stockings for this purpose. Case 3 had a likely metastatic RCC lesion in the thoracic spine; RCC is a highly vascular tumor and this is reflected in the intraoperative estimated blood loss of 850 ml for this case. Despite a high index of suspicion and placement of a wound drain,

this patient still experienced a symptomatic epidural hematoma. This study was not the first to describe this complication; previous reports have documented cases of major neurological deficit with the presence of a functional suction drain. Yi *et al.*¹³ reported on nine patients with post-operative epidural hematoma of whom six had functional suction drains in place.

At our institution, all patients have subfascial wound suction drains placed prophylactically prior to closure. All patients in this series had documented output in their drain post-operatively, which supports the conclusion that these drains were working effectively to drain any developing epidural fluid collection. It is possible that at some point these drains become clotted and are no longer effective. No patient in this series had a drain that was completely full thus rendering it non-functional, which rules this out as a possibility for why the drain may fail. Case 4 in this series had his drain removed on post-operative day 1 after a recorded output of 50 ml, approximately 24 hours prior to the development of neurological compromise. Although this patient had a clearly identifiable risk factor of level 1 anticoagulation given for a perioperative MI, the possibility that his epidural hematoma developed before initiation of heparin therapy while the drain was still in place cannot be completely excluded.

We report four patients who developed early post-operative severe neurological deficit from spinal epidural hematoma despite having documentation of functional subfascial suction wound drains. The incidence of this devastating complication appears to be low in patients with suction wound drains. We identified only two prospective, randomized controlled studies^{9,11} in the currently available literature which directly address drain placement. This lack of high-quality data makes evidence-based recommendations regarding prophylactic drain placement difficult and highlights the need for continued investigation. Nonetheless, spinal surgeons should be cognizant of the fact that early post-operative catastrophic neurological demise from spinal epidural hematoma may occur in patients who have functional suction wound drains.

Conclusions

Post-operative spinal epidural hematoma is a very rare, but potentially devastating, complication after spinal surgery. Prompt diagnosis and intervention are crucial for achieving good functional outcomes. In this case series, we report on four patients who had spinal surgical procedures performed in a different region of the spine (cervical, thoracic, and lumbar);

each patient had one or more drains placed, and each developed an epidural hematoma causing massive neurological deficit. At least one risk factor (age >60) was present in all patients. Functional neurological recovery was achieved in all four cases, although one patient had persistent neurogenic bowel and bladder. The presence of a prophylactic wound suction drain does not appear to prevent the occurrence of this serious complication.

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