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HOW I DO IT

Biportal endoscopy-assisted lateral mass screw fixation using a third portal

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Abstract

Background The technique of spinal decompression under endoscopy has been widely applied, but reports on endoscopic cervical fixation are rare. The unilateral biportal endoscopic (UBE) technique stands out for its lesser muscle intrusion and more flexible surgical approach.

Method We applied the UBE approach for cervical fixation and laminectomy. We achieved bilateral lateral mass screw fixation by making an auxiliary UBE portal combined with the Roy–Camille and Magerl techniques.

Conclusions Our successful implementation of cervical fixation using the UBE technique at the C3/4 level suggests its efficacy. This approach is a valuable and minimally invasive option for cervical fixation.

Keywords Unilateral biportal endoscopic · Bilateral lateral mass screw fixation · Endoscopic cervical fixation · Minimally invasive surgery

Relevant surgical anatomy

To mitigate muscle intrusion, minimally invasive posterior cervical procedures has become more common in recent years [3, 4, 6]. The unilateral biportal endoscopic (UBE) technique has been applied more often in posterior cervical spine surgery [2, 5, 7]. Endoscopic decompression has been widely applied for treating spinal stenosis. Less is known about posterior cervical fixation techniques under endoscopy. We previously reported that unilateral lateral mass screw fixation of C4/5 can be achieved using four incisions. While the spinous process floating technique facilitates bilateral cord decompression, employing the Magerl technique for placing screws across two segments requires two additional surgical incisions [5].

In open surgery, various lateral mass screw placement techniques with different entry points and screw trajectories have been proposed. Applying the characteristics of the Roy–Camille technique for inserting screws perpendicular to the lateral mass (Fig. 1a, b) and the Magerl technique for inserting screws parallel to the facet joint (Fig. 1c, d), we designed a surgical technique for inserting lateral mass screws for two segments through an auxiliary portal on the contralateral side [1].

Jiaming Liang and Chengyue Zhu contributed equally to this work and should be considered co-first authors.

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Description of the technique

Surgical instruments

The surgical instruments used were as described in our prior report [5]. They included a high-speed burr, a toolkit of radiofrequency (RF) systems (Jiangsu BONSS Medical Technology, China), conventional arthroscopic tools featuring a 30° endoscope, and standard open spine surgical implantation equipment.

Position and creation of the incision

Taking C3/4 cervical stenosis as an example, after general anaesthesia, the patient was laid prone, as we have done before [6]. The operating table was adjusted to ensure that the C3/4 intervertebral space was perpendicular to

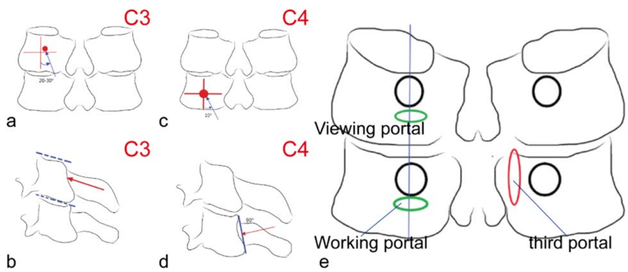

Fig. 1 The Magerl technique for C3 lateral mass screws. The entry point was slightly medial and cranial to the midpoint, and the lateral angulation of the screw was 20° ~ 30° (**a**). The screw was inserted parallel to the adjacent facet joints (**b**). The Roy–Camille technique for C4 lateral mass screws. The entry point was at the midpoint of the lateral mass, and the lateral angulation was 10° (**c**). The screw was inserted perpendicular to the lateral mass (**d**). Schematic representation of the location of the portals; the third portal is a longitudinal incision located at the medial margin of the contralateral C4 pedicle (**e**)

the ground. The ipsilateral longitudinal incision line was strategically placed at the centre of the pedicle, considering both spinous process floating and screw placement. The horizontal line was positioned at the lower edge of the pedicle projection. The cranial intersection point served as the viewing portal, while the caudal intersection point acted as the working portal. On the contralateral side, a longitudinal incision was made at the remote C3 spinous process and medial margin of the contralateral C4 pedicle to accommodate the placement of both contralateral screws (Fig. 1e).

