



# Modified far lateral endoscopic transforaminal lumbar interbody fusion using a biportal endoscopic approach: technical report and preliminary results

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Received: 7 January 2021 / Accepted: 3 February 2021 / Published online: 19 February 2021  
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## Abstract

**Background** Endoscopic transforaminal lumbar interbody fusion (TLIF) has the disadvantage of the small cage size and by consequence risk for cage subsidence. We succeeded to insert a large oblique lumbar interbody fusion (OLIF) cage during biportal endoscopic TLIF.

**Methods** Unilateral total facetectomy was performed to expose the exiting and traversing nerve roots. The distance between the exiting and traversing nerve roots was measured before OLIF cage insertion. We inserted an OLIF cage instead of a TLIF cage.

**Conclusion** We successfully performed modified far lateral biportal endoscopic TLIF using large OLIF cages. Modified far lateral biportal endoscopic TLIF is usually suitable for the L4-5 and L5-S1 levels.

**Keywords** Transforaminal · Fusion · Lumbar · Endoscopy · Biportal

## Relevant surgical anatomy

During endoscopic transforaminal lumbar interbody fusion (TLIF), an interbody fusion cage was inserted through Kambin's triangle or unilateral laminotomy space with ipsilateral facetectomy [5]. Although Kambin's triangle or the unilateral laminectomy area may be relatively narrow spaces for a large-sized cage insertion, unilateral total facetectomy of the superior and inferior articular processes with laminotomy can make enough space for large-sized cage insertion. There may be enough space between the exiting and traversing nerve roots for the insertion of a large-sized cage after laminotomy and facetectomy at the L4-5 and L5-S1 levels. Moreover, the space for a cage insertion can be additionally expanded by slight medial dural retraction with a dura retractor. The large-sized cage off oblique lumbar interbody fusion (OLIF)

can be inserted into this space instead of a transforaminal lumbar interbody fusion cage. Total facetectomy and laminotomy also have direct neural decompression effects for foraminal stenosis or central stenosis [1, 2, 4, 7].

## Description of the technique

### Surgical instruments

We used interbody cages for OLIF or DLIF from three companies (Boaz LT cage, Synusbio, South Korea; Anyplus, GS Medical, South Korea; or CLYDESDALE, Medtronic, USA). The width of the OLIF cages ranged from 16 to 22 mm, and the angle of the cages ranged from 0 to 10°. The length of the OLIF cages was from 40 to 50 mm. The usual biportal endoscopic systems, a tool-kit set for biportal endoscopic surgery, and radiofrequency (RF) systems were used for far lateral TLIF [3] (Fig. 1). Customized cage guidance was used for the cage insertions.

### Position and creation of two portals

Modified far lateral biportal endoscopic TLIF was performed with patients in the prone position under general endotracheal anesthesia or epidural anesthesia (Fig. 1). First, two portals

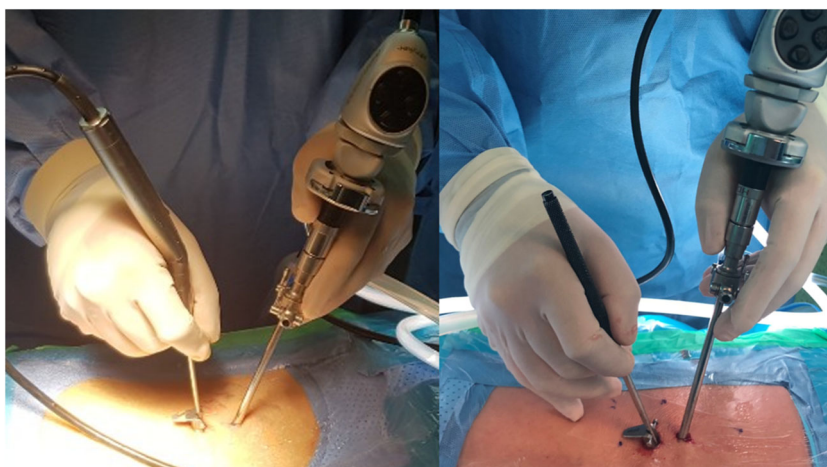
This article is part of the Topical Collection on *Spine degenerative*

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**Fig. 1** Overview of biportal endoscopic lumbar interbody fusion



were made over the pedicles (Fig. 2) [1]. Two 2-cm skin incisions were made and serial dilators were inserted to make two portals [7]. Usually, the dominant hand was used for the working portal and the non-dominant hand was used for the endoscopic portal [2, 6].

