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HOW I DO IT

Biportal endoscopic-assisted cortical bone trajectory screw placement and lumbar interbody fusion

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Abstract

Background Endoscopically assisted screw fixation with lumbar interbody fusion is rarely performed. We succeeded in implanting the cortical bone trajectory (CBT) screws under the guidance of unilateral biportal endoscopy (UBE).

Method We attempted endoscopically assisted screw fixation in a patient with degenerative spondylolisthesis. Through a third portal, ipsilateral CBT screws were implanted without complications.

Conclusions We successfully performed unilateral biportal endoscopic lumbar interbody fusion (ULIF) with CBT and reversed CBT screws. Compared with percutaneous pedicle screw (PPS) placement, this procedure is a minimally invasive, endoscopic alternative that allows precise screw placement.

Keywords Unilateral biportal endoscopy · Lumbar interbody fusion · Percutaneous pedicle screw · Endoscopic spine surgery

Relevant surgical anatomy

Despite the disadvantages of less screw cortical bone purchase and more facet joint violation [1, 2], endoscopic lumbar interbody fusion always requires percutaneous pedicle screw (PPS) fixation [3]. Owing to the need for placement via a lateral to medial trajectory, the entry point of the PPSs, which is located at the intersection of the lateral border of the superior articular facet (SAP) and line through the center of the transverse process (TP), is difficult to expose via biportal endoscopy. In contrast, after endoscopic resection of the inferior articular process (IAP), the entry point of the cranial CBT screw with a medio-latero-superior trajectory was easily determined. Similarly, the medial and superior walls of the pedicle can be observed after SAP removal, and the entry point of the caudal reverse-CBT screw with a medio-latero-inferior trajectory can be precisely located. Because there is less invasion, enhanced-cortical bone contact, and a low risk of neurovascular injuries [4], we created a third portal [5] to implant cortical trajectory screws using biportal endoscopy.

Description of the technique

Surgical instruments

A 30° arthroscope, Kerrison punch, pituitary forceps, angled osteotomes, retractors, high-speed diamond burs, and radiofrequency (RF) with coagulation and ablation modes (Jiangsu BONSS Medical Technology, China) were used. The screw-rod system, which included CBT screws (4.5 mm × 3.5 cm; Beijing Fule Technology Development, China), connecting rods, locking nuts, drivers, and screw-rod holding devices, was prepared.

Position and creation of the portals

Taking right-sided L4-L5 ULIF as an example (Fig. 1), the patient was placed in the prone position on the

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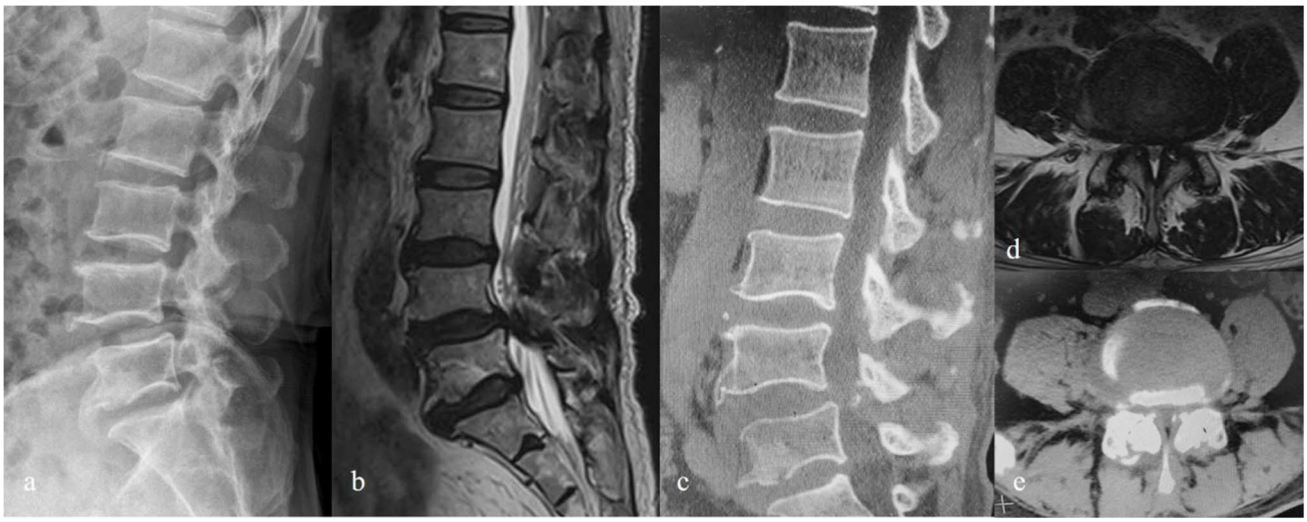

