

CLINIC

pTLIF

US

VERTACONNECT[®]T

Transforaminal Lumbar Interbody Fusion

For distribution in the USA only

**Minimal Access –
Maximal Effect
Percutaneous TLIF**



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SIGNUS
The Spine Sign[®]

INTRODUCTION

Dr Christian Morgenstern, a renowned expert in the field of spinal surgery, combines many years of experience with state-of-the-art techniques in his work. He first completed a degree in electrical engineering and information technology in Germany and the USA, which he concluded with a doctorate. Afterwards he decided to study medicine at the University of Barcelona. After completing his doctorate at the University of Witten-Herdecke in Germany, he continued his medical career with specialist training in orthopaedics and trauma surgery at the Charité – Medical University Berlin. Since 2019, he heads the Morgenstern Institute of Spine in Barcelona. There, the team focuses on complex endoscopic and minimally invasive procedures on the spine.

This brochure presents the percutaneous TLIF (Transforaminal Lumbar Interbody Fusion) technique developed by Dr Morgenstern. The method combines the advantages of an endoscopic approach with those of an open procedure, thus enabling larger implants to be inserted using regular instruments. The techniques and instruments required for using the SIGNUS VERTACONNECT® Cage in conjunction with the Maxfusion system from maxmorespine® are explained step by step.

VERTACONNECT® is an expandable TLIF cage with an open design that allows it to be filled with natural or synthetic bone material.

This brochure was developed in close collaboration with Dr Christian Morgenstern and the maxmorespine® company.



Dr. Dr. med. Dipl.-Ing. Christian Morgenstern
Morgenstern Institute of Spine





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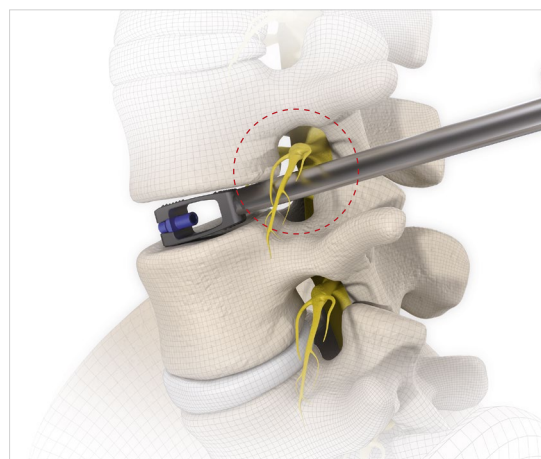
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PERCUTANEOUS TLIF

Percutaneous lumbar extraforaminal, trans-Kambin interbody fusion (pTLIF): the basic idea behind pTLIF is to combine the advantages of endoscopy-based techniques with those of percutaneous approaches. This way, a large-footprint expandable cage can be placed through a minimal skin incision of about 8–20 mm, with an approach that is gentle on the facet joint and tissue.

The learning curve is reduced as one can work with only one image converter. Endoscopic imaging is optional and not necessary in most cases. Sequential dilation eliminates the need for open dissection, which is required in the classic TLIF and MIS-TLIF techniques.

Furthermore, the facet joints can be largely preserved with pTLIF, as less bone has to be removed. The approach is extraforaminal through Kambin's triangle. To achieve a 360° fixation, the cage is supplemented by a dorsal spondylodesis. ^{1, 2, 3, 4, 5, 6}

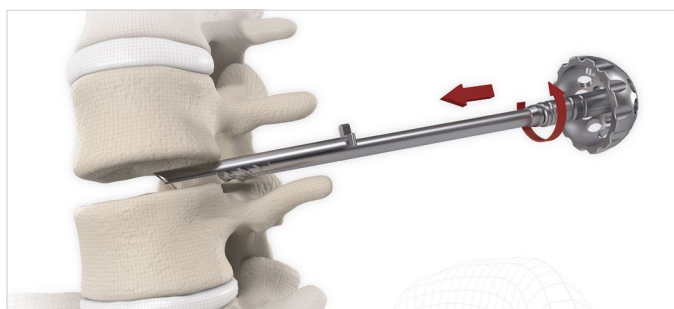


Placement via Kambin's triangle

Percutaneous TLIF: the surgical steps



Defining the approach



Foraminoplasty and clearing the intervertebral disc space



Filling VERTACONNECT[®] with bone material



Placing VERTACONNECT[®]



Expanding VERTACONNECT[®]



