CASE REPORT

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C1-C2 screw fixation in the patient with anomalous course of vertebral artery – a case report

C1-C2 fiksacija šrafom kod bolesnika sa anomalijom toka vertebralne arterije

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Abstract

Introduction. The atlantoaxial complex is a very complicated structure and open reduction of C1-C2 subluxation is very demanding. Atlantoaxial instability may result from the traumatic, inflammatory, neoplastic, congenital or degenerative disorders. Anatomy of the vertebral artery is essential for surgical approach and sometimes the placement of C2 pedicle screw is not possible. In these instances, the translaminar screw placement in C2 can provide an alternative fixation point in C2, without threatening injury to the vertebral artery. **Case report.** We presented 54- year-old patient with cervical myelopathy according to traumatic atlantoaxial subluxation. Computed tomography angiography showed a bilateral vertebral artery anomaly of "high-riding" type. The patient was operated and the posterior C1-C2 screws fixation was used. Due to the vertebral artery anomaly C2 screws were translaminary inserted. Complete reduction of C1-C2 subluxation and excellent neurological improvement were achieved. **Conclusion.** Surgical treatment of C1-C2 subluxation is very challenging. Many techniques of atlantoaxial fixation have been developed. The use of C2 translaminar screw is an alternative method of fixation in the treatment of atlantoaxial instability, especially in cases with the vertebral artery anomaly.

Key words:
cervical vertebrae; joint dislocation; vertebral artery; congenital abnormalities; bone screws; neurosurgery.

Apstrakt

Uvod. Atlantoaksijalni kompleks je veoma kompleksna anatomska struktura, a otvorena redukcija C1-C2 luksacije veoma je zahtevna procedura. Nestabilnost atlantoaksijalnog kompleksa može nastati kao posledica traumatskih, inflamatornih, neoplastičnih, kongenitalnih ili degenerativnih oboljenja. Poznavanje anatomije vertebralne arterije ključno je za obavljanje hirurgije u ovoj regiji, a transpedikularno plasiranje C2 šrafa ponekad nije moguće. U ovim situacijama, translaminarno plasiranje šrafova u C2 pršljen obezbeđuje alternativan način fiksacije, bez opasnosti od povrede vertebralne arterije. **Prikaz bolesnika.** Prikazan je bolesnik, star 54 godine, sa cervikalnom mijelopatijom kao posledicom traumatske atlantoaksijalne subluksacije. Kompjuterizovana tomografska angiografija pokazala je obostranu anomaliju vertebralne arterije "high-riding" tipa. Bolesnik je operisan, učinjena je C1-C2 zadnja stabilizacija šrafovima. Zbog anomalne pozicije vertebralne arterije šrafovi su plasirani u lamine C2 pršljena. Postignuta je odlična repozicija subluksacije kao i odličan neurološki oporavak bolesnika. **Zaključak.** Hirurški tretman C1-C2 luksacije predstavlja veliki izazov. Opisane su brojne hirurške tehnike u tretmanu atlantoaksijalne fiksacije. C2 translaminarno plasiranje šrafova je alternativna metoda stabilizacije u tretmanu atlantoaksijalne nestabilnosti, posebno u slučajevima anomalije vertebralne arterije.

Ključne reči:
pršljenovi, vratni; iščašenje; a.vertebralis; anomalije; zavrtnji za kost; neurohirurgija.

Introduction

The atlantoaxial complex is very complicated structure and surgery in that region is very demanding. Reduction of the C1-C2 subluxations results in the increased space for the spinal cord and is a decompressive strategy for spinal cord compression secondary to the C1-C2 instability [1]. Atlantoaxial subluxation may result from the traumatic, inflammatory, neoplastic, congenital or degenerative disorders. Several techniques have been described to treat atlantoaxial instability, ranging from wiring techniques, transarticular screw technique, C1 lateral mass with C2 pedicle screw and C1 lateral mass screw with C2 translaminar screw. The wiring techniques are limited in their ability to achieve and maintain adequate reduction intraoperatively [1, 2]. The transarticular screw technique is excellent for maintaining alignment, but it does

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not enable reduction [1, 3, 4]. This technique confers immediate stability to atlantoaxial complex and is usually performed in a combination with a wiring technique to provide a substrate for bony fusion, however, this type of screw fixation is technically demanding and associated with the risk of the vertebral artery injury [5, 6]. The presence of a high-riding vertebral artery precludes the safe placement of C2 pedicle screws in C1 lateral mass screw with the C2 pedicle screw technique. The translaminar screw placement in C2 can provide an alternative fixation point in C2 in the patients with anomalous course of the vertebral artery.

