Atlantoaxial wiring hardware failure resulting in intracranial hemorrhage and hydrocephalus: illustrative case

Anass Benomar, MD,1 Harrison J. Westwick, MD, MSc,2 Sami Obaid, MD,3 André Nzokou, MD, MSc,4 Sung-Joo Yuh, MD,3 and Daniel Shedid, MD, MSc3

1Department of Radiology, Centre Hospitalier de l’Université de Montréal, Montreal, Quebec, Canada; 2Service of Neurosurgery, Hôpital du Sacré-Cœur de Montréal, Montreal, Quebec, Canada; 3Division of Neurosurgery, Centre Hospitalier de l’Université de Montréal, Montreal, Quebec, Canada; and 4Service of Neurosurgery, Hôpital Maisonneuve-Rosemont, Montreal, Quebec, Canada

BACKGROUND Atlantoaxial sublaminar wiring has many known complications related to hardware failure, but intracranial hemorrhage is a rare complication.

OBSERVATIONS A 61-year-old female patient with prior atlantoaxial sublaminar wiring for odontoid fracture nonunion experienced decreased level of consciousness due to a subarachnoid and subdural hemorrhage of the posterior fossa with intraventricular extension and hydrocephalus. Rupture of the sublaminar wire with intramedullary protrusion was the cause of the hemorrhage. The patient was treated with ventriculostomy for hydrocephalus and occipital cervical fusion for spinal instability, along with removal of the broken wire and drainage of a hematoma.

LESSONS This uncommon cause of intracranial hemorrhage highlights an additional risk of atlantoaxial sublaminar wiring compared with other atlantoaxial fusion techniques. In addition, this case suggests cervical instrumentation failure as a differential diagnosis of subarachnoid and subdural hemorrhage of the posterior fossa when a history of prior instrumentation is known.

https://thejns.org/doi/abs/10.3171/CASE21211

KEYWORDS sublaminar wiring; subarachnoid hemorrhage; hydrocephalus; spinal

The technique of sublaminar wiring (Brooks wiring) has been well established for atlantoaxial instrumented fusion in the context of instability caused by various pathologies.1–4 Although different hardware constructs have been developed with different advantages,2,3,5–12 sublaminar wiring continues to be employed in various settings.1 Atlantoaxial sublaminar wiring–related complications have been described, including hardware failure, nonunion, durotomy, spinal cord injury, and brain injury.6,13–22

We describe a rare but serious and potentially fatal complication of atlantoaxial sublaminar wiring failure with an atypical presentation of a progressively comatose patient with posterior fossa and upper spinal subdural and subarachnoid hemorrhage resulting in acute hydrocephalus. We also review the literature of spinal hardware failure in relation to subarachnoid hemorrhage.

Illustrative Case

A 61-year-old female presented to the hospital with neck pain, nausea, vomiting, and no focal deficits. She developed a significant headache with rapidly progressive somnolence requiring intubation. Computed tomography (CT) of the head demonstrated subarachnoid and intraventricular hemorrhage with moderate hydrocephalus and signs of intracranial hypertension. Imaging also revealed a high cervical and posterior fossa subdural hematoma (Fig. 1). She was transferred to our institution with a high-grade subarachnoid hemorrhage and hydrocephalus.

She had a prior history of type 2 odontoid fracture nonunion treated with an odontoid screw and subsequent nonunion treated with atlantoaxial Brooks sublaminar wiring at an outside institution. She had sustained a minor trauma in a swimming class 2 weeks...
before consulting, with an acute exacerbation of neck pain for the
past 2 days after a mild effort.

CT angiography of the head and cervical spine revealed a frac-
tured cable protruding into the spinal canal and subdural hematoma
at the level of C1 and C2. There was no identified vascular lesion
(Fig. 2). Digital subtraction angiography eliminated the presence of
aneurysms or pseudoaneurysms in the posterior circulation.

She was immediately treated for hydrocephalus with the inser-
tion of an external ventricular drain (EVD). She was then treated
surgically for removal of sublaminar wires and underwent C1–2 lam-
inectomy, drainage of the subdural hematoma, and occipitocervical
fusion (C0–5). Intraoperatively, the wire was noted to have pro-
truded through the dura into the spinal cord, with the source of
bleeding identified in the posterior spinal cord veins.