Posterior spondylodesis

- 1 Kim HS, Wu PH, Sairyo K, Jang IT. A Narrative Review of Uniportal Endoscopic Lumbar Interbody Fusion: Comparison of Uniportal Facet-Preserving Trans-Kambin Endoscopic Fusion and Uniportal Facet-Sacrificing Posterolateral Transforaminal Lumbar Interbody Fusion. *Int J Spine Surg* 2021; 15(suppl 3):S72-S83
- 2 Clinical spine surgery 2020 : Morgenstern C, Yue JJ, Morgenstern R Full percutaneous Transforaminal Lumbar Interbody Fusion using the facet-sparing, trans-Kambin approach, *Clin Spine Surg* 2020; 33(1): 40-45
- 3 R. Morgenstern, C. Morgenstern 2015: Percutaneous Transforaminal Lumbar Interbody Fusion (pTLIF) with a Posterolateral Approach for the Treatment of Degenerative Disk Disease: Feasibility and Preliminary Results. *Int J Spine Surg*.
- 4 Ishihama Y, Morimoto M, Tezuka F, et al. Full-Endoscopic Trans-Kambin Triangle Lumbar Interbody Fusion: Surgical Technique and Nomenclature. *J Neurol Surg A Cent Eur Neurosurg*. 2022; 83(4):308-313.
- 5 Pholprajug P, Kothheeranurak V, Liu Y, Kim JS. The Endoscopic Lumbar Interbody Fusion: A Narrative Review, and Future Perspective. *Neurospine*. 2023; 20(4):1224-1245.
- 6 C. Morgenstern, R. Morgenstern 2025: Full-Percutaneous Trans-Kambin Lumbar Interbody Fusion With a Large-Footprint Interbody Cage; *Global Spine J*. 2025 Feb 8

REQUIRED UTENSILS / INSTRUMENTS

General instruments (not shown)

1. Skin marker

Marking the correct entry point

2. Various wires, e.g. thick guide wire

Marking the correct entry point

3. Needle

Positioning: 18 G, length approx. 200 - 300 mm

4. Guide wire

Positioning

Art. no. MD 01 0251/MX6

Guidewire nitinol 1.0 x 450 mm

5. Scalpel

Skin incision

6. Mallet

Insertion

7. Dilator 1.2 mm

Positioning of Fusion Dilator

Art. no. 1001-DC-002

small dilator 3 mm

8. Dilator 6.4 mm

Expansion/easier access for Fusion Dilator

Art. no. 1001-DC 018

large dilator 6.4 mm

9. Forceps

Holding the dilators

10. Instruments straight/angled:

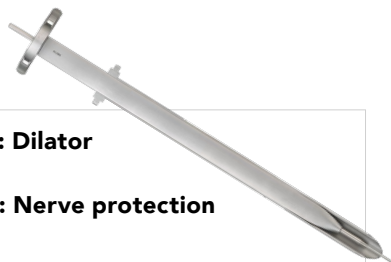
e.g. scoop, scraper, rasp, forceps etc.

Clearing the intervertebral disc space



REQUIRED UTENSILS / INSTRUMENTS

Access and dilator



Fusion Dilator – Part 1: Dilator

Fusion Dilator – Part 2: Nerve protection

Art. no. 690716

Fusion Dilator 2 parts



Manual Bone Drill / Size 6–13

Foraminoplasty

Art. no. 1001-BD 003

Manual bone drill 7.0

Art. no. 1001-BD 004

Manual bone drill 8.0

Art. no. 1001-BD 005

Manual bone drill 9.0

Art. no. 1001-BD 010

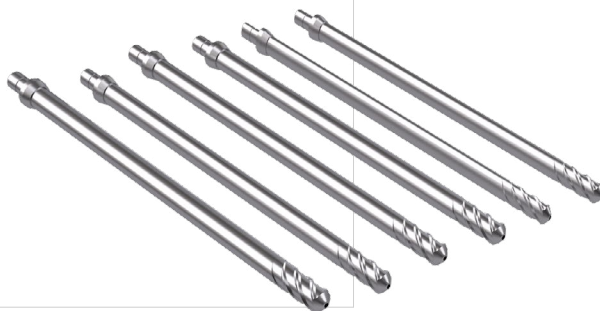
Manual bone drill 10.0

Art. no. 1001-BD 011

Manual bone drill 11.0

Art. no. 1001-BD 012

Manual bone drill 12.0



Handle for manual bone drill

Foraminoplasty

Art. no. 1001-BH-001



REQUIRED UTENSILS / INSTRUMENTS

SIGNUS specific Instruments: Cage

Art. no. CAT3010

Trial instrument 8 mm

Art. no. CAT3012

Trial instrument 10 mm



Art. no. CAT3004

Handle straight



Art. no. CAT3005

Slap hammer for
fixing shaft



Art. no. INT1002

Mallet with exchangeable
plastic jaws



Art. no. INT1001

Nerve root retractor 6 mm



Art. no. CAT4001

Insertor – outer part



Art. no. CAT4002

Insertor – fixing shaft



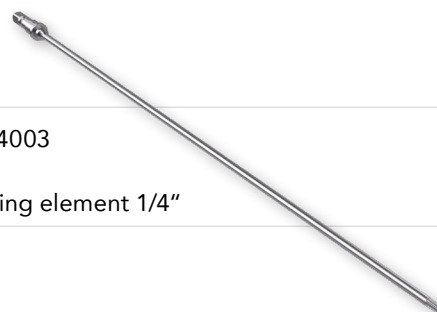
Art. no. CAT4004

Palm handle for
drive expanding element 1/4"



Art. no. CAT4003

Insertor –
drive expanding element 1/4"