Case report

A 54-year-old man was referred to our hospital for cervical myelopathy according to atlantoaxial instability. Three months before admission to our department, he suffered a trauma of cervical spine during physical activity. After few days, he started with myelopathy. On admission, he had severe myelopathy with the Nurick score 4, and 11 according to the modified Japanese Orthopaedic Association (mJOA) scale. He had a severe neck pain and his left arm was almost plaegic. The imaging studies revealed C1-C2 instability, with atlantodental interval of 5 mm (Figures 1 and 2). Preoperative multisliced computed tomography (MSCT) angiography showed that there was a bilaterally anomalous course of vertebral artery, the high-riding type (Figure 3). The operation was performed in general anesthesia, with the patient in the prone position and his head secured in a Mayfield head holder. The final positioning was performed using the real-time fluoroscopy. A standard posterior approach was performed via a medial skin incision. The C1 arch was dissected and followed laterally to the lateral mass of C1 with the use of a subperiostal dissection as described by Goel and Laheri [7]. The C1-C2 articulation was exposed and decorticated, C2 nerve root was retracted inferiorly, exposing the entry point in the midportion of the C1 lateral mass. A pilot hole was made by a diamond burr, and under fluoroscopy control, a bicortical hole was tapped. Trajectory of the hole was parallel to the base of the C1 lateral mass with 10 degrees of medial angulation. A polyaxial screw was inserted bicorticaly, and few millimeters unthreaded portion of the C1 screw stayed above the lateral mass. With the diamond burr, a small cortical windows were made in the base of the spinous process of C2, one on either side. A screw tap was made inside the lamina without any cortical breakthrough one rostral to the other, and the polyaxial screw was carefully inserted along the same trajectory. The C1 lateral mass screws and bilateral laminar C2 screws were connected with the posterior rods, the locking screws were placed and the reduction technique was performed by distraction. The C1 and C2 posterior elements were then decorticated and the autologous occipital bone graft was placed over the C1-C2 posterior elements. The patient, postoperatively, had neurological improvement and he started with physical therapy. The postoperative images showed a good position of the implants and complete reduction of C1-C2 subluxation (Figures 4, 5 and 6). Postoperatively, the patient wore a cervical orthosis for 6 weeks.

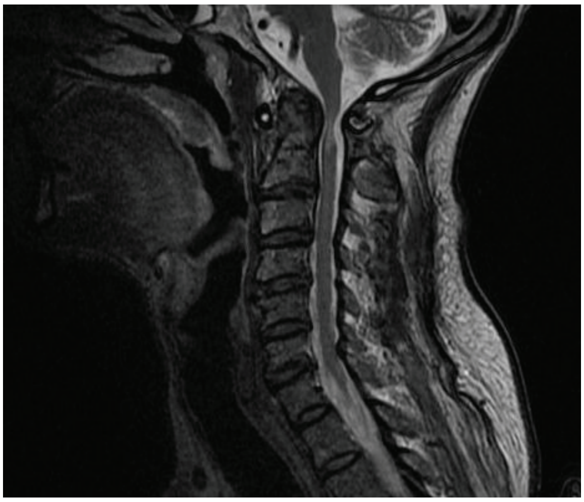

Fig. 1 – Preoperative sagittal cervical spine magnetic resonance image in a 54-year-old man with cervical myelopathy and atlantoaxial instability.