She experienced a good recovery with no sensory or motor de-
cits, and the EVD was progressively weaned and removed. She
was discharged after 2 weeks with a hospitalization complicated by
delirium, hyponatremia, and urinary tract infection. At 2-month fol-
low-up, she had improved cognitively with no residual hydrocepha-
lus and no neurological de cits. Solid occipitocervical arthrodesis
was documented 3 years after her operation. However, shortly after
that and following an incidental fall with head trauma, she experi-
enced cervicalgia, and multiple undisplaced fractures of the left
transverse processes of C7–T3 were found on a CT scan of the
cervical spine. She was managed conservatively and remained sta-
ble 1 year later, without signi cant symptoms.

Discussion

Complications of Brooks posterior wiring are numerous and well
described in the literature.2,3,5,13–22 Their occurrence can be periop-
erative, early postoperative, or late postoperative. The most com-
mon complication is nonunion, reaching 30% in some series.3,7
Nonunion can contribute to increased loading of the cables because
stability is not achieved, and it can precipitate a fatigue failure and
loosening.15 Cables positioned with excessive bowing of the cable
arc into the spinal canal can cause spinal cord compression,22 and
direct spinal cord injury has been described.20

Delayed complications can be related to nonunion where exces-
sive long-term hardware stress can lead to loosening of the cables
delayed subluxation,16 spinal cord compression,22 fracture of
the C1 posterior arch,14 or even syringomyelia.21 Delayed cable
fracture can also occur as a complication of sublaminar wiring;
reports have described cable fracture and migration of the cable
into the spinal cord occurring months to years after surgery and the
potential to cause transient or permanent neurological de cits, men-
ingitis due to cerebrospinal fluid leakage, or, as seen in our case, a
subarachnoid hemorrhage.8,13,15–17,19

Observations

In the present case, cable fracture led to penetration of the thecal
sac and laceration of the posterior spinal cord vessels, resulting in
significant intracranial subarachnoid, intraventricular, and subdural
hemorrhage with concomitant hydrocephalus requiring EVD place-
ment. Only one similar case of subarachnoid hemorrhage related to
atlantoaxial sublaminar wiring was described, by Kakarla et al. in
2010,17 but a case of wire migration through the dura into the brain-
stem causing neurological de cits has also been described, by
Koziarz et al. in 2017.5 These cases highlight the risk of sublaminar
wire with the potential for direct brain and spinal cord injury, duro-
tomy, or hemorrhage; other midline lateral mass screw xation
constructs limit the risk of injury directly to the spinal cord.2,3,10,11
These constructs are also more stable than wires under tension.12
In our case, surgical treatment involved both the drainage of a sub-
dural hematoma and additional instrumented fusion to treat the
underlying spinal instability and pseudoarthrosis.
Lessons
Although rare and infrequent, this complication of intracranial hemorrhage from sublaminar wire breakage highlights two important points. First, in the investigation of subarachnoid hemorrhage or subdural hemorrhage for a patient with a prior history of spinal surgery and cervical instrumentation, instrumentation failure should be considered as an etiology for hemorrhage. Second, we describe an additional potential disadvantage of sublaminar wiring compared with other screw fixation techniques (i.e., direct spinal cord injury in the case of wire loosening or rupture).