OPTIONAL

Art. no. CAT4005

Insertor – indicator for
position of expanding element



NOT SHOWN

Art. no. CAT2011

Instrument tray

SURGICAL TECHNIQUE

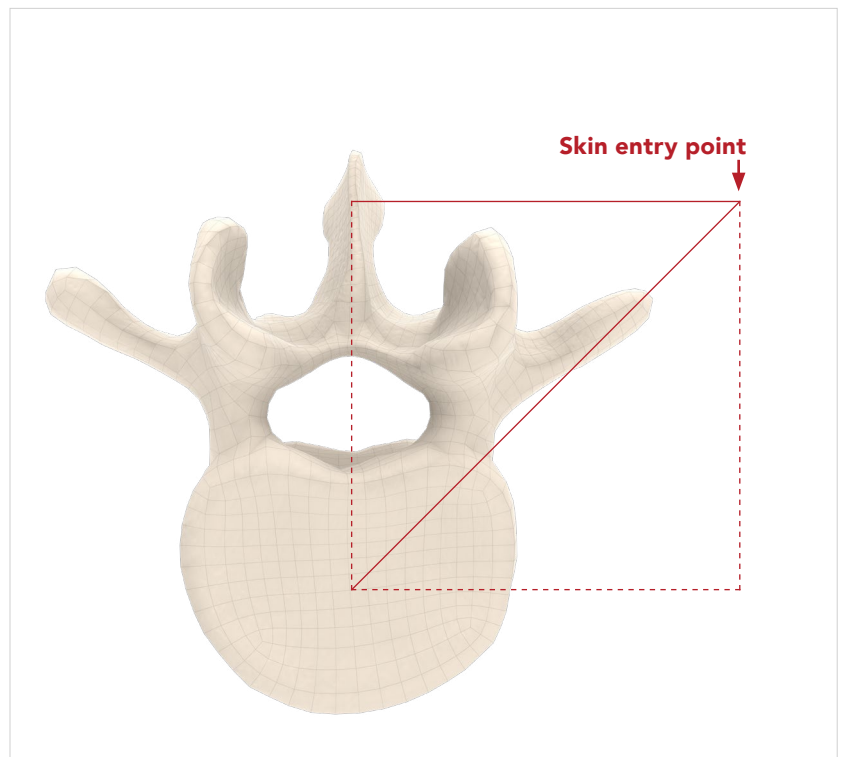
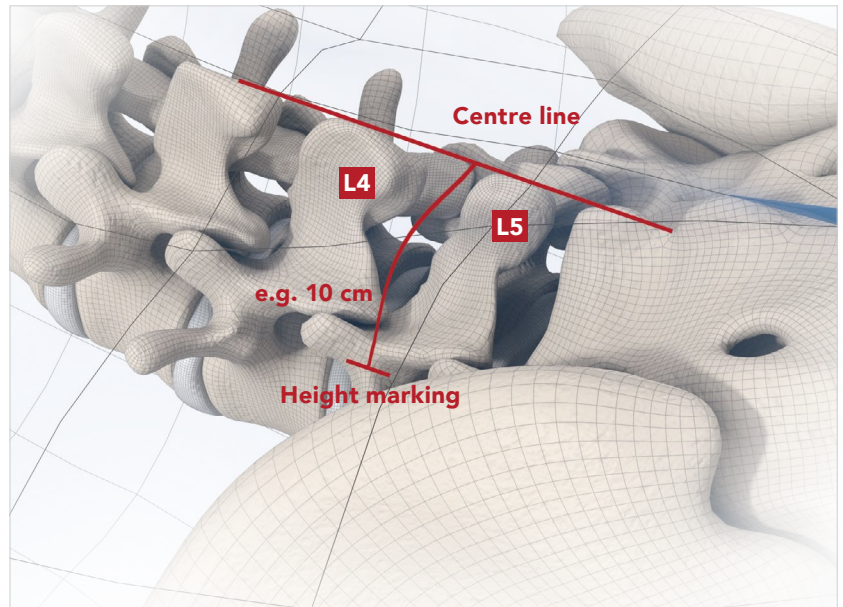
1 APPROACH

CAUTION

Each of the surgical steps shown here is to be performed under constant image intensifier control in true anterior/posterior (A/P) and lateral (true AP = with precise visualization of the intervertebral disc space).

The skin entry point is determined intraoperatively using fluoroscopic imaging.

- Mark the centre line of the spine on the skin in A/P.
- Mark the intervertebral disc space AP on the skin.
- Move the fluoroscope to lateral and then measure the distance from the skin to the ventral edge of the intervertebral disc.
- Transfer this distance to AP. This determines the entry point into the skin.
- Insert the needle into the intervertebral disc through the designated skin entry point.
- Observe symmetries in AP and lateral in the process.
- The guide wire is inserted into the intervertebral disc space through the needle.
- The needle can be removed and the guide wire remains.



SURGICAL TECHNIQUE

2 INSERTING DILATORS

- Skin incision and insertion of the small dilator into the intervertebral disc via the guide wire.
- Insertion of the Maxfusion dilator (both parts together) via the small dilator into the intervertebral disc
- Removal of the guide wire
- Separation of the Maxfusion dilator so that only the nerve protection remains caudal to the foramen, so that the exiting nerve root is protected cranially by the protective sleeve.