Lateral mass screw fixation

First the left lamina, interlaminar space, and C3/4 lateral mass were exposed utilizing radiofrequency. After the soft tissue on the lamina surface was cleaned by RF exposure, a 2-mm diamond burr was used to confirm the correct C4 segment and identify the screw entry point (Fig. 2a, b). To prevent the C3 screw from interfering with endoscopic observation and to avoid the tail of the C3 screw hindering the insertion of the C4 screw, a C4 lateral mass screw was inserted first. A 3.5-mm lateral mass screw with a length of 10 mm was inserted into the C4 lateral mass through the entry point using the Roy–Camille technique (Fig. 2c, d). The C3 lateral mass screw, a 3.5-mm screw with a length of 12 mm, was also accurately inserted following the Magerl technique (Fig. 2e-f). Lastly, an appropriate-length and curved rod connected the two screws.

Spinous floating and contralateral screw fixation

In the first stage of the procedure, we used RF and burrs to explore the base of the spine. The base of the spinous process of C3/4 was drilled using a burr, allowing the remnant tip of the spinous process to float due to the posterior ligamentous complex. With the aid of spinous floating and while exposing the contralateral lamina and lateral mass using RF, the anatomy of the contralateral side became readily visible.

In the second stage, a contralateral auxiliary incision was created at the medial margin of the contralateral C4 pedicle. The auxiliary portal was made at the remote C3 spinous process and medial margin of the contralateral C4 pedicle.

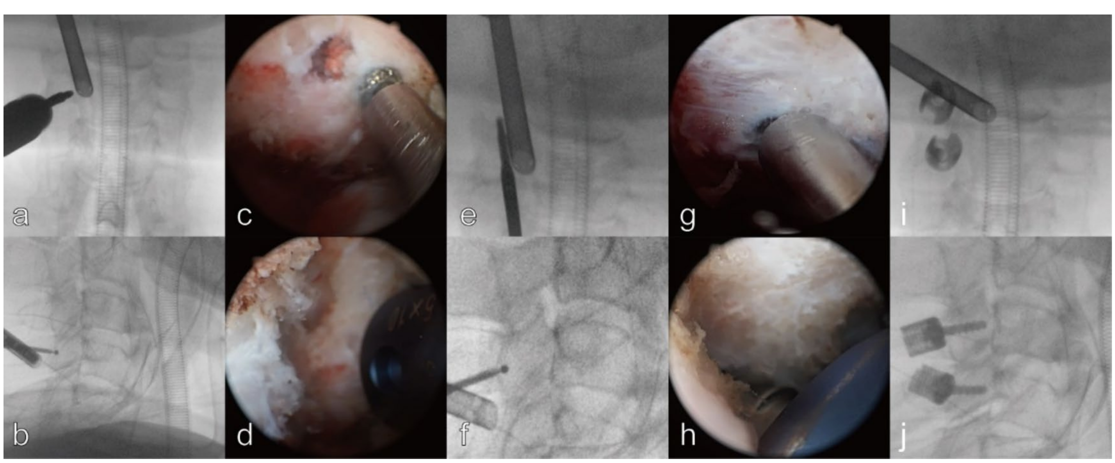

Fig. 2 The C4 screw entry point was at the midpoint of the lateral mass, and the screw was inserted perpendicular to the lateral mass (**a, b**). The burr position is the entry point on the C4 lateral mass adjusted under fluoroscopic guidance (**c**). The C4 screw was inserted endoscopically (**d**). The C3 screw entry point was slightly medial and cranial to the midpoint of the lateral mass, and the screw was inserted parallel to the adjacent facet joints (**e, f**). Endoscopic insertion of the C3 entry point and screw (**g, h**). The positions of the ipsilateral C3 and C4 lateral mass screws were verified by fluoroscopy (**i, h**)

RF was then applied through the auxiliary portal to dissect the remaining soft tissue, further exposing the contralateral lateral mass. Through intraoperative fluoroscopy, the entry point of the contralateral lateral mass screws was confirmed using a 2-mm burr. The C4 screw was inserted by the Roy-Camille technique, the C3 screw was inserted by the Magerl technique, and appropriate rods were placed contralaterally (Fig. 3).

