

Single Case – General Neurology

# Unilateral C1 Posterior Arch Screw-C2 Laminar Screw Posterior Fixation for Vertebral Artery Preservation in Bow Hunter's Syndrome

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## Keywords

Bow hunter's syndrome · Posterior fixation · Posterior arch screw · Vertebral artery injury · Complications

## Abstract

Pedicle or lateral mass screws, which are usually used to fix atlantoaxial instability, increase the risk of vertebral artery (VA) injury in patients with bone or arterial anomalies or osteoporotic bone. Here, we report the use of a unilateral C1 posterior arch screw-C2 laminar screw posterior fixation with a contralateral C1 lateral mass screw for VA preservation in a patient with bow hunter's syndrome (BHS). A 65-year-old male presented with recurrent loss of consciousness in the right rotational and backward-bending head positions for 1 year. Cerebral angiography in the same head position showed that the left VA was disrupted at C1/2 and the right VA was hypoplastic. The patient was diagnosed with BHS. C1-2 posterior fixation and iliac bone grafting were performed. The left VA was on the dominant side, and the VA was in a high position; thus, a C1 posterior arch screw was selected for the left side, a C1 lateral mass screw was selected for the right side, and a C2 laminar screw with O-arm navigation and a C-arm was used to prevent arterial injury. Intraoperative findings revealed no VA injury, and postoperative computed tomography showed the screw at the planned site. In a patient with BHS, posterior fixation with a unilateral C1 posterior arch screw-C2 laminar screw prevented VA injury because the screw could be inserted while avoiding the VA.

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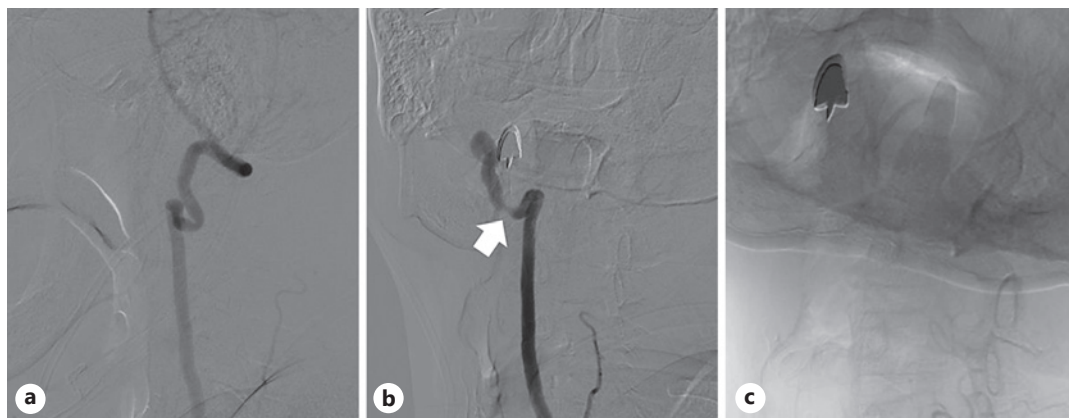
## Introduction

Bow hunter's syndrome (BHS) is a vertebrobasilar insufficiency, also known as rotational vertebral artery (VA) occlusion, due to mechanical stenosis or occlusion of the VA at the atlantoaxial joint. The common symptoms of BHS include dizziness, vertigo, syncope, dysarthria, nausea, and dysphagia [1]. This rare syndrome can be cured with spinal surgery [2]. Methods used for C1-C2 posterior fixation include posterior wiring, transarticular screws, and pedicle or lateral mass screws (LMSs) [3–5]. However, screw fixation is associated with an increased risk of VA injury in patients with VAs in anomalous locations, abnormal bone morphologies, or osteoporosis [6]. Various techniques have been reported to avoid VA injury, and careful preoperative assessment of the VA course is important in planning the fixation. Herein, we present the case of an elderly patient with BHS who required a unilateral C1 posterior arch screw (PAS)-C2 laminar screw (LS) posterior fixation with a contralateral C1 LMS for VA preservation.