3 FORAMINOPLASTY

Permanent radiographic check

Next, access through the foramen is created for the cage.

Using the manual bone drills, one works in progressive 1 mm steps up to the required diameter, up to 1 mm larger than the planned cage size.

One begins with a manual bone drill with a diameter of 6 mm or 7/8 mm.

NOTE

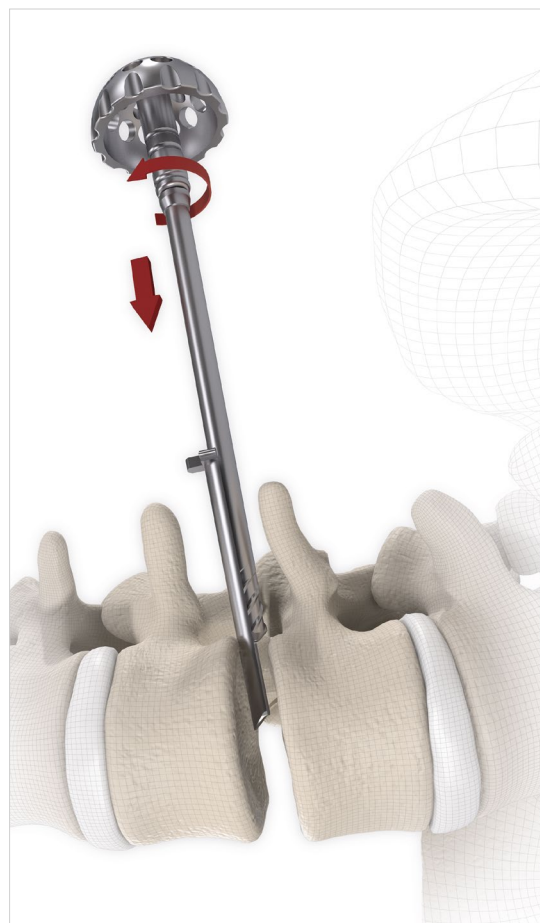
The manual bone drill only cuts in a clockwise direction.

CAUTION

In certain anatomical conditions, e.g. severely reduced intervertebral disc heights; severe foraminal stenosis; high iliac wings; insertion of large cages (greater than or equal to 10 mm in width or height), etc., a case-related endoscopically extended foraminoplasty should be taken into consideration.



Manual bone drill with handle



SURGICAL TECHNIQUE

4 PREPARATION INTERVERTEBRAL DISC SPACE

After using the 8 mm diameter manual bone drill, the intervertebral disc space can be prepared before the next manual bone drills.

Then the cover and end plates have to be prepared.

The standard instruments (straight / curved) can be used for this purpose:

- Forceps
- Scoop
- Endplate scratcher
- Rongeur

5 PREPARING THE CAGE

The VERTACONNECT® cage can be attached to the inserter and loaded with bone substitute.

NOTE

Leave the expander in the cage when filling and pull out carefully, leaving a gap to reintroduce the expander after positioning the cage in situ.

Similarly, a funnel can be used to add bone material to the ventral intervertebral disc before inserting the cage.

6 INSERTING THE CAGE

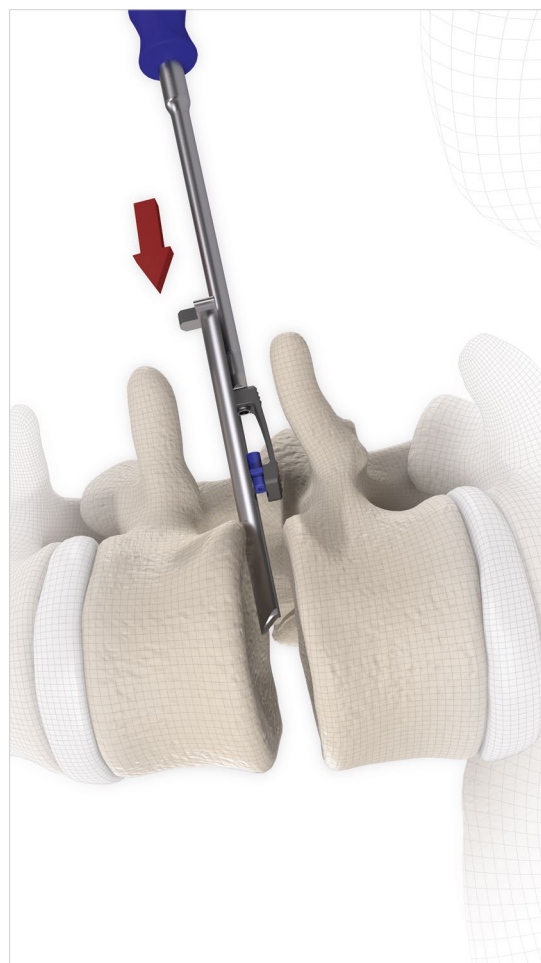
Permanent radiographic check

Now the VERTACONNECT® cage can be inserted.