Total laminectomy for decompression

After accurate fixation of all screws and rods (Fig. 4a, b; Fig. 5), the residual spinous process and soft tissue were removed. The C3/4 lamina was delicately thinned using a 4-mm diamond burr until the ventral lamina surface was exposed. The 1-mm and 2-mm Kerrison rongeurs typically utilized in open surgery were used to excise the ventral lamina. The upper part of C4 was excised until the distal portion of the ligamentum flavum was visible. Gradual separation and resection of the ligamentum flavum between C3/4 ensued. Adequate decompression of the cervical spinal canal was indicated by observable dural pulsation (Fig. 4c). Bone wax was applied to control bone errhysis. To ensure proper drainage, two drainage tubes were placed through the working portal and the auxiliary portal (Fig. 4d).

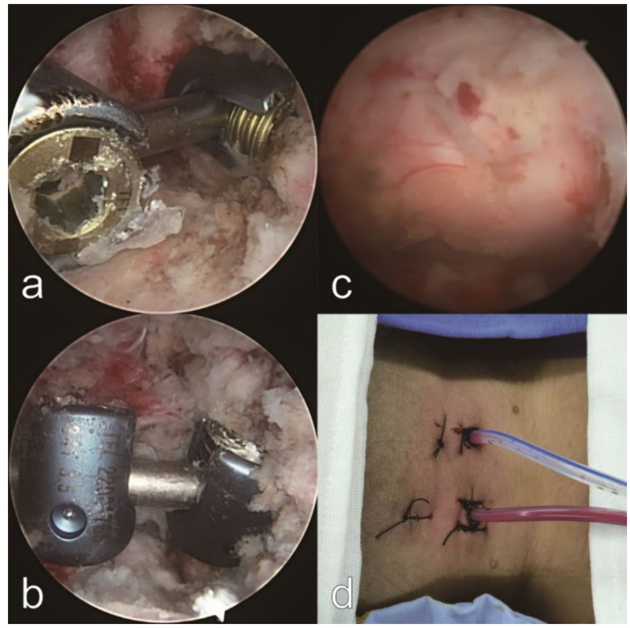

Fig. 4 The ipsilateral (**a**) and contralateral (**b**) lateral mass screws and rods. The C3/4 levels were completely decompressed by endoscopic decompression (**c**). Two drainage tubes were placed by a working and auxiliary portal, and a skin incision was made on the back of the patient's neck (**d**)

Indications

The indications for this technique align with those for traditional open cervical laminectomy. It is suitable for cases of cervical stenosis requiring substantial decompression with cervical instability and cervical herniation accompanied by calcification. It is indicated for patients with hypertrophy of the ligamentum flavum or facet joint hypertrophy leading to posterior spinal canal stenosis and spinal cord compression. In situations where anterior discectomy with fixation has been performed and further posterior decompression and fixation are necessary to prevent postoperative neck pain, a minimal access approach via

