



Unilateral lumbar interbody fusion (ULIF)

Benoit ZACHEE, Luc VANDEN BERGHE

*From the Department of Orthopaedic Surgery, AZ Nikolaas, Sint Niklaas, Belgium
and the department of Orthopaedic Surgery, AZ Sint Lukas, Bruges, Belgium*

Results and clinical outcome of a prospective multi-center clinical study involving 100 patients undergoing a lumbar interbody fusion procedure using a unilateral approach to the spine to introduce a new surgical technique as a viable and less invasive alternative to standard posterior (PLIF) or transforaminal (TLIF) lumbar interbody fusion techniques : For certain indications clinical data show that unilateral lumbar interbody fusion (ULIF) offers the surgeon a considerable time advantage compared to standard lumbar interbody fusion techniques.

Keywords : Interbodyfusion ; ULIF.

INTRODUCTION

Multiple different approaches are used to treat lumbar degenerative disc diseases and spinal instabilities. Both, posterior reconstructive surgery (PLIF) and transforaminal lumbar interbody fusion (TLIF) provide a circumferential fusion and are considered reasonable surgical options.

With this publication the authors want to introduce a new lumbar interbody fusion technique and have set up a prospective study of the effect of the treatment of the degenerated disc using the unilateral lumbar interbody fusion (ULIF) technique : As the unilateral lumbar interbody fusion (ULIF) technique gives the surgeon the choice to use either two or three interbody fusion cages for every treated level the authors compared the different clinical

outcome depending on the use of two or three cages. As the ULIF procedure is a surgical technique using a less invasive approach to the spine the authors compared their results (operation time / treated level / MIN) to the literature (PubMed literature review).

The purpose of this publication is to introduce ULIF, the unilateral exposure using bilateral pedicle fixation with translation of (maximum) three dissimilar sliding cages as a reliable alternative for lumbar interbody fusion.

MATERIAL AND METHODS

A retrospective review of the collected data was completed by an independent reviewer. The authors hypothesis was that the ULIF procedure would be less invasive than TLIF and PLIF procedures, therefore requiring less operative time (OR time / MIN) and fewer complications.

The second hypothesis was that a ULIF procedure using three cages will end up in a more stable construct

■ Benoit Zachee^{1,3}, MD.

■ Luc Vanden Berghe².

¹Orthopaedic Surgeon, AZ Nikolaas, Sint Niklaas, Belgium.

²Orthopaedic Surgeon, Sint Lukas Hospital Bruges, Belgium.

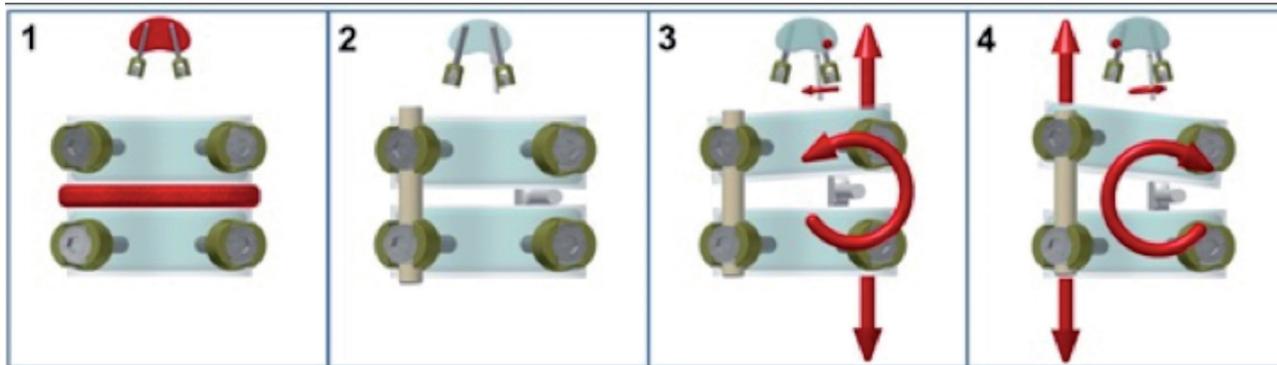
Correspondence : Benoit Zachee, Orthopaedic Surgeon, Department of Orthopaedic Surgery, AZ Nikolaas, Moerlandstraat 1, 9100 Sint Niklaas, Belgium.