The VERTACONNECT® must be aligned such that the flattening of the cage points towards the intervertebral disc, so that the cage can be inserted smoothly under the facet joints. The cage must be rotated in such a manner that it is correctly seated in the intervertebral disc.

CAUTION

When inserting the cage, the inserter should only be tapped if it does not contain an expansion elements.



Insertion of the VERTACONNECT® via the Maxfusion dilator

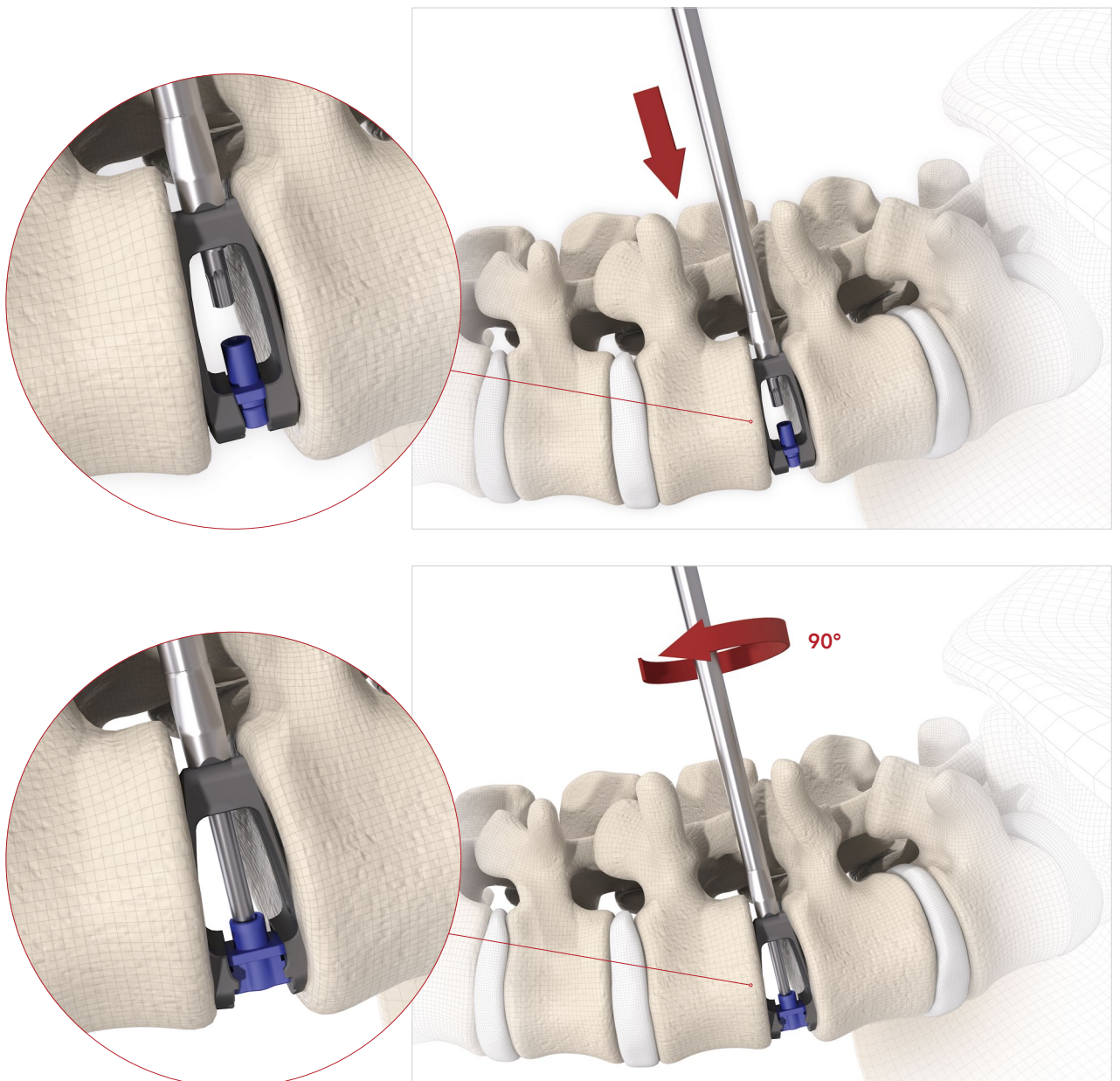
SURGICAL TECHNIQUE

7 EXPANDING THE CAGE

Following correct placement of the VERTACONNECT® in the intervertebral disc space, the Fusion Dilator nerve protection is removed. The expansion core is inserted into the cage and the cage can be expanded.

NOTE

The expansion element has a predetermined breaking point, and if there is too much resistance from the cover and end plates of the adjacent intervertebral bodies, the cage cannot be expanded. If this is the case, the cage can also be left in the non-expanded state.

