Original Article

Symptomatic postoperative spinal epidural hematoma preferentially occurs after anterior cervical discectomy and fusion versus anterior cervical corpectomy and fusion: a retrospective study

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Background: Cervical spondylotic myelopathy (CSM) is a common cause of neurological morbidity, which can have an impact on quality of life. Symptomatic postoperative spinal epidural hematoma (SPSEH) is a rare condition, but can cause permanent neurological deficits and disability if not managed properly. However, there are limited studies on the outcomes of SPSEH after anterior cervical discectomy and fusion (ACDF) and anterior cervical corpectomy and fusion (ACCF) were performed for 2-level CSM. Therefore, the aim of the present study was to compare the clinical outcomes and incidence of SPSEH after ACDF compared with SPSEH after anterior cervical corpectomy and ACCF for 2-level CSM to reduce surgical complications of 2 level CSM.

Methods: A total of 551 patients (261 males and 290 females) who underwent ACDF or ACCF for 2-level CSM from January 2009 to February 2015 were retrospectively reviewed. Preoperative indexes (age, sex, body mass index, bone mineral density, preoperative coagulation, and past medical history), perioperative indexes (length of hospital admission, blood loss, and operation times), preoperative and postoperative neurological statuses, complications, fusion rate, and the SPSEH incidence for ACDF or ACCF were compared simultaneously.

Results: With the exception of blood loss (P<0.001), no significant differences were observed between the 2 groups in terms of sex, prothrombin time, activated partial thromboplastin time, platelet count, length of hospital admission, operation time, the final follow-up Japanese Orthopedic Association score, visual analog scale score, fusion rate, and complications. The overall incidence rate for SPSEH after ACDF was 1.9%, while the rate for SPSEH after ACCF was 0.4%. Following hematoma removal, only one patient showed any improvement in neurological function, despite treatment with hyperbaric oxygen and neurotrophic drugs.

Conclusions: The findings indicated that surgical management of 2-level CSM using ACDF or ACCF showed similar clinical outcomes, fusion rate, complications, and perioperative parameters, with the exception of blood loss. However, SPSEH preferentially occurs after surgery with ACDF. Therefore, whether ACCF surgery for 2-stage CSM is the superior treatment modality.

Keywords: Symptomatic postoperative spinal epidural hematoma (SPSEH); anterior cervical discectomy and fusion (ACDF); anterior cervical corpectomy and fusion (ACCF); cervical spondylotic myelopathy (CSM); retrospective study

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Introduction

Cervical spondylotic myelopathy (CSM) is a common cause of neurological morbidity, and can impact quality of life (1,2). Many studies recommend surgical decompression for CSM. Generally, for patients with 2-level CSM, most surgeons prefer anterior surgery (3,4). For example, vertebrectomy may be considered in patients with developmental vertebral stenosis, large posterior osteophytes adjacent to the endplates, retrograde displacement of free disc fragments into the vertebral body, or a need to reduce the number of fusion surfaces (5). Moreover, some surgeons use anterior cervical discectomy and fusion (ACDF) and anterior cervical corpectomy and fusion (ACCF). Studies have shown that when compression is limited to the disc level, ACDF is superior to ACCF because ACDF has less blood loss, shorter hospital stay, and fewer postoperative complications (6-8). However, when compression is extended to the vertebral level, ACCF is preferable to ACCF because it achieves satisfactory decompression at the vertebral level (6). For ACCF was associated with a higher incidence of complications, including vertebral artery, dura tear, and CSM leakage. ACDF may not be the best choice for incomplete decompression, spinal cord injury, limited visual exposure, and high risk of pseudoarticulation due to an increased number of fused surfaces (9). Meanwhile, among the previous systematic review studies on multilevel cervical spondylosis between ACCF and ACDF, 6 had similar results, and 3 showed that ACCF was superior to ACDF in neurological prognosis (7-9). However, it is difficult to select between ACDF or ACCF for surgery. If 2-level CSM is not included the aforementioned corpectomy criteria, 2-level ACDF or 1-level ACCF for surgery could be an alternative.

Postoperative spinal epidural hematoma (SEH) is a common hematoma that can be identified by computed tomography (CT) scan or magnetic resonance imaging (MRI) in 33–100% of surgical cases (10-15). The majority of these cases have no symptoms (16). However, if cervical spine SEH becomes symptomatic, the consequences can be rapidly progressive quadriplegia, respiratory failure, and even death. Accurate and prompt diagnosis and surgical treatment are imperative to maximize neurological recovery (17-20).