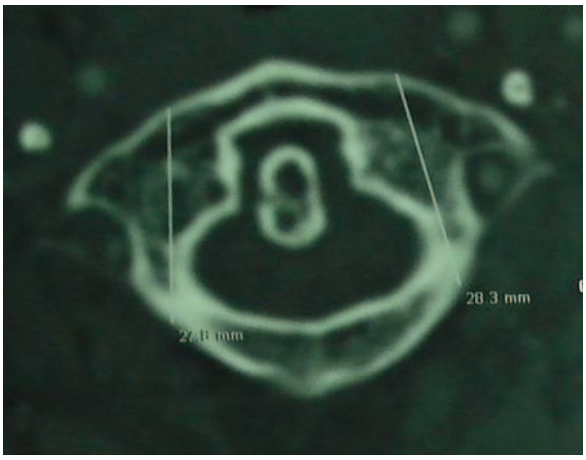

Fig. 2 – Preoperative axial computed tomography image revealing atlantoaxial instability with atlantoaxial distance of 5 mm.

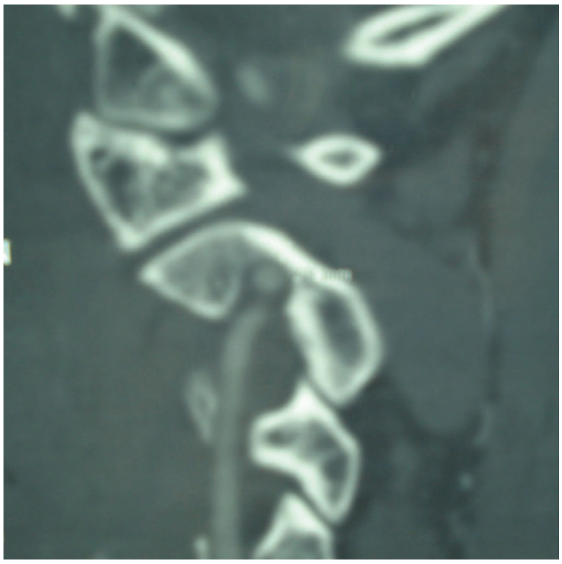

Fig. 3 – Preoperative computed tomography angiography showing the high-riding vertebral artery at the C2 level with a very narrow pedicle.

Fig. 4 – Postoperative lateral radiography showing good position of screws.

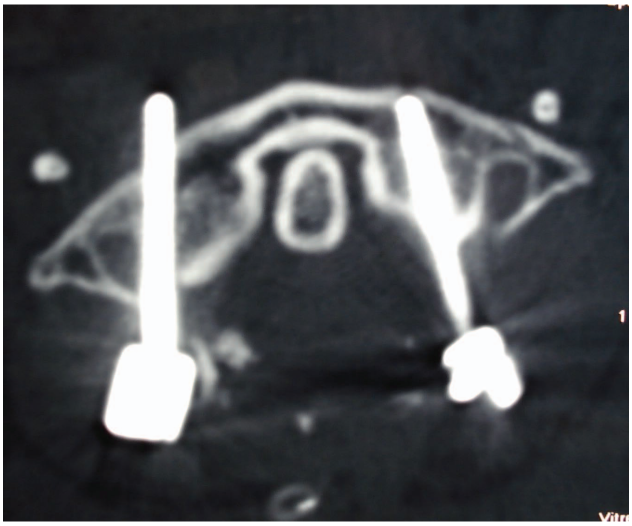

Fig. 5 – Postoperative axial computed tomography image demonstrating a good position of screws in the C1 lateral masses and complete reduction of the C1-C2 subluxation.