E-mail : benoit.zachee@telenet.be

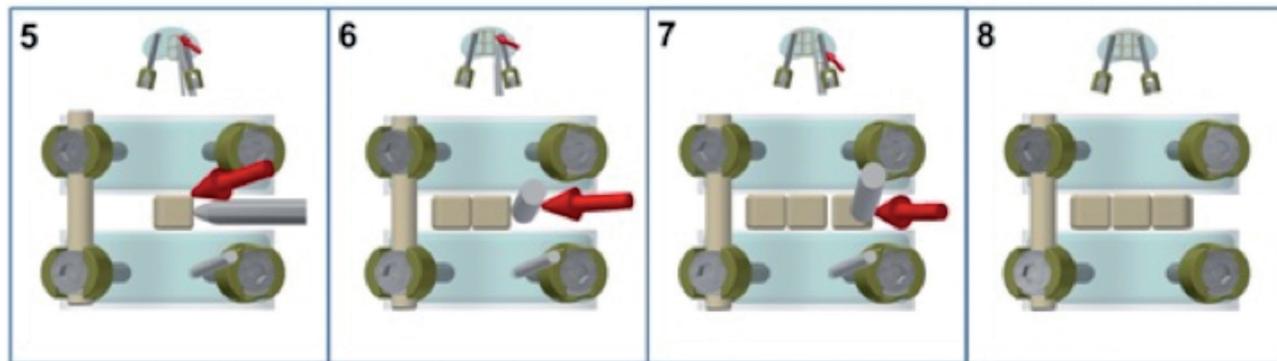
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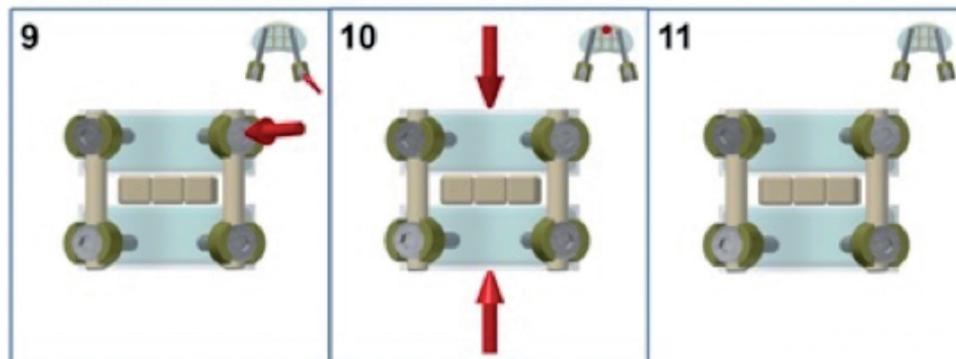
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1) Surgery is performed through a midline posterior approach. The disc is incised in the canal and removed on the ipsilateral side. With the disc distractor in place a contra-lateral over-distraction is performed to create a void and facilitate the transaction of the cages from one side to another.



2) After preparing the disc space the ULIF cages can be inserted. To allow translation from one side to another a pedicle finder is used as a counter lever.



3) Performing the over-distraction-technique and inserting three cages guarantees that the contra lateral cage is well translated to the other side. After implantation of (possible) three ULIF cages the involved segment is compressed.

Fig. 1. — ULIF surgical technique : Over-Distraction-Technique using three cages

allowing a symmetric disc height restoration, thus resulting in a better ODI / VAS score (12 months post-op) and a better significant disc height increase (12 months post-op).