According to our understanding, there was no study has investigated and compared the outcomes and incidence of symptomatic postoperative SEH (SPSEH) after ACDF and ACCF for 2-level CSM. The purpose of the present study was to compare the clinical outcomes and incidence of SPSEH after ACDF and ACCF. The findings of our study will provide a scientific basis for the choice of surgical approach for 2-level CSM. We present the following article in accordance with the STROBE reporting checklist (available at https://apm.amegroups.com/article/view/10.21037/apm-22-488/rc).

Methods

Baseline of clinical data

The clinical records of patients at our hospital who underwent surgical treatment due only to 2-level CSM from January 2009 to February 2015 were reviewed. Patients with cervical myelopathy due to ossification of the posterior longitudinal ligament (OPLL) were excluded from the study. A total of 551 patients were enrolled in the present study (261 men and 290 women, mean age was 58.1±9.43 years). All patients reported discontinuation of anticoagulant medication for at least 7 days before surgery. Ethical approval was obtained from the medical ethics committee of Affiliated Traditional Chinese Medicine Hospital of Southwest Medical University. Informed consent was obtained from each patient. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). Patients were divided into the following 2 groups based on the surgery they received: the ACDF group and the ACCF group. The ACDF group consisted of 302 patients (141 men and 161 women, mean age: 58.80±9.70 years), and the ACCF group consisted of 249 patients (120 men and 129 women, mean age: 57.90±10.10 years).

All surgeries were performed by the same surgical team. The discectomies used cages (Syncage, Synthes, Switzerland) with local autograft bone and semi-constrained plating systems (Atlantis; Medtronic Sofamor Danek, Memphis, TN, USA and Codman; Johnson, Raynham, MA, USA). The corpectomy procedures used titanium mesh cages with local autograft bone and semi-constrained

Table 1 Patient preoperative parameters after 2-level ACDF or 1-level ACCF

Preoperative parameters	2-level ACDF	1-level ACCF	P value
Age (years)	58.80±9.70	57.90±10.10	0.17
Sex (proportion of male, %)	47	49	0.66
BMI (kg/m^2)	24.06±5.15	23.78±3.91	0.44
BMD (g/cm^2)	1.11±0.14	1.12±0.18	0.38
PT (s)	12.14±1.69	12.30±2.03	0.33
APTT (s)	32.89±4.36	33.52±3.54	0.06
PLT (10^3/μL)	197.60±52.62	193.35±52.96	0.35
MAP (mmHg)	75.52±7.01	75.85±7.06	0.57
Segment (C3–5/C4–6/C5–7)	98/121/83	80/101/68	0.99

There were no significant differences between the 2 groups. ACCF, anterior cervical corpectomy and fusion; ACDF, anterior cervical discectomy and fusion; APTT, activated partial thromboplastin time; BMI, body mass index; BMD, Bone mineral density; MAP, mean arterial pressure; PLT, platelets; PT, prothrombin time.

plating systems (Atlantis; Medtronic Sofamor Danek, USA, and Codman; Johnson, USA). All patients wore a semi-rigid cervical collar for immobilization for at least 6 weeks postoperatively.

For the 2 procedures, we reviewed and compared each study participant's age, sex, body mass index (BMI), bone mineral density (BMD), preoperative coagulation parameters [such as prothrombin time (PT), activated partial thromboplastin time (APTT), and platelet count (PLT)], recent anticoagulant medication, mean arterial pressure (MAP), perioperative parameters (hospital stay, blood loss, and operation time), preoperative and postoperative neurological statuses [Japanese Orthopedic Association (JOA) scores and visual analog scale (VAS) scores of neck and arm pain], complications, fusion rate, and SPSEH incidence. Patients with SPSEH were defined as those who developed some degree of neurological deficit, confirmed by the presence of an SEH after MRI. Once the SPSEH diagnosis was confirmed, emergency surgical resection of the hematoma was carried out as soon as possible. The original site of the surgery was re-explored and the clot removed. Spinal dura mater was washed repeatedly with cold saline to lower the cellular metabolism and reduce bleeding. For subsequent re-exploration, all patients had drains inserted during the immediate postoperative period.