References
1. Brooks AL, Jenkins EB. Atlanto-axial arthrodesis by the wedge compression method. J Bone Joint Surg Am. 1978;60(3):279–284.
2. Huang DG, Hao DJ, He BR, et al. Posterior atlantoaxial fixation: a review of all techniques. Spine J. 2015;15(10):2271–2281.
3. Jacobson ME, Khan SN, An HS. C1-C2 posterior fixation: indications, technique, and results. Orthop Clin North Am. 2012;43(1):11–18.
4. Jain VK. Atlantoaxial dislocation. Neurol India. 2012;60(1):9–17.
5. Moon MS, Choi WT, Moon YW, Moon JL, Kim SS. Brooks’ posterior stabilisation surgery for atlantoaxial instability: review of 54 cases. J Orthop Surg (Hong Kong). 2002;10(2):160–164.
6. Saito R, Hase H, Mikami Y, et al. Clinical study of a modified Brooks technique for atlanto-axial subluxation using polyethylene tape. J Spinal Disord Tech. 2006;19(1):11–17.
7. Yang SY, Boniello AJ, Poorman CE, Chang AL, Wang S, Passias PG. A review of the diagnosis and treatment of atlantoaxial dislocations. Global Spine J. 2014;4(3):197–210.
8. Koziarz A, Aref M, Vinh B, Mensinkaw SA, Reddy K. Sublaminar wire migration into the medulla oblongata: a case report. J Spine Surg. 2017;3(2):267–271.
9. Dickman CA, Sonntag VK, Papadopoulos SM, Hadley MN. The interspinous method of posterior atlantoaxial arthrodesis. J Neurosurg. 1991;74(2):190–198.
10. Elliott RE, Tanweer O, Boah A, et al. Atlantoaxial fusion with transarticular screws: meta-analysis and review of the literature. World Neurosurg. 2013;80(5):627–641.
11. Elliott RE, Tanweer O, Boah A, et al. Atlantoaxial fusion with screw-rod constructs: meta-analysis and review of the literature. World Neurosurg. 2014;81(2):411–421.
12. Naderi S, Crawford NR, Song GS, Sonntag VK, Dickman CA. Biomechanical comparison of C1-C2 posterior fixations. Cable, graft, and screw combinations. Spine (Phila Pa 1976). 1998;23(18):1946–1956.
13. Blacklock JB. Fracture of a sublaminar stainless steel cable in the upper cervical spine with neurological injury. Case report. J Neurosurg. 1994;81(6):932–933.
14. Ecker RD, Dekutoski MB, Ebersold MJ. Symptomatic C1-2 fusion failure due to a fracture of the lateral C-1 posterior arch in a patient with rheumatoid arthritis. Case report and review of the literature. J Neurosurg. 2001;94(1 suppl):137–139.
15. Garcia R Jr, Gorin S. Failure of posterior titanium atlantoaxial cable fixation. Spine J. 2003;3(2):166–170.
16. Geremia GK, Kim KS, Cerullo L, Calenoff L. Complications of sublaminar wiring. Surg Neural. 1985;23(6):629–635.
17. Kakarla UK, Valdivia JV, Sonntag VK, Bambakidis NC. Intracranial hemorrhage and spinal cord injury from a fractured C1-C2 sublaminar cable: case report. Neurosurgery. 2010;66(6):E1203–E1204.
18. Laidlaw JD, Kavar B, Siu KH. Acute atlanto-axial post-operative subluxation following posterior C1/2 fusion. J Clin Neurosci. 2004;11(2):172–178.
19. Li H, Lou J, Liu H. Migration of titanium cable into spinal cord and spontaneous C2 and C3 fusion: case report of possible causes of fatigue failure after posterior atlantoaxial fixation. Medicine (Baltimore). 2016;95(52):e5744.
20. Lundy DW, Murray HH. Neurological deterioration after posterior wiring of the cervical spine. J Bone Joint Surg Br. 1997;79(6):948–951.
21. Mizutani J, Tsuboucim S, Fukuoka M, Otsuka T, Matsu S. Syringomyelia caused by loosening of multistrand cables following C1-2 Brooks-type fusion in the rheumatoid cervical spine. Case report. J Neurosurg. 2002;97(3 suppl):366–368.
22. Sudo H, Abumi K, Ito M, Kotani Y, Minami A. Spinal cord compression by multistrand cables after solid posterior atlantoaxial fusion. Report of three cases. J Neurosurg. 2002;97(3 suppl):359–361.

Disclosures
The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author Contributions
Conception and design: Shedid, Benomar, Westwick, Obaid. Acquisition of data: Benomar, Westwick, Obaid, Nzokou. Analysis and interpretation of data: Obaid, Nzokou. Drafting the article: Benomar, Westwick, Obaid, Yuh. Critically revising the article: Shedid, Westwick, Obaid, Yuh. Reviewed submitted version of manuscript: Shedid, Obaid, Nzokou. Approved the final version of the manuscript on behalf of all authors: Shedid. Administrative/technical/material support: Obaid. Study supervision: Shedid, Obaid, Yuh.

Correspondence
Daniel Shedid: University of Montreal, Centre Hospitalier de l’Université de Montréal, Montreal, QC, Canada. danielsheidid@gmail.com.