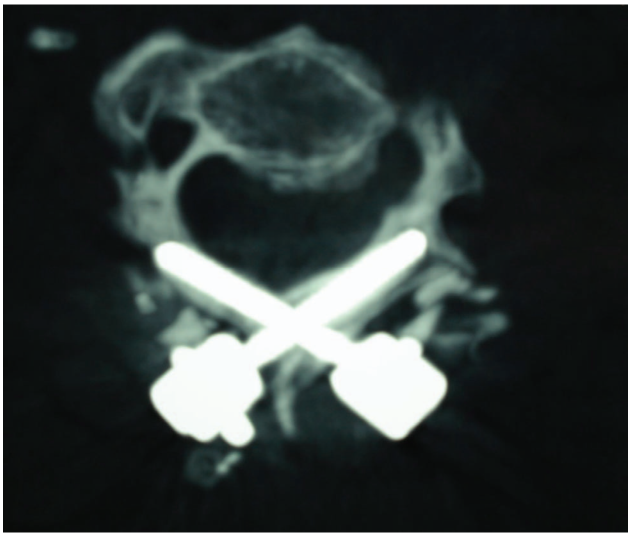

Fig. 6 – Postoperative axial computed tomography image showing a proper position of the C2 translaminar screws.

Discussion

In 1910, Mixter and Osgood [8] provided the first description of surgical treatment for atlantoaxial instability using heavy silk to tie the spinous process of C1 and C2 together. Since then, many other surgical techniques have been developed [9]. These posterior surgical techniques can be strongly divided into the wiring and screw techniques. The wiring techniques of dorsal atlantoaxial fusion are technically simple and do not require fluoroscopy. However, maintaining the reduction can be difficult, and it requires a rigid postoperative immobilization for a successful fusion [2]. Because of these disadvantages of the wiring techniques, newer screw techniques have been developed. Magerl and Seemann [10] described a transarticular screw method, and that instrumentation had superior stability in comparison to the wiring techniques [11]. This technique requires a reduction of C1-C2 luxation before fixation and an overall complication rate was high, especially in case of the vertebral artery injury [12–14]. According to these limitations of transarticular technique, Goel and Laheri described four screw C1-C2 fixation technique while other auhors [15, 16] and Harms and Melcher [17] popularized this technique. If the C2 pedicle screw cannot be placed due to the vertebral artery anomaly, an alternative techniques like C2 translaminar screw can be implemented. The vertebral artery was considered high riding if the isthmus thickness was less than 5 mm or the isthmus internal height was less than 2 mm [18]. Wright [19] and Leonard and Wright [20] described new technique which involved the insertion of polyaxial screws into the laminae of C2 in a bilateral, crossing fashion, which were then connected to the C1 lateral mass screws [9]. The intralaminar screw technique would be the safest technique in regard to the vertebral artery injury, and also, there was no need for an acute angle for the placement of screws and the C2 intralaminar screws can be placed with visual and tactile feedback without the fluoroscopy or image guidance [4, 19]. The only drawback of this technique is its requirement for an intact and adequately sized lamina. The C1 lateral mass-C2 translaminar screw constructs are biomechanicaly similar to the transarticular and C1 lateral mass-C2 pedicle screws in flexion-extension and axial rotation, although the C2 translaminar screws were significantly less resistant to lateral bending [4, 21]. Similar technique of fixation, which involves screw insertion into the base of the spinous process of the axis, was described by Goel and Kulkarni [22], also. Thorough assessment of the vascular anatomy is recommended before an operative intervention in the upper cervical spine to minimize the risk of complications. Surgical possibilities to treat the atlantoaxial instability are numerous, and according to surgical anatomy, a surgeon's skills and type of injury, surgeon can choose the best one.

Conclusion

Surgical treatment of the C1-C2 subluxation is very challenging. Many techniques of atlantoaxial fixation have been developed. The use of the C2 translaminar screw is an alternative method of fixation in the treatment of atlantoaxial instability, especially in cases with vertebral artery anomaly.