Statistical analysis

Data were recorded and statistical analysis was performed using SPSS 20.0 software (IBM, Armonk, NY, USA). Data were presented as mean ± standard deviation. Intergroup comparisons were made using the *t*-test, the Mann-Whitney *U*-test, or χ^2-test. P<0.05 indicated statistical significance.

Results

Preoperative parameters

The characteristic of the patients is showed in *Table 1*. There were no significant differences in terms of age, sex, BMI, BMD, MAP, PT, APTT, PLT, and decompressed segments between the 2 groups (P>0.05).

Perioperative parameters

A summary of the perioperative parameters (hospital stay, blood loss, and operation time) is provided in *Table 2*. There was a significant difference for blood loss (P<0.05), but there were no significant differences for hospital stay and operation time between the 2 groups (P>0.05).

Complications

A summary of complications is provided in *Table 3*. None of the patients had infection or tracheal, vascular, or esophageal injuries related to the operation. Surgery related-complications and instrumentation-related and graft-related complications were no difference between the 2 groups (P=0.694).

Table 2 Patient Perioperative parameters after 2-level ACDF or 1-level ACCF

Perioperative parameters	2-level ACDF	1-level ACCF	P value
Hospital stay (days)	6.37±1.71	6.50±1.79	0.41
Blood loss (mL)	158.60±55.40	249.32±80.71	<0.001†
Operative time (min)	139.13±29.33	138.56±35.97	0.84

†, P value <0.05; the table shows blood loss is statistically significant difference between the 2 groups. ACCF, anterior cervical corpectomy and fusion; ACDF, anterior cervical discectomy and fusion.

Table 3 Complications of patients who underwent 2-level ACDF or 1-level ACCF

Complications	2-level ACDF	1-level ACCF	P value
Surgery-related complications			0.98
CSF	6	4	
Hoarseness	3	2	
Dysphagia	5	4	
Total	14	10	
Instrumentation- and graft-related complications			0.76
Graft dislodgement	2	3	
Subsidence	2	2	
Total	4	5	

There was no significant difference between the 2 groups. ACCF, anterior cervical corpectomy and fusion; ACDF, anterior cervical discectomy and fusion; CSF, cerebrospinal fluid leakage.

Table 4 Clinical outcomes of patients who underwent 2-level ACDF or 1-level ACCF

Clinical outcomes	2-level ACDF	1-level ACCF	P value
Preoperative JOA score	9.13±1.30	9.35±1.69	0.09
Postoperative JOA score	13.93±1.51	13.98±0.93	0.64
Preoperative neck VAS score	6.15±3.01	5.69±3.79	0.12
Postoperative neck VAS score	2.68±1.68	2.92±1.38	0.07
Preoperative arm VAS score	7.07±2.53	6.88±2.21	0.35
Postoperative arm VAS score	2.63±1.41	2.80±1.54	0.20
Fusion rate	98.30%	98.60%	0.56

There was no significant difference between the 2 groups. ACCF, anterior cervical corpectomy and fusion; ACDF, anterior cervical discectomy and fusion; JOA score, Japanese Orthopaedic Association score; VAS, visual analogue scale.

Clinical outcomes

A summary of the clinical outcomes (JOA score, VAS, and fusion rate) is provided in *Table 4*. There were no differences in the final follow-up JOA score, VAS score, or fusion rate between the 2 groups (P>0.05).

SPSHE incidence and outcomes

Six of the 551 patients were diagnosed with SPSEH after 2-level ACDF; the overall incidence was 1.9%. A lower SPSEH incidence of 0.4% was observed after 1-level ACCF, as 1 patient in the ACCF group was diagnosed with SPSEH

(P<0.05).

The average interval from symptom onset to hematoma removal was 123 minutes. Surgical removal of an SPSEH resulted in neurological improvement in 6 patients. The mean follow up was 15 months (range, 12–18 months). Five patients returned to baseline neurological examination status within 2 h of their surgical decompression. One patient had residual right-hand and right-leg weakness, which mildly improved at the 6-month follow up. Another patient showed no change in neurological function, even after treatment with hyperbaric oxygen and neurotrophic drugs at the 12-month follow up after hematoma removal.

Discussion

CSM is one of the most common disorders following spinal surgery. From 1993 to 2002, the number of spinal fusion procedures performed on MSM patients increased nearly seven-fold (21). Spinal cord compression due to cervical spine degeneration often results in progressive clinical symptoms, and surgical decompression can reduce this process and possibly restore function. It is reported that 92% of patients have improved symptom after anterior or posterior decompression for CSM by Fessler *et al.* (22). Therefore, surgery is the common choice for CSM treatment.