PLIF and TLIF techniques are usually performed utilizing a bilateral exposure of the posterior aspect of the spine, followed by an intraspinal (PLIF) or transforaminal (TLIF) access to the disc space. In order to reduce the

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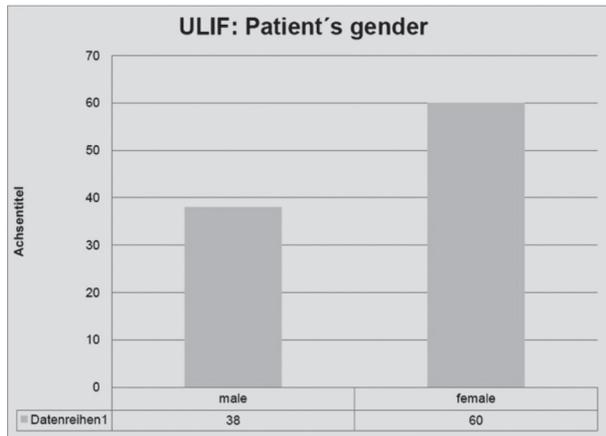


Fig. 2. — Overview – ULIF : Patient's gender

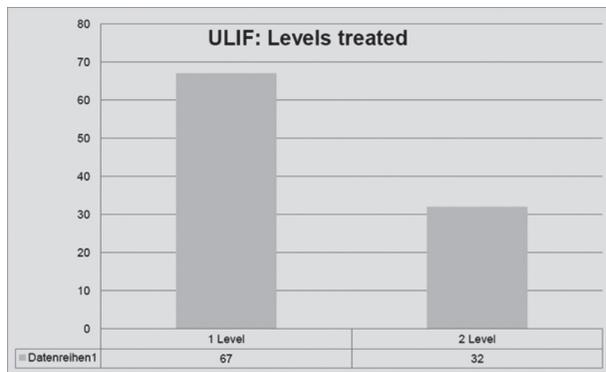


Fig. 3. — Overview – ULIF : Levels treated

surgical morbidity, a less invasive surgical technique was developed with limitation of the exposure to a single side of the spinous process : the unilateral lumbar interbody fusion (ULIF) technique.

A retrospective analysis (Multi Center Cage Study involving two experienced surgeons) was completed on 100 consecutive cases performed between 2009/2011 with maximum post op follow up of 12 months using standard questionnaires (ODI / VAS) and radiographic analysis. A literature review (TLIF and PLIF) was performed to compare clinical methods and outcomes.

Surgical Procedure

Surgery is performed through a midline posterior approach. The muscles are released on both sides of the spinous process and screws are placed bilaterally. A unilateral opening of the canal follows, removing the facet joint and doing a hemilaminotomy. The disc than is incised

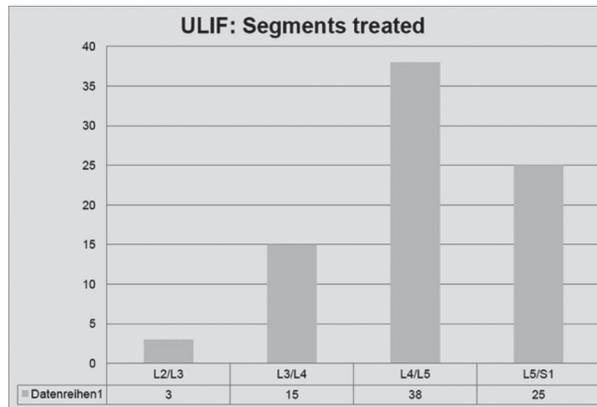


Fig. 4. — Overview – ULIF : Segments treated

ULIF Surgical technique		
	2CD Two Cage Design	3CD Three Cage Design
One level	n=31	n=29
Two level	n=20	n=20

Fig. 5. — Patient series per level and per cage design

in the canal. This is the most important difference to a TLIF (transforaminal) technique : Doing an ULIF surgery the disc is approached in the canal and not in the foramen as the TLIF technique requires.

