CASE REPORT

Use of C2 spinous process screw for posterior cervical fixation as substitute for laminar screw in a patient with thin laminae

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SUMMARY

Rigid screw fixation of C2 including transarticular screw and pedicle screw contain the risk of vertebral artery (VA) injury. On the other hand, translaminar screws are considered to be safer for patients with anomalous VA. But C2 translaminar screw placement was limited in patients who have thin laminae and there is marked variation in C2 laminar thickness. Appropriate C2 fixation method for a patient who has thin laminae and high-riding VA together was controversial. Here, we present a case of an elderly Asian woman who had thin laminae and high-riding VA together with progressive myelopathy to report a first case of C2 spinous process screw insertion. Although the stability and safety of C2 spinous process screw was reported in cadaver series, there was no clinical report to our knowledge. Spinous process screw can be an option of C2 fixation for patients with high-riding VA and severe degenerated cervical spines including thin C2 laminae.

BACKGROUND

Cervical screw fixation has become widely used for the treatment of various spinal disorders, but it carries potential risks of vascular and neural injuries. Specifically, insertion of pedicle or transarticular screws to the axis is associated with substantial risk of injury to the vertebral artery (VA), which can lead to serious sequel including death.^{1 2} To avoid this devastating complication, an alternative technique using C2 translaminar screw has been recently introduced.³ This technique has increasingly gained popularity over the past decade because of its relative safety, especially in the presence of high-riding or other anomalous VA; however, its placement is not always feasible owing to anatomical constraints of the C2 laminae. Here we report a case of C2–T1 fixation by using a C2 spinous process screw, inserted horizontally through the base of the spinous process, as a fixation anchor.

CASE PRESENTATION

A 78-year-old Japanese woman presented with a 3-month history of progressive myelopathy including numbness of extremities and increasing urinary frequency. Her symptoms were slightly alleviated by bed rest and exacerbated by bending her neck forward. Her muscle strength was impaired and her deep tendon reflexes were hyperactive below C4 level. She also presented hypoesthesia on both hands.

A plain radiograph on flexion and extension revealed subaxial instability at C2/C3 and C5/C6 levels. MRI showed multilevel spinal cord compression with intramedullary high signal on T2-weighted image (figure 1). CT revealed that her C2 laminae were thin (3.7 mm) and C1 lateral mass and C2 pedicles were narrow with erosion. But her C2 spinous process was 13 mm width and 14 mm height. CT angiography showed high-riding VA was on the right side (figure 2).

Although cervical spine fixation was needed, she had anatomical limitations for screw insertion. Subsegment preoperative planning using computer navigation system showed transarticular screw or C2 pedicle screw were not acceptable on the right side because of high-riding VA and translaminar screws trajectories could not be allowed because of thin laminae. She was scheduled for laminectomy of compression levels (C3–C6) and posterior fixation (C2, C6 and T1) by using C2 spinous process screw on the right side and pedicle screw on the left side.

TREATMENT

On operation, the head was fixed using a Mayfield 3-pin skull fixation. The cervical spine was

Figure 1 Preoperative MRI T2-weighted image (T2WI); the C5 slipped forward and C6 was transferred backward. Severe spinal cord compression was revealed with high signal on T2WI at C3–C6 level.

To cite: Nagata K, Baba S, Chikuda H, *et al.* *BMJ Case Rep* Published online: [please include Day Month Year] doi:10.1136/bcr-2013-009889

Figure 2 (A) Preoperative CT; the axial image of C2 showed thin laminae and narrow pedicles. However, the size of spinous process was large enough. (B) Three dimensional-CT angiography; the sizes of both vertebral arteries (VAs) were same and her right VA was high riding.

maintained in a neutral position. After getting the surgical field expanded to lateral aspect of intervertebral articulation, 4 mm in diameter pedicle screw was inserted to the left side of C2. Then, we decorticate C2 spinous process base at the right side with surgical airtome to set a screw hole. We planned the hole to a little caudal direction in order to get an appropriate screw length because her C2 spinous process was in a triangle shape. A 3.5 mm in diameter spinous process screw was selected and inserted bicortically to a 30° caudal direction through a single minimal skin incision (figure 3). Next, we set 3.5 mm in diameter translaminal screws to C7 and 4 mm in diameter pedicle screws on both sides of T1, respectively.