Fig. 1 **a** Preoperative X-ray image showing degenerative spondylolisthesis at L4-L5. **b–e** Preoperative sagittal and axial CT and MRI showed lumbar stenosis at L4-L5

operating table with the abdomen free. The table was adjusted to make the target intervertebral space perpendicular to the ground. Two horizontal lines were marked along the L4 and L5 pedicles, and a vertical line was drawn along the lateral edge of the pedicle in the anteroposterior view. The left-sided junctional point was used as the viewing portal, while the right-sided junctional point served as the working portal. At the intersection of the spinous process (SP) and inferior edge of the lower lamina, a longitudinal incision was made as a third auxiliary portal (Fig. 2a).

Facetectomy, endplate preparation, and cage insertion

After triangulation with the arthroscope and RF probe, the facet joint was exposed, a swing saw was used to remove the IAP at L4, and the LF was resected piece-by-piece along with the SAP at L5. Adequate decompression and perineural adhesiolysis were performed until the L5 root was confirmed to be free by gentle endoscopic manipulation. A 1.5-mm Kirschner wire was inserted through the third portal as a retractor to protect the nerve root, the endplate was fully

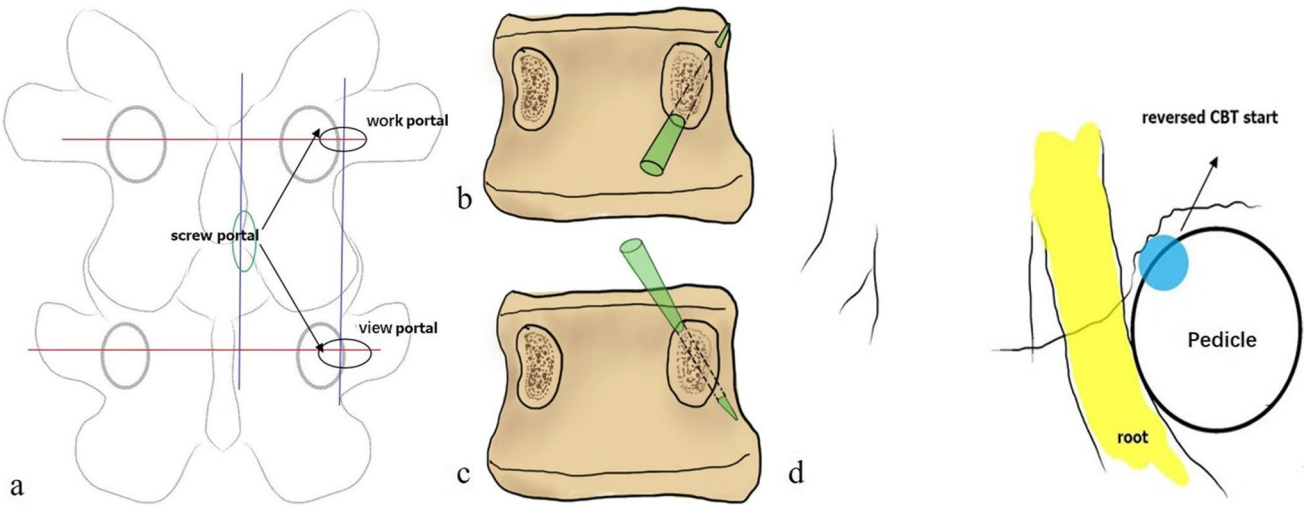

Fig. 2 **A** Schematic representation of the portal locations; **b** the standard orientation of the CBT screw was from medio-inferior to the latero-superior; **c** the orientation of the reversed CBT screw was from medio-superior to latero-inferior; **d** the entry point of the reversed CBT screw (blue circle)

prepared, and a serial trial was performed. The autogenous bone harvested from the osteotomy was placed in the anterior intervertebral disc space. Once a suitable cage was inserted at an ideal depth, the Kirschner wire was removed.