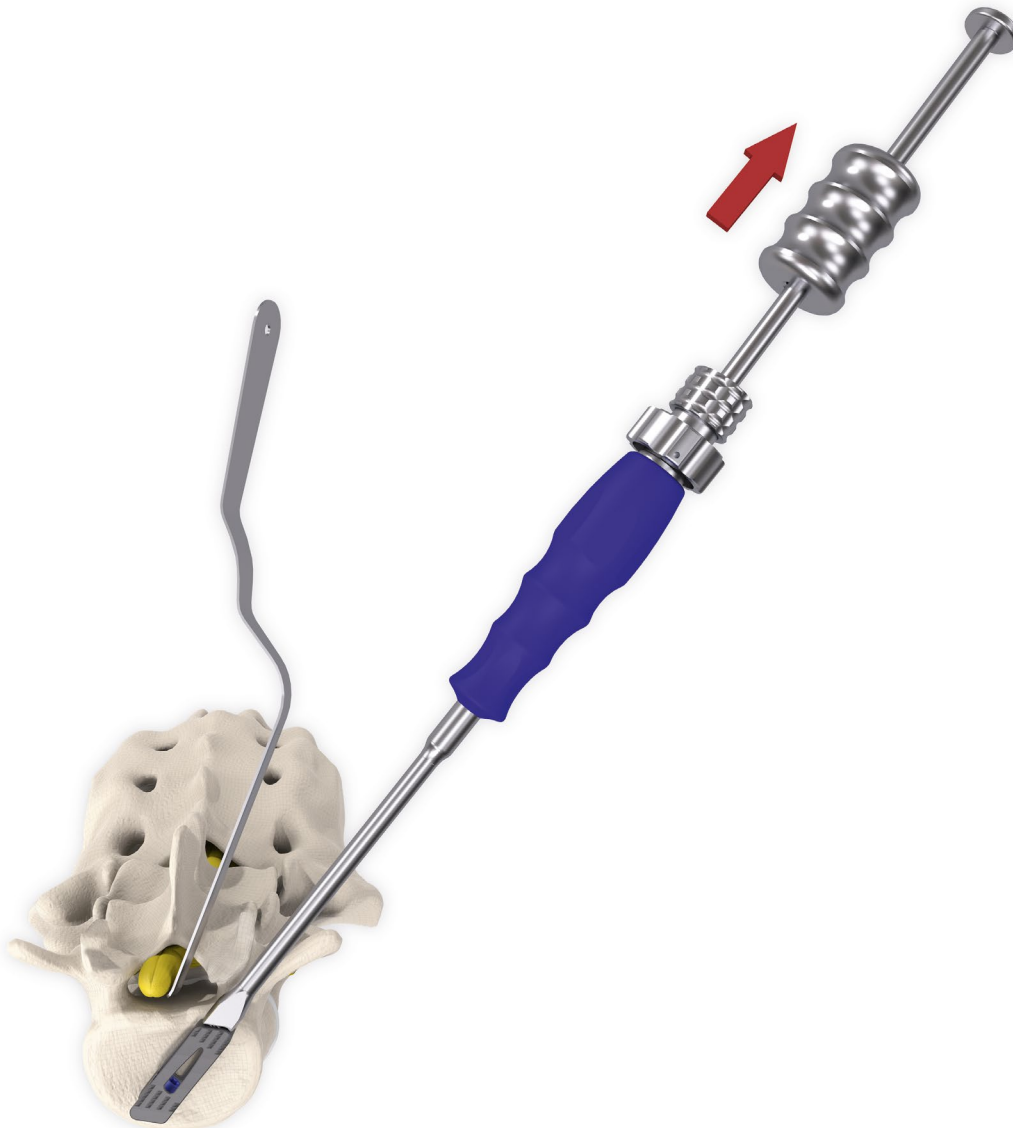


SURGICAL TECHNIQUE

8 REVISION

VERTACONNECT® can be revised if necessary. To do so, select a suitable approach and expose the implant. Special attention should be paid to preparation of the nerve tissue and any scar tissue that may have developed. The tissue must first be removed in order to extract the implant. To remove the implant, reattach it to the inserter and, if the cage was expanded, it is returned to the initial condition using the drive expanding element used to expand the implant.

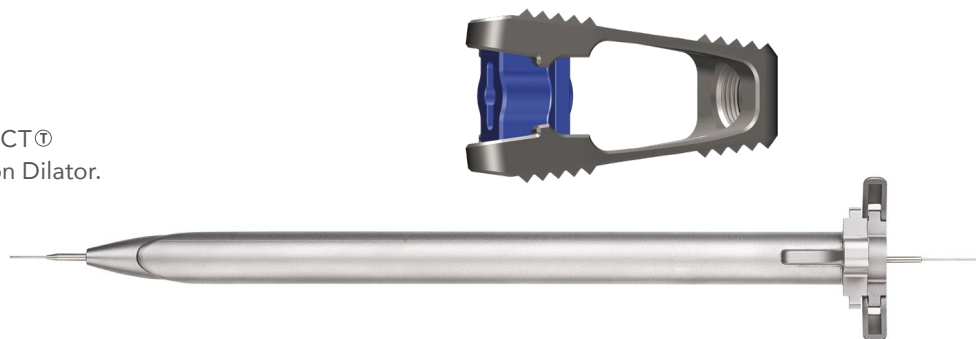
Remove the implant from the intervertebral disc space with the mallet. While doing so, ensure that the integrity of the nerve structures is preserved.