Although surgical treatment of a CSM is controversial, most surgeons prefer an anterior procedure for patients with 2-level CSM. However, the relative merits of cervical fusion after segmental discectomy or corpectomy in 2-level CSM without OPLL remain debatable. The choice between 2-level ACDF and 1-level ACCF is still difficult.

With the exception of blood loss, our retrospective review of 551 patients who underwent ACDF or ACCF for 2-level CSM found no significant differences between the 2 groups in terms of age, sex, PT, APTT, PLT, decompressed segments, hospital stay, operation time, final follow-up JOA score, VAS score, fusion rate, and complications. Our findings are similar to those of previous studies (7,23). However, in a study of 31 patients with 2-level CSM without OPLL who underwent anterior surgical treatment, it was found that ACDF was superior to ACCF with respect to not only blood loss but also operation time, which is in contrast with our results (5). This difference between Oh *et al.* (5) and our study could be due to the lack of comparative data available on these 2 surgical treatments for CSM. However, both studies showed that 2-level ACDF could be a better choice than 1-level ACCF for 2-level CSM regardless of SPSEH occurrence.

Although many studies on SPSHE have been published, few have compared 2-level ACDF and 1-level ACCF. In our study, we found that SPSEH was diagnosed in 6 patients for an overall incidence of 1.9% for 2-level ACDF. Only 1 patient was diagnosed with SPSEH; therefore, a low SPSEH incidence of 0.4% was observed for 1-level ACCF.

Postoperative SEH is a well-known complication after spinal surgery. When an SEH of the cervical spine becomes symptomatic, the consequences can be significant, and include rapid progressive quadriplegia, respiratory dysfunction, and even death. In the present study, the rate of symptomatic postoperative SEH was significantly higher in the 2-level ACDF group than in the 1-level ACCF group. Therefore, based on SPSEH incidence, 1-level ACCF could be a better choice for surgical treatment.

The incidence of symptomatic postoperative SEH was significantly higher in the 2-level ACDF group than in the 1-level ACCF group. In the ACCF group, after the titanium mesh cages with a local autograft bone was placed between the 2 vertebral bodies, the intraspinal hematoma could easily flow to the front of the cervical vertebral body through the pores of the titanium interbody cages. Therefore, there was more space for the hematoma to occupy (*Figure 1A*). For the 2-level ACDF group, the SEH of the cervical spine became symptomatic when the hematoma was large enough; this occurred after the cage was placed between the 2 vertebral bodies, where the cage had a local autograft bone similar to a bottle stopper and created a wall with the other vertebral bodies and disc and stopped the intraspinal hematoma flow to the front of the cervical vertebral body (*Figure 1B*). In addition, the hematoma could also flow out through the drainage tube. Therefore, the ACCF procedure did not create a hematoma that was large enough to compress the spinal cord, and the SEH of the cervical spine might become symptomatic.

In clinical practice, choosing to reoperate after spinal surgery because of neurological deterioration, and operating without any complementary radiological investigation, is common. Epidural hematoma should be suspected in patients with new defects after surgery, and prompt surgery is an important factor for complete recovery of neurological function (23-25). However, postoperative cord dysfunction can also be caused by spinal cord injury during surgery, such as incorrect alignment of the spine due to graft complications (26). In the study, one patient presented with symptoms of shortness of breath and neurological dysfunction after surgery. The respiratory symptoms could

