Spinal Subarachnoid Hemorrhage as a Very Rare Complication Following Circumferential Minimally Invasive Surgery Using Lateral Interbody Fusion and Percutaneous Pedicle Screw Fixation for Adult Spinal Deformity

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Lateral interbody fusion (LIF) and percutaneous pedicle screw (PPS) fixation are established surgical management methods for adult spinal deformities (ASD). Adverse events related to this surgical strategy, such as cardiopulmonary and gastrointestinal events, mechanical and/or neurological deficits, infection, urinary events, and epidural hematoma, have been previously described^{1,2)}. However, to the best of our knowledge, spinal subarachnoid hemorrhage (sSAH) is an extremely rare complication of ASD that is managed with circumferential minimally invasive surgery (cMIS) using LIF and PPS fixation.

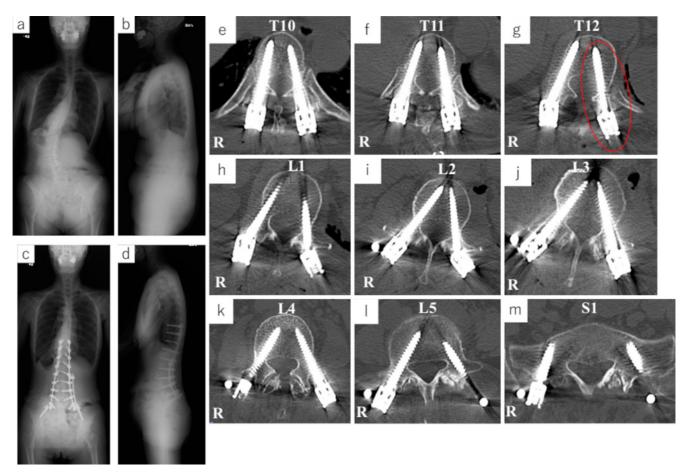
We report a case of a 68-year-old woman with ASD who underwent surgery (Fig. 1a, b). Preoperatively, the patient did not take any antithrombotic drugs and had no history of spinal vascular disease. Blood sample examination did not reveal any coagulation disorder: platelets were $247 \times 10^3/\mu$ L (normal range: $150-350 \times 10^3/\mu$ L), and PT-INR, APTT, and fibrinogen were 1.03 (normal range: 0.9-1.3), 32.7 sec (normal range: 24-34 sec), and 250 mg/dL (normal range: 200-400 mg/dL), respectively. The patient underwent LIF from L 1 to L5, transforaminal lumbar interbody fusion (TLIF) at the L5/S1 level, and bilateral PPSs from T10 to the iliac region (Fig. 1c, d and Table 1). All the screws were inserted through the first trajectory. Only the left T12 pedicle screw violated the medial wall of the pedicle (Fig. 1e-m). LIF cages did not enter the spinal canal. Intraoperatively, the dura was exposed at the L5/S1 level while performing TLIF but was not torn. No cerebrospinal fluid leakage was observed. A drainage tube of 3.5 mm was placed at this level. Postoperatively, the patient's voluntary movements of both the lower extremities were good. However, sensory disturbance and motor weakness in the bilateral lower extremities suddenly appeared 2 days later. The patient was on bed rest for 2 days. Remarkable postoperative hypertension was not observed, and systolic/diastolic blood pressures were 109-157/64-88 mmHg, respectively. The amount of bloody drainage from the drainage tube gradually decreased from 5 to 1 ml/h over these days. Multiple hypointense lesions from the thoracic level to the lumbar region on magnetic resonance images were indicative of postoperative hemorrhage (Fig. 2). An emergency surgery was performed. The dura was exposed following laminectomy from T11 to L2. Dark reddish lesions were identified beneath the dura, but pulsation of the dura was not observed (Fig. 3a). Upon opening the dural and arachnoid membranes, the hematoma spilled out (Fig. 3 b). A subarachnoid hemorrhage was recognized ventrally and dorsally in the thoracic spinal cord and cauda equina (Fig. 3c). The subarachnoid hemorrhage was removed; however, no apparent origin of bleeding was identified intraoperatively. After the second surgery, the symptoms improved gradually.

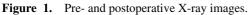
sSAH is considered very rare³⁾, and no reports have de-

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An adult spinal deformity was observed preoperatively (a, anterior-posterior projection; b, lateral projection). The spinal deformity was corrected with lateral interbody fusion and percutaneous pedicle screws from T10 to the iliac spine (c: anterior-posterior projection, d: lateral projection). The percutaneous pedicle screws were placed within the pedicles except for the left T12 screw (red circle) (g) (e-m: axial computed tomography images).

Table 1. Radiological Parameters Related to Adult Spinal Deformity.

	Preoperative	Postoperative
Cobb angle between T11 and L4	48°	17°
Lumbar lordosis	9°	55°
Pelvic tilt	40°	20°
Pelvic incidence-Lumbar lordosis	50°	4°
Sagittal vertical axis	66 mm	13 mm

scribed sSAH following cMIS using LIF and PPSs fixation for ASD⁴⁻⁶⁾. Reduced subarachnoid pressure related to cerebrospinal fluid leakage may result in sSAH³⁾, however, dural tears or cerebrospinal fluid leakage were not observed intraoperatively in our case. Therefore, we believe that the surgical procedure did not directly result in postoperative sSAH. Our patient did not take any antithrombotic drugs and had no apparent underlying disease responsible for postoperative sSAH. No hemorrhagic origin was identified in the second surgery, and the sSAH did not recur. Therefore, overlooked or unidentified preoperative vascular lesions were not observed in this patient.