Using specific scrapers the disc is removed on the ipsilateral side and the appropriate height of the cage is sized. With the disc distracter in place a contra lateral over-distractor must be performed to create a void in order to facilitate the translation of the cages from one side to the other.

Now the discs space is prepared using specific angled curettes to clean out the disc from one side to another. The ULIF cages can be inserted when the disc space is sufficiently prepared. To allow translation from one side to the other a pedicle finder is used as a counter lever, and is implanted in the ground plate of the superior vertebra.

The author's initial main concern with the two cage technique of Commarmond (xx) was that there was no proof during surgery that the contra lateral cage was

Indications	
Deg disc disease and herniation	n=16
Deg spondylolisthesis	n=18
Foraminal stenosis	n=22
Central stenosis	n=12
Deg disc disease	n=38

Fig. 6. — Indications

sufficiently translated to the other side. The possibility to insert a third (middle) cage as well as the over-distraction-technique gives the surgeon a guarantee that the contra lateral cage is well translated to the other side.

After implantation of the ULIF cages the segment is compressed and the contra lateral facet joint is roughened and grafted to create a facet joint arthrodesis.

A total of 100 one- or two-level unilateral lumbar interbody fusion surgeries performed in 2011 at the Ortho-

paedic Department AZ Sint Nikolaas, 9100 Sint-Niklaas, Belgium and in the Orthopaedic Department AZ Sint Lukas, 8310 Bruges, Belgium have been included in the analysis. Patient data was obtained from the medical records.

Indications for surgery included painful degenerative disc disease with or without radiculopathy, instability, spinal stenosis, facet arthropathy, or degenerative spondylolisthesis (Fig. 6).

An extensive presurgical clinical work-up was performed. A diagnosis of degenerative disc was based on one or more of the following characteristics on magnetic resonance imaging (MRI): disc dehydration, decreased disc height, endplate destruction. MRI also helped to determine whether or not there was neural compression due to disc herniation and/or central stenosis.

Clinical parameters such as surgical blood loss, duration of the procedure (OR time / MIN), length of hospitalization, and intraoperative and perioperative complications were assessed for ULIF reconstructive surgeries.

Complications were divided into two groups: major and minor. No complications appeared.

The total of 100 patients undergoing ULIF surgery were divided into four sub-groups: (a) one-level 2CD (two cage design) ULIF procedure, (b) two level 2CD ULIF procedure, (c) one-level 3CD (three cage design) ULIF procedure and (d) two-level 3CD ULIF procedure.

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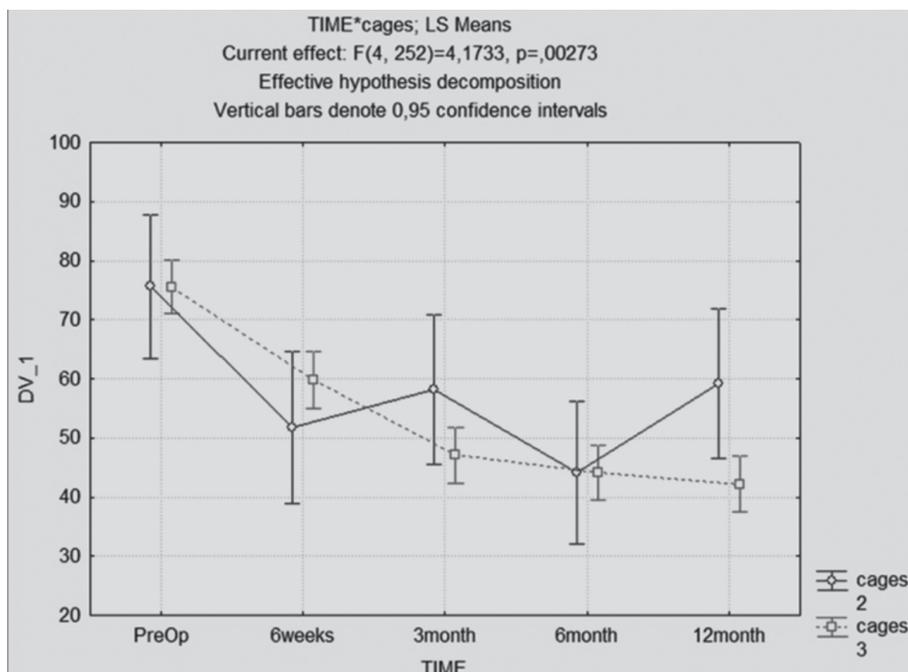