R E F E R E N C E S

1. *O'Brien JR, Gokaslan ZL, Riley LH, Suk I, Wolinsky JP.* Open reduction of C1-C2 subluxation with the use of C1 lateral mass and C2 translaminar screws. Neurosurgery 2008; 63(1 Suppl 1): ONS95–8; discussion ONS98–9.
2. *Papagelopoulos PJ, Currier BL, Hokari Y, Neale PG, Zhao C, Berglund LJ,* et al. Biomechanical comparison of C1-C2 posterior arthrodesis techniques. Spine (Phila Pa 1976) 2007; 32(13): E363–70.
3. *Claybrooks R, Kayanja M, Milks R, Benzel EC.* Atlantoaxial fusion: a biomechanical analysis of two C1-C2 fusion techniques. Spine J 2007; 7(6): 682–8.
4. *Lapsiwala SB, Anderson PA, Oza A, Resnik DK.* Biomechanical comparison of four C1 to C2 rigid fixative techniques: anterior transarticular, posterior transarticular, C1 to C2 pedicle, and C1 to C2 intralaminar screws. Neurosurgery 2006; 58(3): 516–21; discussion 516–21.
5. *Resnik DK, Benzel EC.* C1-C2 pedicle screw fixation with rigid Cantilever beam construct: case report and technical note. Neurosurgery 2002; 50(2): 426–8.
6. *Mandel IM, Kambach BJ, Petersilge CA, Johnstone B, Yoo JU.* Morphologic considerations of C2 isthmus dimensions for the placement of transarticular screws. Spine (Phila Pa 1976) 2000; 25(12): 1542–77.
7. *Goel A, Laheri V.* Plate and screw fixation for atlanto-axial subluxation. Acta Neurochir (Wien) 1994; 129(1–2): 47–53.
8. *Mixter SJ, Osgood RB.* IV. Traumatic Lesions of the Atlas and Axis. Ann Surg 1910; 51(2): 193–207.
9. *Menendez JA, Wright NM.* Techniques of posterior C1-C2 stabilization. Neurosurgery 2007; 60(1 Suppl 1): S103–11.
10. *Magerl F, Seemann PS.* Stable posterior fusion of the atlas and axis by transarticular screw fixation. In: *Kehr P, Wiedner A*, editors. Cervical Spine. New York: Springer; 1986. p. 322–7.
11. *Henriques T, Cunningham BW, Olerud C, Shimamoto N, Lee GA, Larsson S,* et al. Biomechanical comparison of five different atlantoaxial posterior fixation techniques. Spine (Phila Pa 1976) 2000; 25(22): 2877–83.
12. *Vegara P, Bal JS, Hickman Casey AT, Crockard HA, Choi D.* C1-C2 fixation: are 4 screws better than 2? Neurosurgery 2012; 71(1 Suppl Operative): 86–95.
13. *Finn MA, Apfelbaum RI.* Atlantoaxial transarticular screw fixation: update on technique and outcomes in 269 patients. Neurosurgery 2010; 66(3 Suppl): 184–92.
14. *Neo M, Fujibayashi S, Miyata M, Takemoto M, Nakamura T.* Vertebral artery injury during cervical spine surgery: a survey of more than 5600 operations. Spine 2008; 33(7): 779–85.
15. *Goel A, Desai KI, Muzumdar DP.* Atlantoaxial fixation using plate and screw method: a report of 160 treated patients. 2002; 51(6): 1351–6; discussion 1356–7.
16. *Goel A.* Treatment of basilar invagination by atlantoaxial joint distraction and direct lateral mass fixation. J Neurosurg Spine 2004; 1(3): 281–6.
17. *Harms J, Melcher RP.* Posterior C1-C2 fusion with polyaxial screw and rod fixation. Spine (Phila Pa 1976) 2001; 26(22): 2467–71.
18. *Elgafy H, Pompo F, Vela R, Elsamaloty HM.* Ipsilateral arcuate foramen and high-riding vertebral artery: implication on C1-C2 instrumentation. Spine J 2014; 14(7): 1351–5.
19. *Wright NM.* Posterior C2 fixation using bilateral, crossing C2 laminar screws: case series and technical note. J Spinal Disord Tech 2004; 17(2): 158–62.
20. *Leonard JR, Wright NM.* Pediatric atlantoaxial fixation with bilateral, crossing C-2 translaminar screws. Technical note. J Neurosurg 2006; 104(1 Suppl): 59–63.
21. *Dorward IG, Wright NM.* Seven years of experience with C2 translaminar screw fixation: clinical series and review of the literature. Neurosurgery 2011; 68(6): 1491–9; discussion 1499.
22. *Goel A, Kulkarni AG.* Screw implantation in spinous process for occipitoaxial fixation. J Clin Neurosci 2004; 11(7): 735–7.

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