The following theory has been postulated as a mechanism of sSAH: minor trauma can increase the intrathoracic, intraabdominal, and intraluminal pressures of the spinal vessels, especially the valveless radiculomedullary veins traversing the subarachnoid space. If cerebrospinal fluid fails to neutralize the increased pressure, spinal vessel rupturing can lead to $sSAH^{\gamma}$. In our case, the stress on the intraabdominal pressure when scoliosis was intraoperatively corrected following cMIS using LIF and PPS fixation could have resulted in a minor tear of the radiculomedullary veins and sSAH. Tractions related to spinal correction may also have resulted in increased intravenous pressure. As the postoperative symptoms related to sSAH appeared 2 days after the first surgery, it seems coherent that persistent bleeding from a minor tear of the radiculomedullary veins formed the sSAH. Tension of the spinal cord and nerve roots after correction surgery could also have resulted in venous rupture and sSAH formation.

Because the left T12 PPS violated the medial wall of the pedicle, this could have also resulted in sSAH⁸). However, as there have been no similar reported cases, further research is warranted to clarify the pathology of sSAH after cMIS using LIF and PPS fixation for ASD.

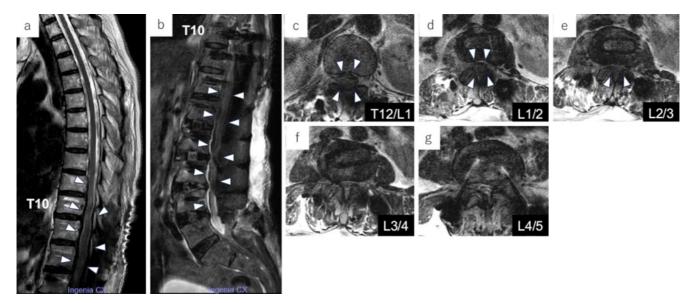


Figure 2. Magnetic resonance images after the first operation.

T2-weighted magnetic resonance images revealed multiple hypointense ventral and dorsal lesions (white arrowheads). These findings indicate hematoma (a and b: sagittal images; c-g: axial images).

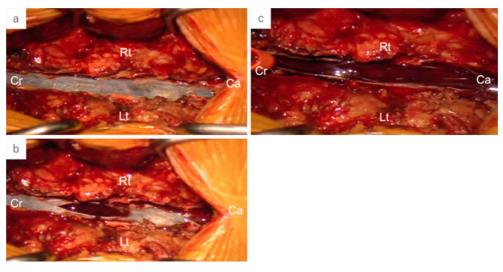


Figure 3. Intraoperative findings.

The exposed dura was reddish (a). The subarachnoid hemorrhage spilled after the subarachnoid membrane was incised (b). A subarachnoid hemorrhage is longitudinally identified (c) (Ca, caudal; Cr, cranial; Lt, left; and Rt, right).

Conflicts of Interest: The authors declare that there are no relevant conflicts of interest.

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Author Contributions: Tomohisa Harada, Yoshinori Maki, and Satoshi Makio designed the study; Tomohisa Harada performed surgery; Yoshinori Maki wrote the first manuscript; and Tomohisa Harada revised the manuscript critically. Kenji Takahashi supervised the study and approved the final version of the manuscript.

Ethical Approval: This study was approved by the ethical committee of Rakuwakai Marutamachi Hospital (approval number 2019-2).

Informed Consent: Informed consent was obtained from the patient prior to publication of this study.

References

- Kim HJ, Yang JH, Chang DG, et al. Adult spinal deformity: a comprehensive review of current advances and future directions. Asian Spine J. 2022;16(5):776-88.
- **2.** Yang H, Liu J, Hai Y, et al. What are the benefits of lateral lumbar interbody fusion on the treatment of adult spinal deformity: a systematic review and meta-analysis deformity. Global Spine J. 2023;

13(1):172-87.

- **3.** Li M, Liu Q, Tang H. Delayed diagnosis of spinal subarachnoid hemorrhage in association with warfarin administration: a case report and literature review. J Int Med Res. 2020;48(10): 300060520961683.
- **4.** Domenicucci M, Ramieri A, Paolini S, et al. Spinal subarachnoid hematomas: our experience and literature review. Acta Neurochir. 2005;147(7):741-50.
- **5.** Kakitsubata Y, Theodorou SJ, Theodorou DJ, et al. Spontaneous spinal subarachnoid hemorrhage associated with subdural hematoma at different spinal levels. Emerg Radiol. 2010;17(1):69-72.
- 6. Gonzalez LF, Zabramski JM, Tabrizi P, et al. Spontaneous spinal

subarachnoid hemorrhage secondary to spinal aneurysms: diagnosis and treatment paradigm. Neurosurgery. 2005;57(6):1127-31.

- Morandi X, Riffaud L, Chabert E, et al. Acute nontraumatic spinal subdural hematomas in three patients. Spine. 2001;26(23):E547-51.
- **8.** Nogami R, Matsuoka H, Ohashi S, et al. Spinal subarachnoid hemorrhage after percutaneous kyphoplasty: a case report and literature review. J Spine Surg. 2022;8(4):491-6.

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