STUDY RESULTS

SUMMARY OF SIGNIFICANT STUDIES AND PUBLICATIONS ON pTLIF

Figure 1: VERTACONNECT® expanded and Maxfusion Dilator.



1. Percutaneous technique meets large cage footprint

C. Morgenstern, R. Morgenstern 2025: Full-Percutaneous Trans-Kambin Lumbar Interbody Fusion With a Large-Footprint Interbody Cage; Global Spine J. 2025 Feb 8; doi 10.1177/2192568225131865309.

Study design and objective: exploratory prospective observational cohort. The aim of this study was to evaluate an insertion system that allows a completely percutaneous lumbar extraforaminal, trans-Kambin interbody fusion with a large-footprint lumbar intercorporeal cage.

Method: a total of 47 patients (27 women and 20 men) with a median age of 61.9 years (range = 26–80) were prospectively examined after undergoing elective full-percutaneous trans-Kambin TLIF surgery (pTLIF) using an insertion system (Maxfusion dilator). Among others, the VERTACONNECT® (SIGNUS Medizintechnik, Alzenau) was used. Clinical follow-up was performed pre- and postoperatively using the results of the Visual Analogue Scale (VAS) and the Oswestry Disability Index (ODI), as well as radiological follow-up employing computer tomography.

Clinical results were recorded at least preoperatively, at discharge, as well as 1 month, 3 months, 6 months, 12 months (Ø follow-up = 29.4 months; ± 9.1).



Figure 2: The positioned nerve protection of the Maxfusion Dilator.

ADVANTAGES of the surgical technique:

- No endoscope required
- No restriction due to the diameter of the endoscopic working sleeve
- It is possible to use larger instruments to remove the intervertebral disc
- Placement of a cage with a large footprint is possible
- Treating segments L2–S1 is possible

Results:

- Significant improvement of the VAS back scores over time (7.0 ± 2.1 pre-op to 1.4 ± 2.0 latest post-op FU)
- Significant improvement of VAS leg scores over time (6.3 ± 3.1 pre-op to 1.1 ± 1.7 latest post-op FU)
- Significant improvement of the ODI score over time (32 ± 48.0 pre-op to 10.3 ± 8.5 latest post-op FU)
- 90 % fusion rate after 12 months post-op
- Significant post-operative increase in segmental lordosis ($+ 3.7^\circ$)
- Median implantation time for the cage: 28 min per level
- Low complication and revision rates (revision n = 2)

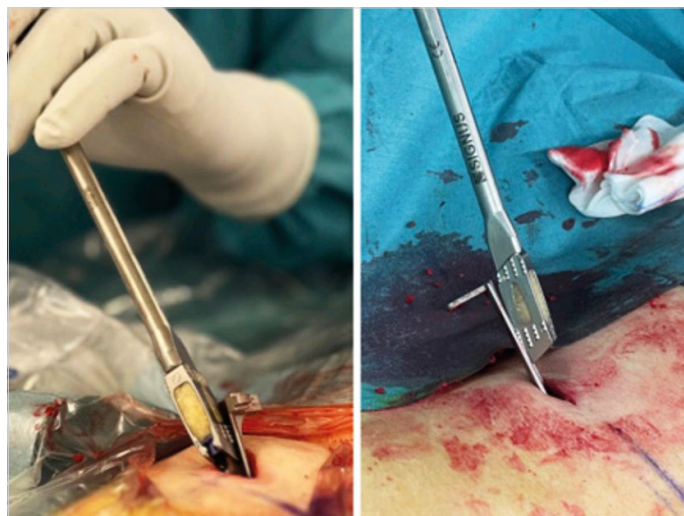


Figure 3: The filled VERTACONNECT® cage is placed over the Maxfusion Dilator.

STUDY RESULTS

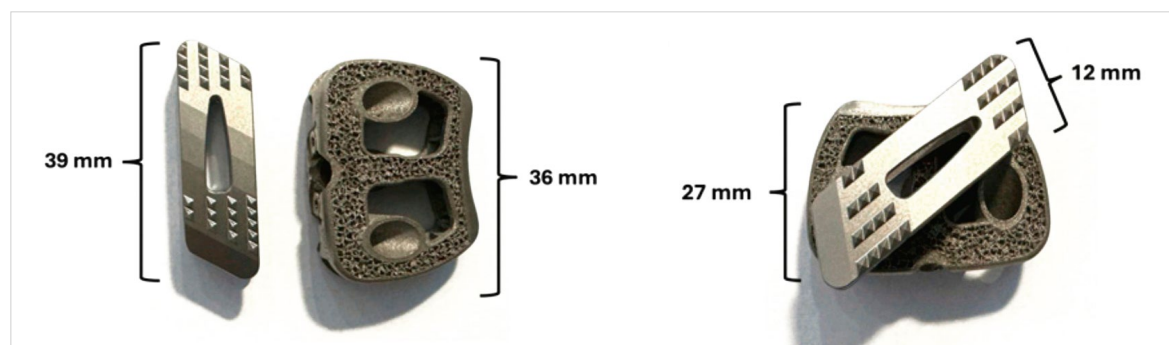


Figure 1: Visual comparison of the cages used

2. pTLIF compared to ALIF

C. Morgenstern, et.al. 2025: Anterior Lumbar Interbody Fusion (ALIF) Versus Full-Endoscopic/ Percutaneous TLIF With a Large-Footprint Interbody Cage: A Comparative Observational Study. Global Spine J. 2025 Jan 26; doi 10.1177/21925682251316280.