Cranial CBT implantation

The soft tissue was further detached using RF until the isthmus of L4 was exposed. The entry point (Fig. 2b) was found at the 7 o'clock position of the pedicle endoscopically and confirmed radiographically. Through the third portal, the cortical bone was accessed using a stabber, the guidewire was introduced into the pedicle, and the ball tip feeler was used at every step to ensure that the pedicle walls were not violated. The assistant on the contralateral side implanted the CBT screw through a 25–30° cranial and 10° lateral route for maximum contact between the screw and the cortical bone (Fig. 3a–d; Fig. 4a–d).

Caudal reversed-CBT implantation and fixation

After the residual SAP was removed using a 2-mm diamond bur, the medial and superior walls of the L5 pedicle were endoscopically visualized. The entry point (Fig. 2c, d) was found at the 11 o'clock position of the pedicle, and the reversed-CBT screw was implanted through a 25–30° caudal and 10° lateral route (Fig. 3e–h; Fig. 4e–h). A 3-cm rod was chosen to connect the screws, and the locking nuts were secured (Fig. 3i). A drainage tube was inserted through the working portal, and the incision was closed using a traditional method. The whole process of CBT screw fixation was performed via arthroscopy (video clip 1). Finally, PPS fixation was performed via conventional methods through 2 additional incisions on the left side (Fig. 3j).

Indications

I. Degenerative or isthmic spondylolisthesis (Grade I)
II. Lumbar instability with or without canal stenosis (Fig. 5)

The procedure is optimal for older patients with osteoporosis.

Limitations

I. Severe degenerative lumbar spine with indistinct anatomical markers
II. Concurrent vertical foraminal stenosis
III. Pars interarticularis defect

How to avoid complications

In contrast to cranial CBT screw implantation, when the entry point of the caudal CBT screw neighbors the exposed nerve root, a diamond burr can be used to roughen the entry point to ensure the ease of preparing the screw trajectory and prevent damaging the nerve roots. CT scans should be carefully reviewed before the operation to select CBT screws of appropriate length and diameter.

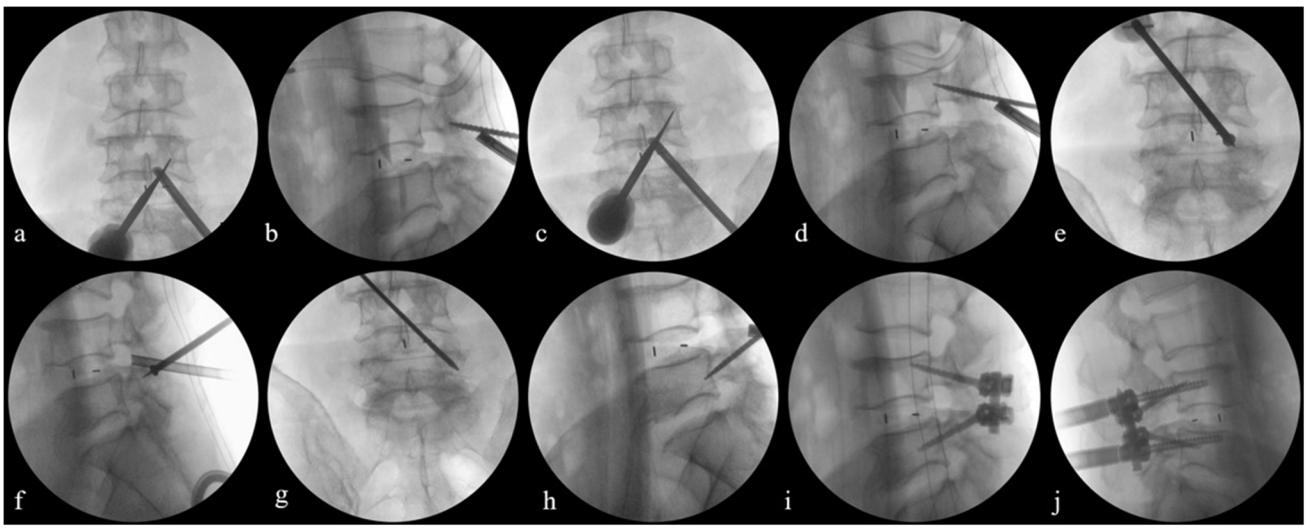

Fig. 3 **a**, **b** The cranial entry point was at 7 o'clock on the pedicle; **c**, **d** the CBT screw was inserted along a medio-inferior to latero-superior trajectory; **e**, **f** the caudal entry point was at 11 o'clock on the pedicle; **g**, **h** the trajectory of the reversed CBT screw extended from medio-superior to latero-inferior; **i** the position of the CBT screw-rod system was finally verified via fluoroscopy; **j** the contralateral PPS was inserted