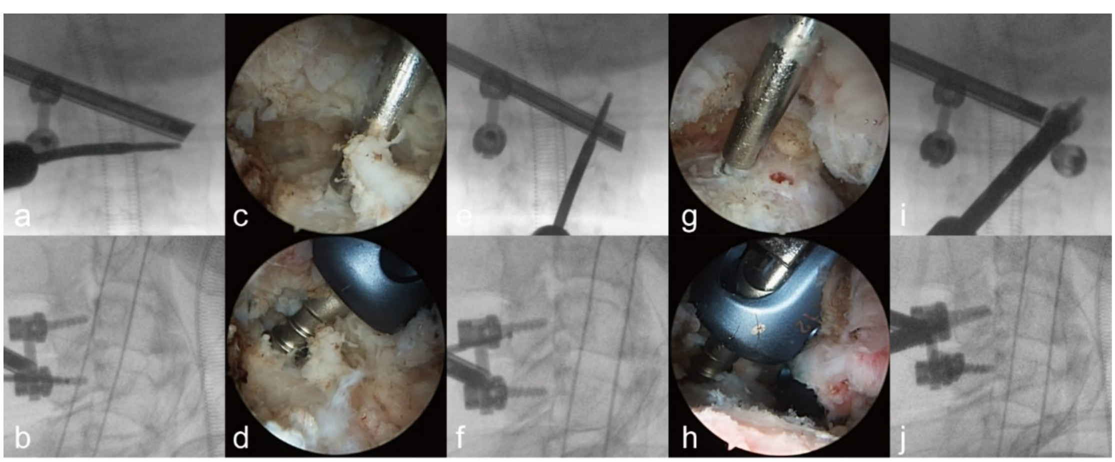

Fig. 3 The contralateral C4 screw entry point and screw trajectory under fluoroscopy (**a, b**). Endoscopic placement of the contralateral C4 screw entry point and screw (**c, d**). The contralateral C3 screw entry point and screw trajectory under fluoroscopy (**e, f**). Endoscopic placement of the contralateral C3 screw entry point and screw (**g, h**). The positions of the contralateral C3 and C4 lateral mass screws were verified by fluoroscopy (**i, j**)

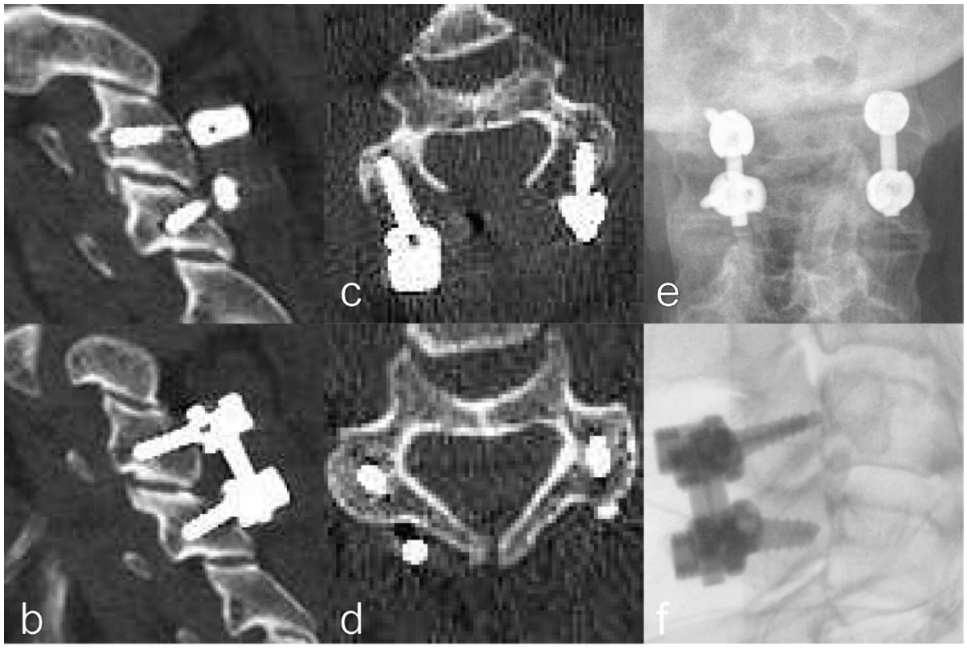

Fig. 5 Postoperative CT scan showing that the contralateral (**a**) and ipsilateral (**b**) screws were completely inserted within the cervical lateral masses, without invasion of the exiting nerve roots or facet joints. A transverse CT scan demonstrated adequate decompression of the C3 spinal canal and satisfactory internal fixation (**c**). Bilateral lateral mass screws at C4 (**d**). The anteroposterior and lateral radiographs showed satisfactory cervical fixation (**e**, **f**)

UBE is a good choice. It is not recommended for patients with cervical trauma, infection, or deformities.