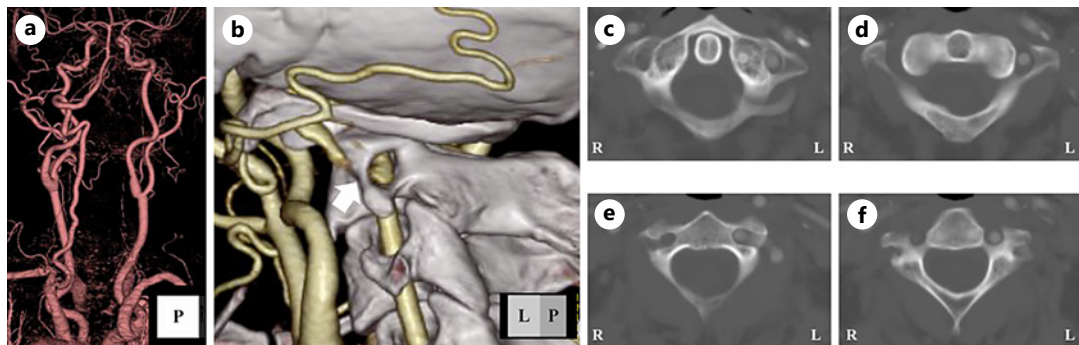
## Case Description

A 65-year-old male patient presented at our hospital with recurrent loss of consciousness in the right rotational and backward-bending head positions for a year. Cerebral angiography in the same head position showed that the left VA was disrupted at C1/2 (Fig. 1). Three-dimensional computed tomography angiography in the neutral position revealed right VA hypoplasty (Fig. 2a). When the patient's head was rotated to the right side, the left VA exhibited stenosis just distal to the C2 transverse foramen (Fig. 2b arrow). The patient was diagnosed with BHS.

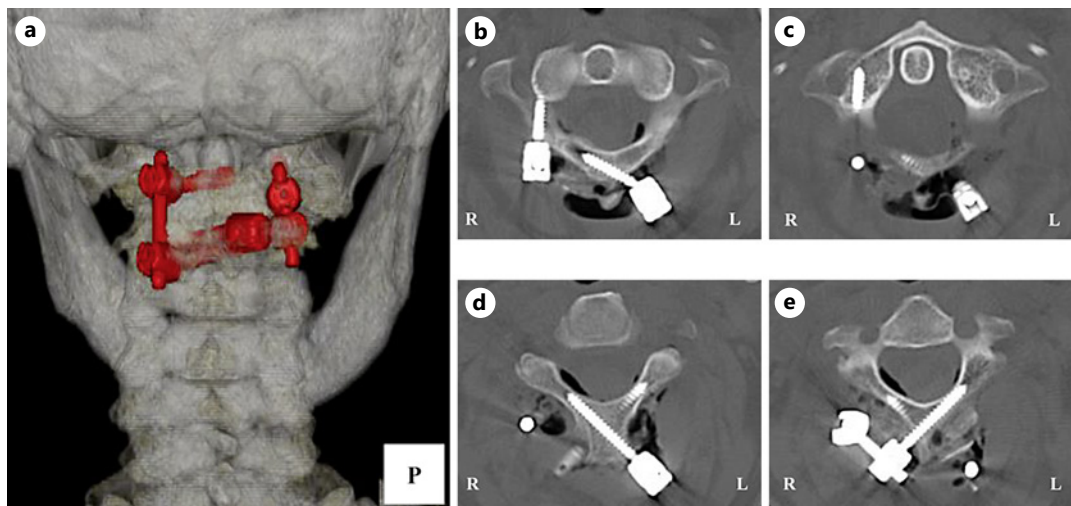
The patient was given general anesthesia and underwent C1-2 posterior fixation and iliac bone grafting in the prone position. The high-riding VA could be seen on the left-side narrow pedicle at C2 (Fig. 2e, f). Thus, a unicortical LS was placed (Fig. 3d, e). A C1 PAS was used on the left side, and a C1 LMS was used on the right side with O-arm navigation and a C-arm because the left VA was on the dominant side. Placing a LMS at that location could put the patient at risk for a dominant VA injury if the screw loosened (Fig. 3b, c). A high-speed burr was first used to open a small cortical window at the entry point of the posterior C1 arch and the lamina of C2. After probing and tapping, 3.5 mm screws (Medtronic Inc., Memphis, TN, USA) were inserted into C1 and C2, respectively. The C1-C2 posterior fixation was successful using connecting rods



**Fig. 1.** Angiography of the vertebral artery (VA). **a** The left VA shows no stenosis in the neutral position. **b** When the head is rotated to the right, the left VA shows stenosis just distal to the C2 transverse foramen (arrow). **c** In the right rotational and backward-bending positions of the head, the left VA is occluded.



**Fig. 2.** Preoperative computed tomography angiography (CTA). **a** Three-dimensional CTA in the neutral position, revealing right VA hypoplasia. **b** When the head rotated to the right side, the left VA shows stenosis just distal to the C2 transverse foramen (arrow). **c, d** CTA axial images showing the posterior arch width >3.5 mm at C1. **e, f** Left high-riding VA and narrow pedicle at C2.