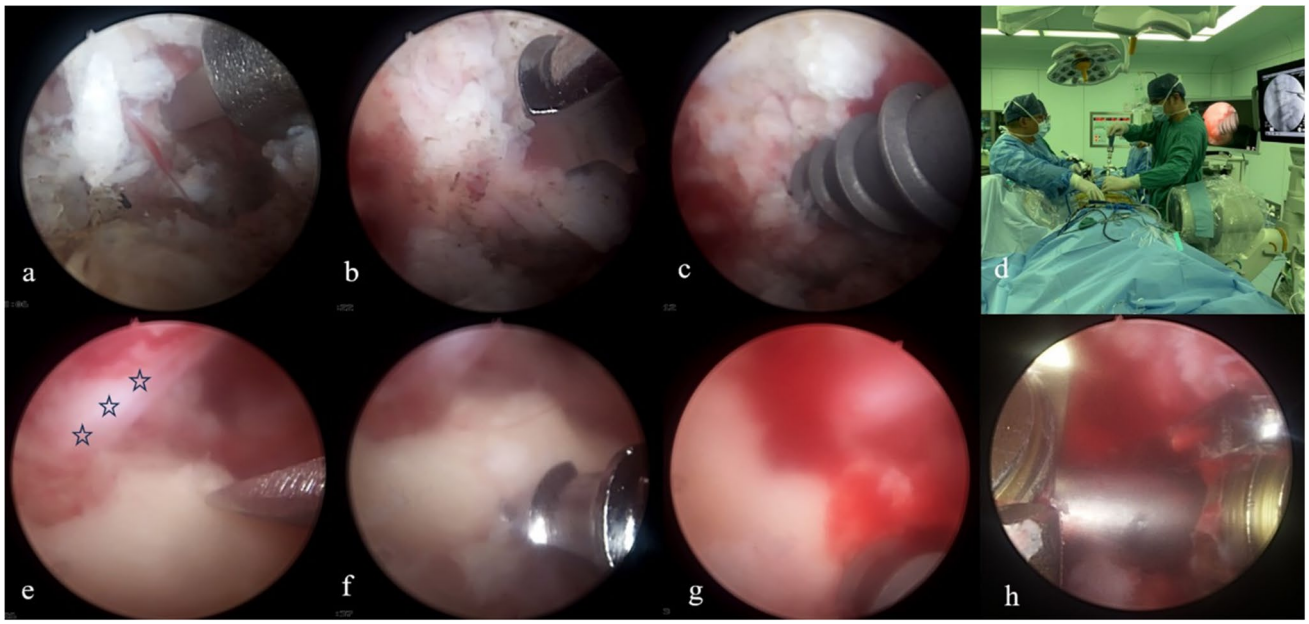

Fig. 4 **a**, **e** Determining the cranial and caudal entry points under arthroscopy (pentangles represent nerve roots); **b**, **f** the trajectory of the CBT and reversed CBT screws was prepared; **c**, **g** the screws were inserted into the pedicle under endoscopic guidance; **d** the assistant on the contralateral side inserted the CBT and reversed CBT screws; **h** Biportal endoscopic view of the screw-rod system