Fig. 7. — ODI score comparing two cage designs over a 12 months time period

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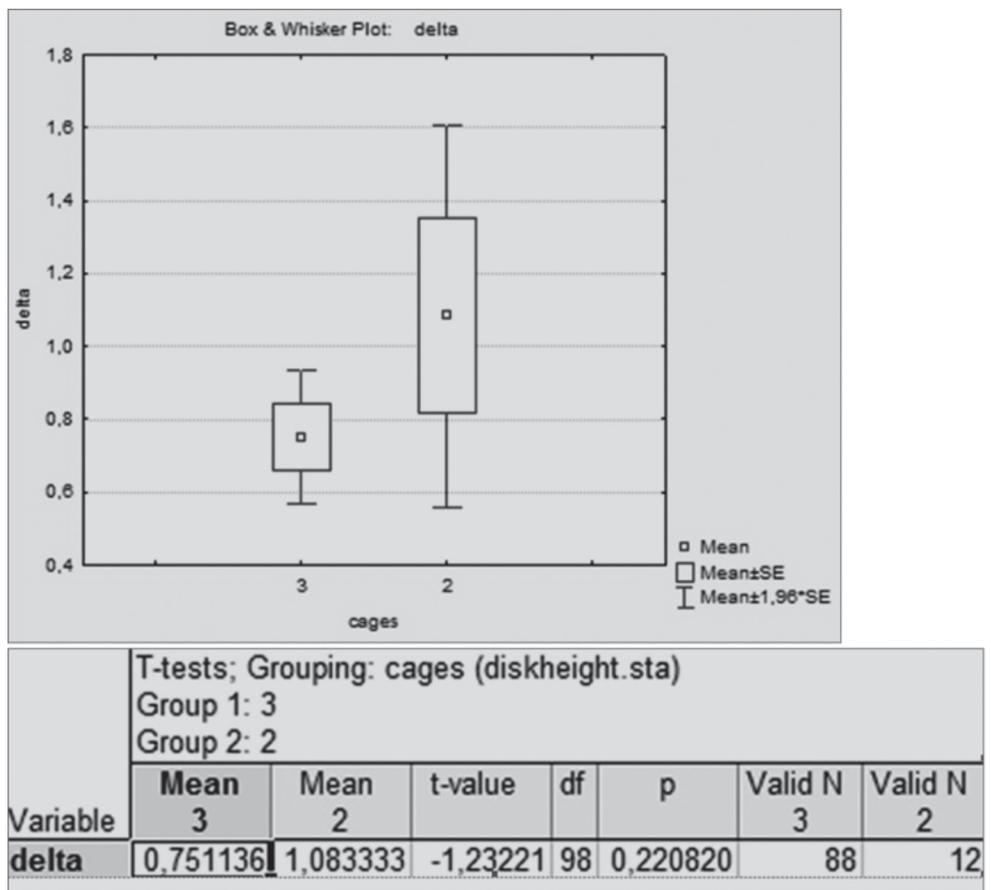


Fig. 8. — Significant Disc Height Increase (delta)

RESULTS

Statistical Analysis using ANOVA models : The data given was analyzed using ANOVA models. Analysing the ODI score, the dependent variables are metric so a 2 factorial ANOVA model was applied containing one between factor (2CD vs. 3CD) and one within factor (moment in time). Each dependent variable was analyzed independent of other dependent variables to enhance analysis parsimony.