### Unilateral total facetectomy and laminotomy (Video clip 1)

The ipsilateral lamina and facet joint were dissected and exposed using dissectors and RF probes. Ipsilateral laminotomy and facetectomy were performed using a drill, Kerrison punches, and small osteotomes. Bone chips from the lamina and facet joint were used as bone fusion material. The ipsilateral ligamentum flavum was completely removed. The foraminal

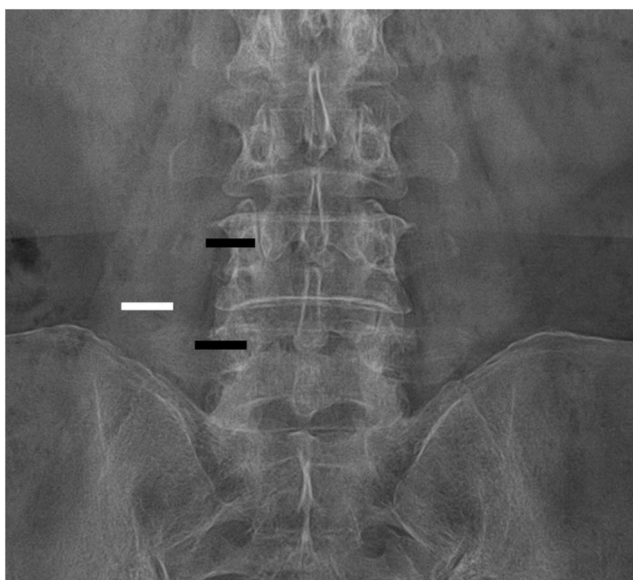
ligamentum flavum was also removed (Fig. 3a). We decompressed the ipsilateral traversing and exiting nerve roots. If the patient had contralateral nerve root symptoms, we resolved the contralateral sublaminal decompression by removing the contralateral ligamentum flavum.

### Discectomy and endplate preparation (Video clip 1)

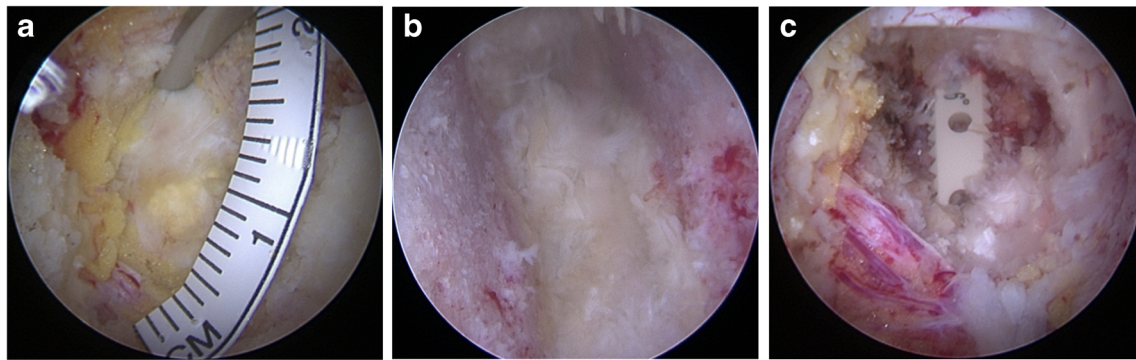
An annular incision was made using a small-diameter RF probe or blunt knife. The nucleus pulposus was completely removed using endplate shavers and pituitary forceps. We separated the cartilaginous endplate from the osseous endplate under a magnified endoscopic view (Fig. 3b). The cartilaginous endplate could be completely removed from the osseous endplate under the endoscopic view [1, 2]. Contralateral disc materials were removed using angled curettes and angled pituitary forceps. The collapsed disc space was distracted by an endplate shaver. Endplate preparation could be achieved without injury to the osseous endplate [1, 2].