Limitations

Lateral mass screw fixation is applicable to the C3 to C7 vertebrae. Hence, this procedure is restricted to use in the subaxial cervical spine. More portals will be required for decompression and fixation involving more levels. Traditional open-surgical instruments are not suitable for placing connecting rods under endoscopy, as longer rods pose greater difficulty.

How to avoid complications

Anatomical abnormalities may impact lateral mass screw placement, emphasizing the necessity of thorough CT imaging before surgery. During spinal canal decompression, ensuring irrigation outflow patency and maintaining low water pressures are crucial to reducing the risk of spinal cord injury. Postoperative haemostasis, including bone surface, small artery, and surgical portal bleeding, is essential for preventing spinal canal haematoma. Employing neurological electrophysiological monitoring during the operation enhances surgical safety.

Specific information for the patient

Patients should be informed that due to anatomical abnormalities, incomplete decompression, or severe dural injury, their surgery may be converted to open posterior decompression and fixation. Second-stage anterior cervical decompression may be necessary if the initial decompression is incomplete. A postoperative semirigid cervical collar should be prescribed for 3 months.

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Authors' contributions Conceptualization: WZ and HP; methodology: WZ; resources and writing—original draft preparation: JM L; writing review and editing: WZ and CY Z; supervision: WZ and HP; project administration: WZ. All authors contributed to the article and approved the submitted version.

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Data availability The original data and material presented in the study are included in the article/Supplementary Material; further inquiries can be directed to the corresponding author.

Code availability Not applicable.

Declarations

Ethics approval The studies involving human participants were reviewed and approved by the Institutional Review Board of Hangzhou Traditional Chinese Medicine Hospital Affiliated with Zhejiang Chinese Medical University.

Consent to participate The patients provided their written informed consent to participate in this study.

Consent for publication Written informed consent was obtained from the patient for publication of this technical note and any accompanying images.

Conflict of interest The authors declare no competing interests.

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Key points

1. We successfully performed C3/4 laminectomy while simultaneously completing the implantation of bilateral lateral mass screws through a third auxiliary UBE portal.

2. Implanting the contralateral lateral mass screw first may reduce the interference from ipsilateral screws on endoscopic visualization and manipulation.

3. If the anatomical structures on the contralateral side are not clearly visible with a 30° endoscope, a 45° endoscope may be considered, but this requires higher proficiency.

4. Flexible use of different lateral mass screw implantation methods can complete two segments of screw fixation in one incision.

5. The spinous floating technique enables complete laminectomy while preserving the integrity of the posterior cervical ligamentous complex. Please note that it is essential to use bone wax for haemostasis at the base of the floating spinous process.

6. The sliding technique enables the decompression of multiple segments through the fewest surgical portals.

7. Implanting cervical rods under endoscopy using traditional surgical instruments takes patience. The creation of purpose-built endoscopic implantation instruments is pending.

8. We can use the third UBE portal to decompress the contralateral side. It not only reduces the risk of spinal cord injury through the ipsilateral working portal but also reduces the occlusion of the surgical instrument for the endoscopic visual field.

9. Haemostasis with bone wax and drainage tube placement are important steps to avoid intraspinal haematoma. It is necessary to close the saline irrigation and check for soft tissue bleeding in the surgical portals before the end of the operation.

10. The hook knife helps to open the ventral side of the lamina and avoid excessive compression of the spinal cord.

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