Study design and objective: explorative prospective case-control observational study in which ALIF is compared versus full-endoscopic / percutaneous TLIF with a large-footprint cage.

Method: a total of 87 patients (44 ALIF and 43 pTLIF) with a median age of 56 ± 12.8 years (ALIF) and 61.3 ± 12 years (pTLIF) received elective ALIF or pTLIF surgery. Clinical follow-up was performed pre- and postoperatively using the results of the Visual Analogue Scale (VAS) and the Oswestry Disability Index (ODI), as well as radiological follow-up employing computer tomography. Clinical results were recorded at least pre-operatively, at discharge, and at 1 month, 3 months, 6 months, 12 months (mean follow-up = 32.6 months; ± 10.2).

Comparison of the surgical technique:

- Both methods allow the placement of a large-footprint lumbar cage.
- pTLIF is a good alternative to ALIF, especially if the focus is on a minimally invasive approach, shorter surgery time and a lower intraoperative risk.
- In many countries, a specialist surgeon for approaches is required to perform an ALIF procedure, which limits its acceptance by orthopaedic/neurological surgeons.
- For patients who require optimal lordosis correction or who are at high risk of cage migration, ALIF is the preferred option.

Results:

- VAS back scores over time: ALIF 6.9 ± 2.3 pre-op to 1.6 ± 1.7 latest FU vs. pTLIF 7.0 ± 2.2 pre-op to 1.3 ± 1.9 latest FU
- VAS leg scores over time: ALIF 5.8 ± 3.1 pre-op to 0.8 ± 1.3 latest FU vs. pTLIF 6.4 ± 3.0 pre-op to 1.0 ± 1.6 latest FU
- ODI scores over time: ALIF 31.2 ± 7.7 pre-op to 11.3 ± 8.1 latest FU vs. pTLIF 32.0 ± 7.9 pre-op to 10.4 ± 8.1 latest FU
- 90 % fusion rate after 12 months ALIF and pTLIF
- Segmental lordosis: ALIF $+7.1^\circ$ vs. pTLIF $+3.7^\circ$
- Subsidence: ALIF 7 % vs. pTLIF 17 %
- Revision rate: ALIF 0 % vs. pTLIF 4 %
- Postoperative radiculitis: ALIF 21 % vs. pTLIF 28 %
- Duration of hospitalization (median): ALIF 52 h vs. pTLIF 27 h
- Mobilization (median): ALIF 16 h vs. pTLIF 5 h
- Median operating time: ALIF 72.5 min vs. pTLIF 28 min
- Intraoperative complications: ALIF - venous bleeding 7 %, peritoneal defect 4%, retrograde ejaculation 4 % vs. pTLIF none

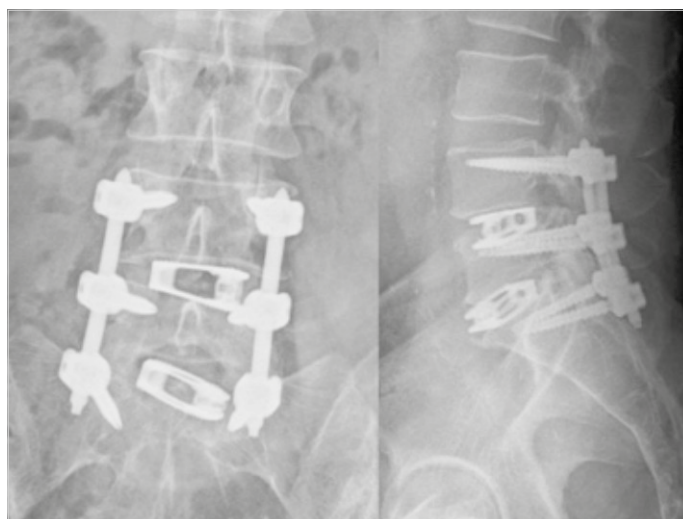


Figure 2: a 2-level pTLIF case with cages in L4/L5 and L5/S1 and posterior screw fixation

NOTE: This document was written by the technical department at SIGNUS Medizintechnik GmbH. Despite being reviewed by trained personnel, the sole purpose of this brochure is to provide an explanation of the technical aspects of handling the product described. This document, in particular the description of the surgical procedure, should not be considered medical scientific literature.

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SIGNUS USA Inc.
560 Lexington Avenue, 16th Floor
New York, NY 10022 / USA

SIGNUS Medizintechnik GmbH
Industriestr. 2
63755 Alzenau / Germany

t. +49 (0) 6023 9166 0
f. +49 (0) 6023 9166 161
info@signus.com
www.signus.com