### Insertion of a large-sized cage

We checked the length between the lateral border of the dura (traversing nerve root) and the exiting nerve root (Fig. 3a). If the length between the lateral border of the dura and the exiting nerve root was under 16 mm, we used TLIF cages instead of OLIF cages. Before the insertion of an OLIF cage, we made an additional third portal for the lateral insertion of a large OLIF cage (Fig. 2). We put a trial cage into the disc space under C-arm guidance to determine the size of the cage (Figs. 3c and 4a). An OLIF cage or trial cage was inserted under cage guidance after slight medial retraction of the dura and traversing the nerve root (Fig. 4a). The exiting nerve root was protected by the customized cage guidance. The exiting and traversing nerve roots were carefully monitored during OLIF cage insertion using an endoscopic view and C-arm fluoroscopic guidance. The OLIF cage was re-positioned



**Fig. 2** Skin incision points for two portals (black lines) and cage insertion. An endoscopic portal and a working portal were made over the pedicles. An additional portal was made for the insertion of a large OLIF cage (white line)



**Fig. 3** After decompression of the exiting and traversing nerve roots, the distance between the exiting and traversing nerve roots was measured for OLIF cage insertion (a). Final endoscopic view of endplate preparation

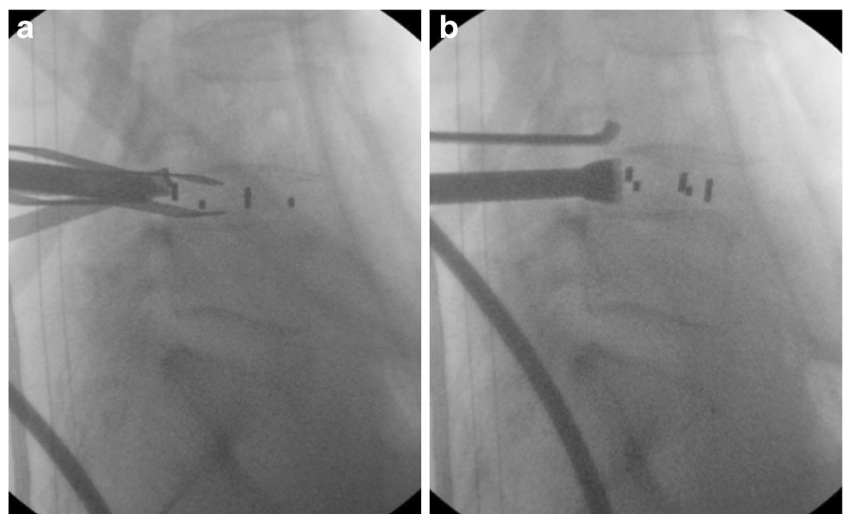
(b). An OLIF cage was inserted and re-positioned transversely (c). The traversing and exiting nerve roots were completely decompressed (c)

transversely using a cage impactor under C-arm fluoroscopic guidance (Figs. 4b and 5). After bleeding control, a drainage catheter was inserted. Two ipsilateral skin incisions of two portals were used for the insertion of ipsilateral percutaneous pedicle screws (Figs. 2 and 6). Two additional skin incisions were made contralaterally for contralateral percutaneous pedicle screw fixation (Figs. 2 and 6).

## Indications

The indications for modified far lateral TLIF were similar to minimally invasive TLIF or endoscopic TLIF. We performed one- or two-level lumbar interbody fusion procedures for lumbar degenerative disease (Fig. 5). The indications for this technique were degenerative spondylolisthesis, isthmic spondylolisthesis, lumbar central stenosis, and lumbar foraminal stenosis. [1, 2]. We did not perform the procedure in patients with high-grade spondylolisthesis, infections, trauma, or tumors.