The ODI Questionnaires given to the patient reflect the patient’s condition in relation to the different tested cage-designs (2CD / 3CD) and resulted in a data series covering the ODI score over a 12 months period. Observations are available for

5 moments in time : Pre-op, 6 weeks, 3 months, 6 months, 12 months post surgery : Repeated measures anova on all data show a significance at 12 months where 2 cages show significantly higher disability scores (p = 0.0273). Using three cages, the ODI disability score improved over time. The improvement in VAS score was even higher than improvement in Oswestry disability score.

Clinical results postoperatively have been collected and compared within the ULIF group : ULIF 3CD versus ULIF 2CD. ODI score and significant disc height increase are presented in Figure 7 and Figure 8. Analyzing the data given we have to report that the mean delta values do not differ significantly between 2 and 3 cages. Concerning the analysis of the clinical data, the authors put their

AUTHOR	PROCEDURE	LEVEL	OR TIME (MIN)
Villavicencio et al ^[27]	Minimal invasive (MI) TLIF	One level	203 (114-309)
		Two level	307 (227-390)
		Mean	255
	Open TLIF	One level	204 (141-309)
		Two level	241 (164-359)
		Mean	222
Ray et al ^[28]	PLIF		159
Whitecloud et al ^[29]	TLIF		213
Hacker et al ^[30]	PLIF		120
Hee et al ^[30]	TLIF		172
Foley et al ^{[31] [32]}	MI ALIF	Not reported	375
	MI TLIF		240
	MI PLIF		290
Schwender et al ^[33]	MI TLIF		240
Khoo et al ^[34]	MI PLIF		315
El Shazly et al ^[35]	Discectomy+TLIF+Instrumentation		
	Discectomy+PLF+Instrumentation		186 (+/- 16,82 STD)
Humphreys et al ^[36]	TLIF	One level	144,4 (107-214)
		Two level	174,5 (130-265)
	PLIF	One level	159 (100-380)
		Two level	186,9 (107-255)
Vanden Berghe, Zachee	ULIF / 3 Cage-Design	One level ^(a)	133 (65-180)
		Two level ^(b)	150 (85-185)

Fig. 9. — Lumbar Interbody Fusion (PLIF / TLIF / ALIF / ULIF) – OR time / MIN overview obtained from literature (PubMed).

emphasis on the ULIF technique using 3 cages. Operative time (OR time / MIN) is presented in Figure 9 and compared to the literature in Figure 10.

DISCUSSION

Perhaps the greatest concern with a standard PLIF is the amount of neural retraction required, which potentially leads to nerve root injury, dural tear, and epidural fibrosis. The unilateral posterior lumbar interbody fusion was developed to address some of these problems [XX].

Compared to PLIF and standard TLIF, the ULIF technique is a relative easy and less invasive proce-

dure. For single or two level fusion the insertion of ULIF cages preserves the muscles on one side of the spine. Clinical and radiographic outcomes were comparable to those of bilateral fusion techniques (PLIF and TLIF), however with reduced tissue morbidity, operative time and blood loss. Operative time was considerably reduced compared to the PLIF and the TLIF technique. Performing an ULIF procedure is also possible at the level of L5/S1.