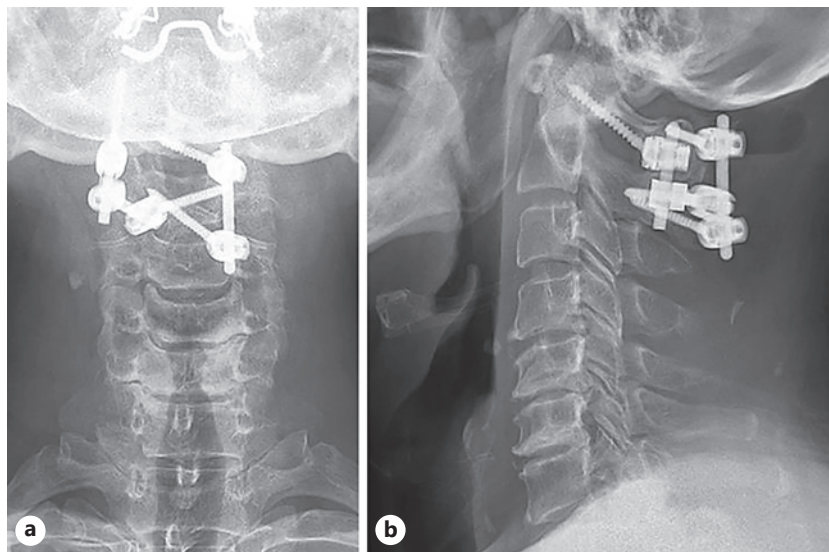
**Fig. 3.** Postoperative computed tomography (CT). Three-dimensional CT (**a**) and CT images after surgery show the correct placement of the implants at C1 (**b, c**) and C2 (**d, e**).

between the screws. After securing the rods, decortication and autologous iliac crest bone grafting were performed. Intraoperative findings revealed no VA injury, and postoperative computed tomography (CT) showed that the screw was placed at the planned site (Fig. 3).

The postoperative plain radiograph showed good alignment of C1–C2 (Fig. 4). The patient was immobilized in a Philadelphia cervical collar for 3 months after surgery. CT revealed posterior fusion between the C1 posterior arch and the C2 lamina (Fig. 4), with no loosening of the C1 LMS and PAS or the C2 LS. The patient no longer experienced loss of consciousness for 4 months after surgery.

### Discussion

Sorensen coined the term “bow hunter’s syndrome” based on a patient who developed Wallenberg stroke during archery practice [1]. Symptoms of BHS include syncopal or near-syncopal events, drop attacks, vertigo, dizziness, and impaired vision. These symptoms



**Fig. 4.** **a** Postoperative anterior-posterior and **(b)** lateral radiographs show correct placement of the implants and good alignment.

may be associated with poor collateralization; the contralateral VA is either hypoplastic or absent, or the circle of Willis is deficient. Symptoms are often elicited by contralateral rotation if the occlusion is at the craniocervical junction. Surgical treatment carries an excellent prognosis [2]. The options for surgery include decompression, fusion, or a combination of decompression and fusion. No symptom recurrence occurs in patients who undergo fusion or decompression and fusion. Fusion is also a successful salvage procedure for recurrent or persistent symptoms after decompression. [2, 7, 8] In this case, no decompression of the C1 transverse process was used to ensure the prevention of dominant VA injury.

C1-C2 posterior fixation using the C1 LMS-C2 PS method is the most effective technique. However, a systematic review revealed a 2.9% incidence of vascular injury after C1/2 transarticular screw fixation, and vascular injury following posterior C1/2 instrumentation resulted in ipsilateral stroke in 10.0% of patients [6]. Various techniques have been employed to reduce the risk of VA injury, including the use of bilateral LSs crossing the C2 lamina [9], the use of a unilateral C2 PS combined with a contralateral C2 LS, and the use of a C1 PAS [10–12].

In this case, insertion of the C2 PS was difficult due to the high-riding VA at C2. However, the PAS and the contralateral C1 LMS could be placed under direct visualization and, therefore, was safer than the bilateral C1 LMS and prevented dominant VA injury. In addition, the PAS in this method had a lower bleeding risk from the venous plexus during screw insertion because treatment around the venous plexus was unnecessary. For the successful insertion of the C1 PAS, the bone morphology and VA courses should be rigorously examined using preoperative CT angiography and three-dimensional images. In addition, the sounder should be carefully checked to ensure that the screw does not enter the spinal canal during insertion.

Fixation with a unilateral C1 PAS-C2 LS is an alternative to C1 LMS and C2 PS and is a reasonable surgical treatment option for BHS. We are following our case closely to monitor the appearance of radiological problems and clinical symptoms.

## Conclusion

In a patient with BHS, posterior fixation with a unilateral C1 PAS-C2 LS prevented VA injury because the screw could be inserted while avoiding the VA. The CARE Checklist has been completed by the authors for this case report and is attached as supplementary material.

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## Statement of Ethics

This study was conducted in line with the principles of the Declaration of Helsinki. Written informed consent was obtained from the patient for publication of this case report and any accompanying images. Ethical approval is not required for this study in accordance with local guidelines.

## Conflict of Interest Statement

The authors declare that there is no conflict of interest.

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## Author Contributions

Tatsuya Tanaka: care of patient and writing, designing, and editing of the manuscript. Ren Fujiwara, Haruki Funao, Shigeto Ebata, Ryohei Sashida, Yu Hirokawa, Tomihiro Wakamiya, Yuhei Michiwaki, Fumitaka Yamane, and Ken Ishi: care of patient and editing of the manuscript. Kazuaki Shimoji, Eiichi Suehiro, Keisuke Onoda, Masatou Kawashimaa, and Akira Matsunoo: editing of the manuscript.

## Data Availability Statement

All data generated or analyzed during this study are included in this article. Further inquiries can be directed to the corresponding author.

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