**Fig. 4** Intraoperative fluoroscopic images of OLIF cage insertion. An OLIF cage was safely inserted under cage guidance (a). The cage was re-positioned transversely using a cage impactor (b)

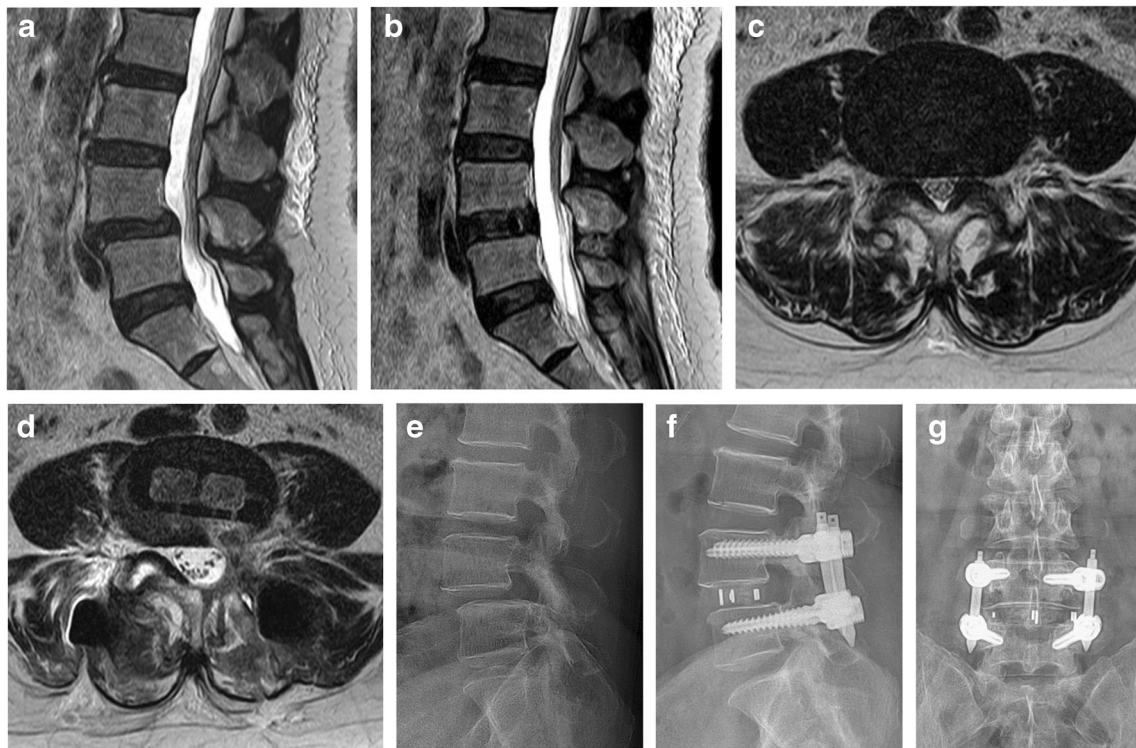


## Limitations

This technique has the possibility of injuring the exiting nerve root or the traversing nerve root due to the large size of the cage [5]. The distance between the exiting and traversing nerve roots was usually narrow in the upper lumbar area. Therefore, we strongly recommend that this technique should be considered at the lower lumbar level (L4-5 and L5-S1). This approach was usually possible at the L4-5 and L5-S1 levels (Figs. 5 and 6), but not at the upper lumbar levels (L1-2, L2-3, and L3-4).

## How to avoid complications

Sufficient space should be made for inserting a large-sized OLIF or DLIF cage. The superior and inferior articular processes were removed before cage insertion, and central decompressive procedures including laminotomy and flavectomy

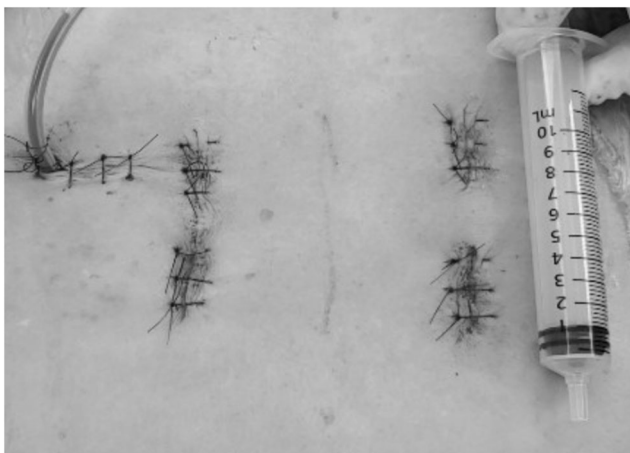


**Fig. 5** A 73-year-old man presented with left-sided radicular leg pain with claudication. The preoperative MRI showed degenerative spondylolisthesis with central stenosis at level L4-5 (a). This patient received modified far lateral biportal endoscopic TLIF using an OLIF cage ( $45 \times 18 \times 10$  mm size) (b). Preoperative spondylolisthesis (a) and