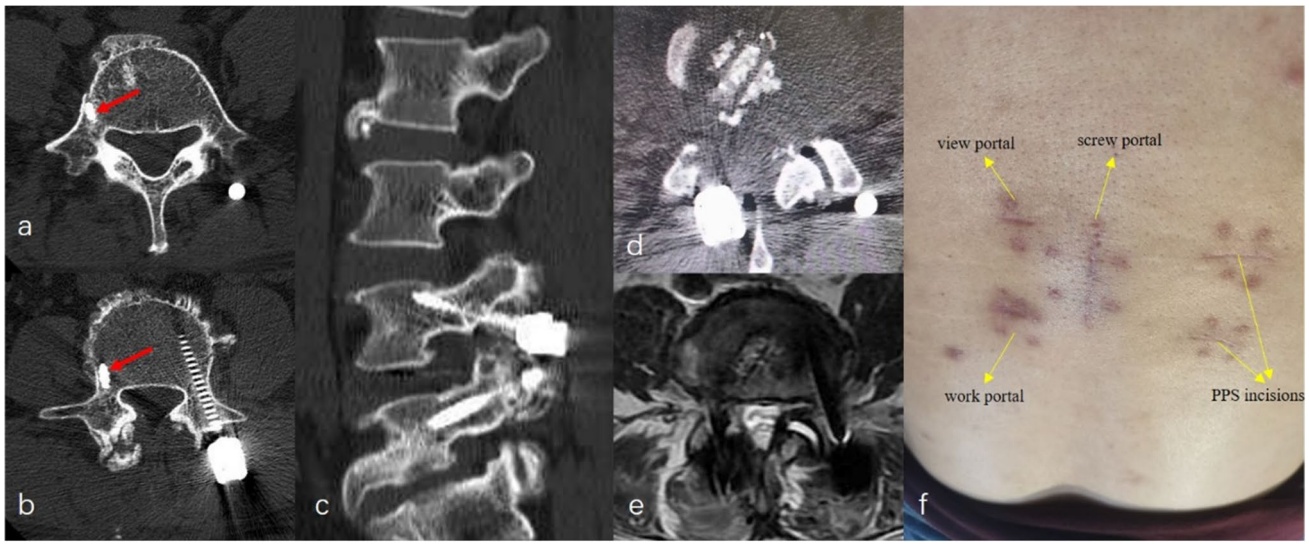

Fig. 5 **a**, **b**, **c** Postoperative CT scan showing that the CBT and reversed CBT screws (red arrows) were inserted along a medial to lateral trajectory in the axial and sagittal planes through the pedicle, and maximum contact between the screws and the cortical bone was ensured. **d**, **e** The position of the cage and the extent of decompression of the canal were satisfactory. **f** Skin wounds after CBT screw placement and lumbar interbody fusion using the biportal endoscopic approach

Specific perioperative considerations

The preoperative imaging data need to be carefully evaluated to exclude patients with severe lumbar spine degeneration without anatomical landmarks. Considering that unilateral CBT screw fixation cannot provide sufficient rotational stability, we implanted PPSs contralaterally. A lumbar brace was used for immobilization for no more than 6 weeks, and the patient could start ambulatory activities after the drainage tube was removed.

Specific information for the patient

Difficulties in determining the entry points during surgery may cause the failure of biportal endoscopic CBT screw implantation. Patients have to be informed of the possibility of conversion to PPS fixation. No published papers have reported the long-term clinical or radiological outcomes of ULIF with endoscopic-assisted cortical trajectory screw fixation.

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Author contribution Conceptualization: WZ and HP; methodology: WZ; resources: JL; writing—original draft preparation: CZ; writing—review and editing: WZ; 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 unilateral biportal endoscopic-assisted cortical trajectory screw fixation (ULIF).
2. By performing a contralateral facetectomy through the third portal [6], theoretically, it is also possible to achieve endoscopic CBT and reversed CBT screw implantation on the contralateral side.
3. In endoscopic CBT and reversed CBT screw implantation, the surgical field is small, and adequate exposure of an accurate entry point minimizes the risk of muscle and facet joint injury while reducing operative time and radiation exposure.
4. The cortical bone at the entry point can be entered using an endoscopic high-speed burr to avoid slipping when inserting screws.
5. The CBT screw can be safely inserted by an assistant on the contralateral side under endoscopic monitoring.
6. The screw was first inserted on the right side to avoid obstructing the view for endoscopic observation.
7. The strength of solid CBT screws may be greater than that of hollow pedicle screws.
8. When the screw-rod system is inserted, it is advisable to suture the working portal temporarily to prevent the formation of a vortex, which may cause the surgical field to appear blurry.
9. The "stop irrigation test" was helpful in determining the bleeding points, and complete haemostasis was recommended to prevent epidural haematoma formation.
10. Extensive experience in biportal endoscopic lumbar interbody fusion has aided in performing this new procedure.