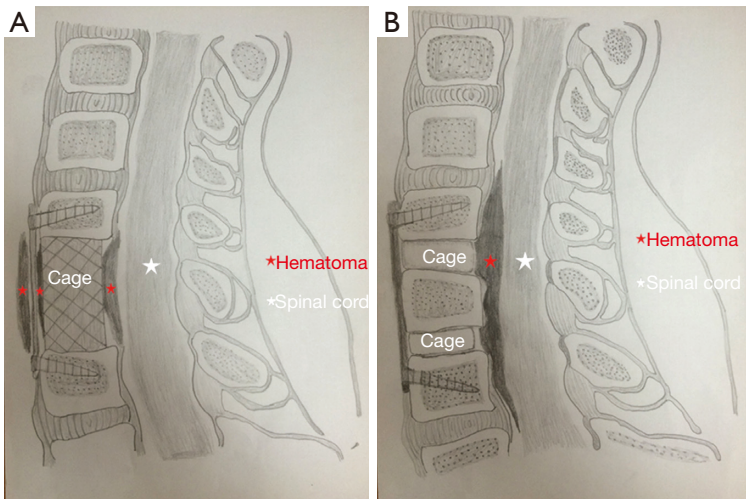

Figure 1 Schematic diagram of surgical hematoma. (A) Cage was similar to a bottle stopper to create a wall with the other vertebral bodies and disc to stop the intraspinal hematoma flow to the front of the cervical vertebral body. (B) Intraspinal hematoma can easily flow to the front of the cervical vertebral body through pores of the titanium interbody cages, as there is more space for the hematoma to occupy.

have been prompted by the administration of piritramide, or the deterioration of spinal cord function at a level higher than that of the surgical site. The neurological signs were consistent with a lesion in the upper region of the cervical spinal cord, rather than the level of the surgical site. Therefore, an MRI examination should be performed before any further surgery (26-29).

The present study has some limitations. The short follow-up period and low number of patients did not allow for a thorough evaluation. As a retrospective study, our study did not use a randomized, controlled trial design. Therefore, long-term follow up and a prospective randomized study that includes a large patient cohort are required in the future. However, we believe that our study provides evidence to help choose between 2-level ACDF and 1-level ACCF for anterior treatment approaches for 2-level CSM.

Conclusions

In the present study, the surgical management of 2-level CSM with either 2-level ACDF or 1-level ACCF did not result in significantly different outcomes, including perioperative parameters (hospital stay and operation time), complications, and clinical outcomes (JOA score, VAS, and fusion rate), although blood loss was an exception. Nonetheless, postoperative epidural hematoma preferentially occurs after ACDF compared with ACCF for 2-level CSM treatment. Our study provides a scientific basis for the choice between 2-level ACDF and 1-level ACCF for the treatment of 2-level CSM.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://apm.amegroups.com/article/view/10.21037/apm-22-488/rc

Data Sharing Statement: Available at https://apm.amegroups.com/article/view/10.21037/apm-22-488/dss

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://apm.amegroups.com/article/view/10.21037/apm-22-488/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). This study was reviewed and approved

by the Ethics Committee of Affiliated Traditional Chinese Medicine Hospital of Southwest Medical University, and informed consent was taken from all the patients.