central stenosis (c) significantly resolved postoperatively (b, d). The preoperative X-ray image demonstrated degenerative spondylolisthesis of L4-5 (e). Postoperative X-ray images revealed reduced spondylolisthesis and the insertion of an OLIF cage (f, g). The patient's pain significantly improved after surgery

were performed. Central decompressive procedures and total facetectomy may make enough space for the insertion of an OLIF or DLIF cage. It was possible to create sufficient space for an OLIF cage insertion by the slight medial retraction of the dura with the traversing nerve root (Video 1). Preoperative measurement of the distance between the traversing and

exiting nerve roots using axial magnetic resonance imaging (MRI) views was important for determining the feasibility of far lateral endoscopic TLIF (Fig. 7). We re-checked the distance between the dura (traversing nerve root) and the exiting nerve root intraoperatively (Fig. 3a). If the distance was at least 16 mm, OLIF cages were available. If there was not enough space between the traversing and exiting nerve roots, we inserted the usual TLIF cage. A customized retractor may help to safely insert a large-sized cage (Fig. 4a). Specialized cages should be developed for modified far lateral biportal endoscopic TLIF surgery.

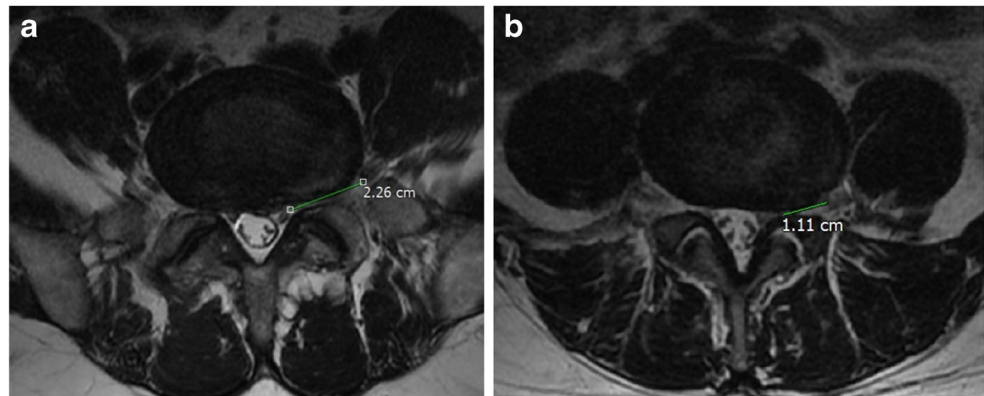


**Fig. 6** Skin wounds after modified far lateral TLIF using the biportal endoscopic approach

### Specific perioperative considerations

For the safe insertion of a large OLIF cage, a more oblique trajectory angle was needed, and an additional skin incision was made more laterally (Figs. 2 and 6). An OLIF cage was inserted after medial retraction of the dura and the traversing nerve root under C-arm and endoscopic guidance (Figs. 3b and 4). We could monitor the indentation of the exiting nerve root by a cage using an endoscopic view.

**Fig. 7** Measurement of the distance between the traversing nerve root and the exiting nerve root. If the distance is more than 16 mm, an OLIF cage can be inserted (a). Since the distance is usually short in the upper lumbar area, the insertion of an OLIF cage is impossible (b)



### Specific information to give the patient about surgery and potential risks

Although modified far lateral endoscopic TLIF had the advantages of minimal invasiveness [7], there was a possibility of exiting nerve root injury due to the width of the OLIF cage. If there was not enough space between the traversing and exiting nerve roots, we inserted the usual TLIF cage (Figs. 3a and 7). No studies have reported the long-term clinical and radiologic results of endoscopic lumbar interbody fusion [4, 5].

**Supplementary Information** The online version contains supplementary material available at <https://doi.org/10.1007/s00701-021-04758-7>.

### Declarations

**Conflict of interest** The authors declare no competing interests.

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