On the left side we connected a slightly bent 120 mm-length rod from C2 pedicle screw to T1 pedicle screw. It was then attached to C7 laminar screw via two lateral connectors. Spinous process and laminae of the affected level (C3–C6) are removed by a high-speed surgical airtome. Afterwards we set a right side rod by using one lateral connector. A 3 mm width non-absorbable ultrahigh-molecular-weight polyethylene tape was tied around C2 laminae as a sublaminar wiring. During the

Figure 3 The rod on her left side was connected between C2 and T1, and then it was attached to the C7 laminar screw via two lateral connectors. The picture was taken just after laminectomy between C3 and C6 following connection a 120 mm-length rod between C2 and T1 on her right side which was attached to C7 via one lateral connector.

procedure, there was no change in the motor evoked potential monitoring.

OUTCOME AND FOLLOW-UP

Her Japanese Orthopaedic Association score improved from 9 before operation to 11 on discharge. Two years after operation, there was no loss of her instruments (figure 4).

DISCUSSION

Owing to their excellent mechanical properties, spinous processes have been used as anchors for cervical fixation for more than 120 years.^{4 5} In the present case, we inserted a screw horizontally through the base of the C2 spinous process. We found that the C2 spinous process screw may have several advantages. First, the horizontal trajectory of the screw practically eliminates the risk of canal compromise. Second, its placement can be performed without assistance of fluoroscopy or navigation and its connection to the rod can be performed using a conventional lateral connector with ease. Last, with bicortical purchase, a C2 spinous process screw, when combine with sublaminar wiring, seems to provide sufficient stability for multilevel fixation without need for additional fixation points at adjacent levels.

Although the C2 translaminal screw technique described by Wright is versatile and seemingly applicable for great majority of patients, there is a subgroup of patients whose laminae is not capable of containing C2 translaminal screws. According to the cadaveric studies examining anatomical feasibility of C2

Figure 4 Two year postoperative x-ray; C2 spinous process screw runs bicortically to 30° caudal direction C2 spinous process screw and pedicle screw was inserted appropriately without loosening two years after operation. Postoperative CT; spinous process screw was inserted to a little caudal direction based on preoperative simulation.

translaminar screws, wide range of laminar thickness has been noted.^{6–8} Cassinelli *et al*⁸ found marked variation in C2 laminar thickness ranging 1.35–9.7 mm. Ma *et al*⁶ examined 120 cadaveric specimen of Asian population and reported that 14.2% (16/120) of specimen had laminae of insufficient size (<4 mm) at least on one side. They found that 5% of C2 were unacceptable in size for the placement of translaminar screws bilaterally.

The spinous process of the axis is larger in size as compared with its subaxial counterparts and serves as attachment for multiple muscular structures. Although clinical application of the C2 spinous process screw has not been reported in the literature, there is a cadaveric study examining the feasibility of the C2 spinous process screw.⁹ The researchers reported that the C2 spinous process screws were placed without impingement of spinal cord or VA and breakage of the spinous process; they concluded that the C2 spinous process screw fixation has the anatomic feasibility.

In this paper, we reported potential usefulness of the C2 spinous process screw as a substitute for translaminar screw in a patient presented with thin C2 laminae that precluded insertion of translaminar screws. To our knowledge, clinical use of C2 spinous process screw has never been explicitly reported. Although further biomechanical studies are needed, the C2 spinous process screw can be a useful alternative option, especially in patients with anomalous VA and concomitant thin C2 laminae.

Competing interests None.

Patient consent Obtained.

Provenance and peer review Not commissioned; externally peer reviewed.

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Learning points

- ▶ As C2 fixation, C2 translaminar screw or C2 pedicle screw insertion is technically difficult in size or anomalous artery, respectively.
- ▶ The C2 spinous process screw is anatomically feasible in anomalous vertebral artery and concomitant thin C2 laminae.
- ▶ The C2 spinous process screw can be a useful alternative option.

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