References

1. Rao RD, Gourab K, David KS. Operative treatment of cervical spondylotic myelopathy. J Bone Joint Surg Am 2006;88:1619-40.
2. Ghogawala Z, Coumans JV, Benzel EC, et al. Ventral versus dorsal decompression for cervical spondylotic myelopathy: surgeons' assessment of eligibility for randomization in a proposed randomized controlled trial: results of a survey of the Cervical Spine Research Society. Spine (Phila Pa 1976) 2007;32:429-36.
3. Djurasovic M, Campion C, Dimar JR 2nd, et al. Postoperative Epidural Hematoma. Orthop Clin North Am 2022;53:113-21.
4. Yonenobu K, Fuji T, Ono K, et al. Choice of surgical treatment for multisegmental cervical spondylotic myelopathy. Spine (Phila Pa 1976) 1985;10:710-6.
5. Oh MC, Zhang HY, Park JY, et al. Two-level anterior cervical discectomy versus one-level corpectomy in cervical spondylotic myelopathy. Spine (Phila Pa 1976) 2009;34:692-6.
6. Wen Z, Lu T, Wang Y, et al. Anterior Cervical Corpectomy and Fusion and Anterior Cervical Discectomy and Fusion Using Titanium Mesh Cages for Treatment of Degenerative Cervical Pathologies: A Literature Review. Med Sci Monit 2018;24:6398-404.
7. Jiang SD, Jiang LS, Dai LY. Anterior cervical discectomy and fusion versus anterior cervical corpectomy and fusion for multilevel cervical spondylosis: a systematic review. Arch Orthop Trauma Surg 2012;132:155-61.
8. Al-Mutair A, Bednar DA. Spinal epidural hematoma. J Am Acad Orthop Surg 2010;18:494-502.
9. Guan L, Hai Y, Yang JC, et al. Anterior cervical discectomy and fusion may be more effective than anterior cervical corpectomy and fusion for the treatment of cervical spondylotic myelopathy. BMC Musculoskelet Disord 2015;16:29.
10. Dina TS, Boden SD, Davis DO. Lumbar spine after surgery for herniated disk: imaging findings in the early postoperative period. AJR Am J Roentgenol 1995;164:665-71.
11. Djukic S, Vahlensieck M, Resendes M, et al. The lumbar spine: postoperative magnetic resonance imaging. Bildgebung 1992;59:136-46.
12. Ikuta K, Tono O, Tanaka T, et al. Evaluation of postoperative spinal epidural hematoma after microendoscopic posterior decompression for lumbar spinal stenosis: a clinical and magnetic resonance imaging study. J Neurosurg Spine 2006;5:404-9.
13. Montaldi S, Fankhauser H, Schnyder P, et al. Computed tomography of the postoperative intervertebral disc and lumbar spinal canal: investigation of twenty-five patients after successful operation for lumbar disc herniation. Neurosurgery 1988;22:1014-22.
14. Sokolowski MJ, Garvey TA, Perl J 2nd, et al. Prospective study of postoperative lumbar epidural hematoma: incidence and risk factors. Spine (Phila Pa 1976) 2008;33:108-13.
15. Ramírez Villaescusa J, Restrepo Pérez M, Ruiz Picazo D. Spinal Epidural Hematoma Related to Vertebral Fracture in an Atypical Rigid Diffuse Idiopathic Skeletal Hyperostosis: A Case Report. Geriatr Orthop Surg Rehabil 2017;8:18-22.
16. Kebaish KM, Awad JN. Spinal epidural hematoma causing acute cauda equina syndrome. Neurosurg Focus 2004;16:e1.
17. Shi H, Huang ZH, Huang Y, et al. Which Criterion for Wound Drain Removal is Better Following Posterior 1-Level or 2-Level Lumbar Fusion With Instrumentation: Time Driven or Output Driven? Global Spine J 2021. [Epub ahead of print].
18. Liao CC, Lee ST, Hsu WC, et al. Experience in the surgical management of spontaneous spinal epidural hematoma. J Neurosurg 2004;100:38-45.
19. Yi S, Yoon DH, Kim KN, et al. Postoperative spinal epidural hematoma: risk factor and clinical outcome. Yonsei Med J 2006;47:326-32.
20. Lad SP, Patil CG, Berta S, et al. National trends in spinal fusion for cervical spondylotic myelopathy. Surg Neurol 2009;71:66-9; discussion 69.
21. Hwang SL, Lee KS, Su YF, et al. Anterior corpectomy with iliac bone fusion or discectomy with interbody titanium cage fusion for multilevel cervical degenerated

disc disease. J Spinal Disord Tech 2007;20:565-70.
22. Fessler RG, Steck JC, Giovanini MA. Anterior cervical corpectomy for cervical spondylotic myelopathy. Neurosurgery 1998;43:257-65; discussion 265-7.
23. Kou J, Fischgrund J, Biddinger A, et al. Risk factors for spinal epidural hematoma after spinal surgery. Spine (Phila Pa 1976) 2002;27:1670-3.
24. Scavarda D, Peruzzi P, Bazin A, et al. Postoperative spinal extradural hematomas. 14 cases. Neurochirurgie 1997;43:220-7.
25. Lonjon MM, Paquis P, Chanalet S, et al. Nontraumatic spinal epidural hematoma: report of four cases and review of the literature. Neurosurgery 1997;41:483-6; discussion 486-7.
26. Yonenobu K, Hosono N, Iwasaki M, et al. Neurologic complications of surgery for cervical compression myelopathy. Spine (Phila Pa 1976) 1991;16:1277-82.
27. Alexiadou-Rudolf C, Ernestus RI, Nanassis K, et al. Acute nontraumatic spinal epidural hematomas. An important differential diagnosis in spinal emergencies. Spine (Phila Pa 1976) 1998;23:1810-3.
28. Hentschel SJ, Woolfenden AR, Fairholm DJ. Resolution of spontaneous spinal epidural hematoma without surgery: report of two cases. Spine (Phila Pa 1976) 2001;26:E525-7.
29. Butler AJ, Donnally CJ 3rd, Goz V, et al. Symptomatic Postoperative Epidural Hematoma in the Lumbar Spine. Clin Spine Surg 2021. [Epub ahead of print]. doi:10.1097/BSD.0000000000001278.

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