The time advantage of the ULIF technique applied to one level surgery is almost 40 minutes. A two level surgery using the ULIF technique saves more than 70 minutes in time. Therefore the ULIF technique is a valuable alternative in interbody

Author	Surgical Technique	OR time (MIN)		
		One level	Two level	Not reported
Literature (average)	Posterior Lumbar Interbody Fusion (PLIF/TLIF)	177,6	227,35	212,9
Literature	ALIF			375
Vanden Berghe, Zachee	Unilateral Lumbar Interbody Fusion (ULIF) / 3 Cage-Design	133 (a)	150 (b)	

(a) patient n= 29
 (b) patient n= 20

Fig. 10. — ULIF 3CD (one level / two level) – OR time / MIN compared to literature (PubMed)

fusion surgery of the lumbar spine in certain indications. The ULIF technique has proven to be safe and leads to a high fusion rate and clinical results at least comparable to bilateral pedicle fixation constructs employed in TLIF or PLIF procedures. As it is less invasive, and surgical time, costs and morbidity are reduced, the ULIF technique is a viable alternative to standard bilateral pedicle fixation with classic TLIF or PLIF technique but with more limited indications: Patients with clear radicular symptoms have better results than patients with only back pain.

Because of the design of the cages, care must be taken during the preparation of the endplates. Only an exact and carefully preparation of the endplates guarantees a stable positioning of the middle cage without migration. The Preparation of the endplates is a crucial factor for high fusion rates. Insufficient preparation of the endplates may lead to stress shielding of the middle cage and to lower fusion rates compared to other lumbar surgical techniques.

This prospective bi-centric study of hundred consecutive patients showed that there might be

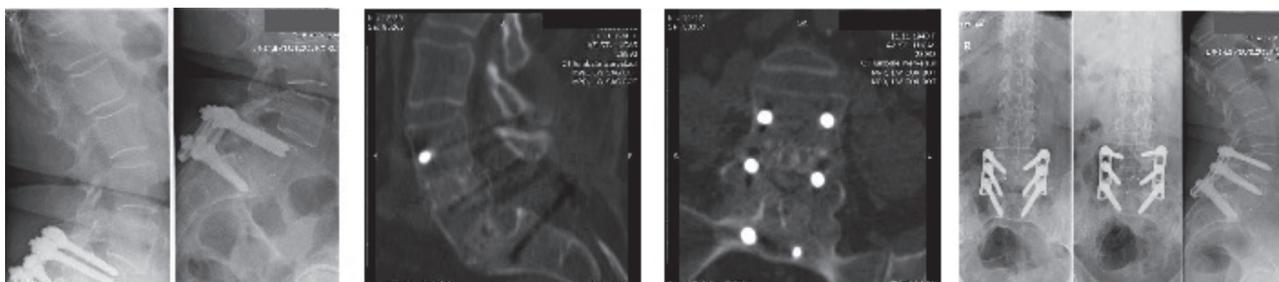


Fig. 11. — Case study ULIF 1

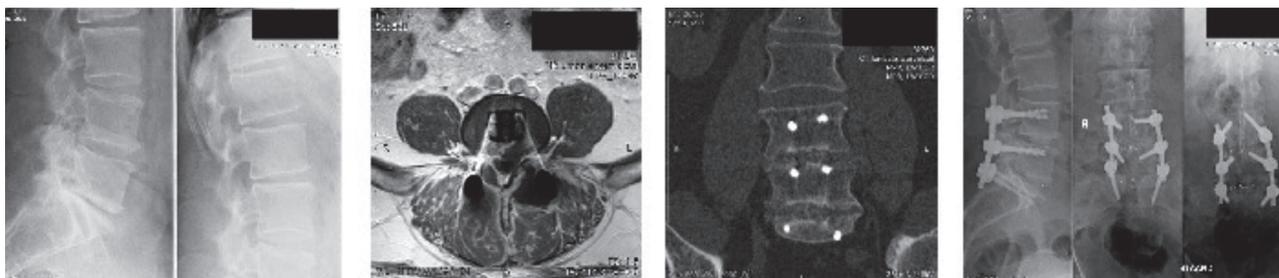


Fig. 12. — Case study ULIF 2

insufficient ingrowths at the middle cage due to the shape of some end plates. Therefore the authors emphasize the use of two cages in a sandwich-position and encourage the industry to develop an ULIF cages-design (three cages) in a more anatomic, domed shape.

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