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DOI:
10.4103/JOASP.JOASP_63_21

# Surgical treatment of symptomatic non-union after transforaminal lumbar interbody fusion

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## Abstract

**INTRODUCTION:** Transforaminal lumbar interbody fusion (TLIF) is frequently performed to treat lumbar degenerative diseases. As with any fusion procedure, there are patients who fail to achieve a solid fusion and require revision surgery. The purpose of this study is to evaluate the clinical and functional outcomes of revision procedures performed by different approaches for non-union following TLIF.

**MATERIALS AND METHODS:** Electronic medical records and radiographs of 52 adult patients with symptomatic non-union confirmed at surgery after single or multilevel TLIF who underwent revision surgery from 2012 to 2019 and had at least 1-year follow-up were reviewed. Data collected included demographics, surgical approach, numeric back and leg pain scores (0–10), Oswestry Disability Index scores before and after revision and complications.

**RESULTS:** Revision for non-union was performed for an average of 31.7 months, following the index procedure. Fifteen patients underwent an anterior-only approach, and 28 cases underwent a combined anteroposterior approach with exchange of posterior instrumentation and decompression. Nine cases underwent a posterior-only approach with or without decompression and bone graft on the lateral gutters. There were no significant differences between various surgical approaches in terms of demographics, surgical parameter, pain relief, functional improvement, or complications.

**CONCLUSIONS:** The current study showed that improvement of clinical symptoms and functional outcome was less than 50%, regardless of the surgical approach type. A low percentage of individuals experienced aggravation of leg pain, back pain, or dysfunction. There was also no distinctive advantage for any individual approach in TLIF revision.

**Keywords:**

Complications, non-union, outcomes, revision, surgical approach, transforaminal lumbar interbody fusion

## Introduction

Transforaminal lumbar interbody fusion (TLIF) is frequently performed to treat a variety of degenerative diseases of the lumbar spine.[1,2] As with any fusion procedure, there is a subset of patients who fail to achieve a solid fusion, and they become symptomatic and require revision surgery. The authors have suggested various techniques including anterior, posterior, or combined approaches to treat non-union following TLIF.[3-18] While there is limited literature reporting on the functional outcome of revision surgery for non-union of posterolateral fusion (PLF), there are scarce data regarding the outcome of revision procedures for non-union following TLIF surgery. The purpose of this study is to evaluate the clinical and functional outcomes of revision procedures performed by different approaches for non-union following TLIF.

## Materials and Methods

Electronic medical records and radiographs of 52 adult patients with symptomatic non-union after single or multilevel TLIF who

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**Received** : 19 December 2021
**Accepted in revised form:** 24 January 2022
**Published:** 23 June 2022



**How to cite this article:** Nabizadeh N, Glassman SD, Brown ME, Carreon LY. Surgical treatment of symptomatic non-union after transforaminal lumbar interbody fusion. J Orthop Spine 2021;9:56-9.

underwent revision surgery from 2012 to 2019 and had at least 1-year follow-up were reviewed. The initial diagnosis of non-union was made by plain radiograph or computed tomography (CT) scan findings such as: loss of segmental lordosis, angular or translational motion visualized in dynamic views, radiolucency around the cage or screws, implant failure, cage subsidence, cage dislodgment, or absence of bony bridging traversing the disc space. The diagnosis of non-union was confirmed at surgery.

Data collected included demographics, surgical approach, numeric back and leg pain scores (0–10)[19] Oswestry Disability Index (ODI)[20] scores before and after revision and complications. The radiographic results and assessment of bony fusion after the revision were based only on the review of plain radiographs.

Anterior approaches were primarily performed through an open transperitoneal or retroperitoneal technique. Revision entailed resection of the TLIF cage and reinstrumentation. Some cases underwent anterior revision and additional posterior exploration and fusion. A third group of cases underwent a posterior-only approach for hardware exchange and revision PLF.

All analyses were performed using IBM SPSS Statistics for Windows, Version 27.0 (Armonk, NY, USA). Data are presented as frequencies, percentage, mean, and standard deviation. Continuous variables between the two groups were compared using independent *t*-tests, and categorical data were analyzed using Fisher's exact test. A *P*-value of less than 0.05 was considered significant. Based on a previous study by Copay, minimum clinically important difference (MCID) values used were 12.8 points for ODI, 1.2 points for back pain, and 1.6 points for leg pain.[21]

## Results

The study included 52 patients (58 levels): 27 were male and 25 were female. The average age was 51.8 years (range 28–76). Thirty-four cases (65%) were current or former smokers. The average body mass index (BMI) was 31.7 kg/m$^2$. Seventeen cases were ASA 2 and 33 were ASA 3. The non-union was at L5-S1 (30, 58%), L4-L5 (20, 36%), L3-L4 (4, 9%), L2-L3 (3, 5%), and L1-L2 (1, 2%). Revision for non-union was performed for an average of 31.7 months (range 6–150), following the index procedure.

Fifteen patients (80% female, 20% male) underwent an anterior-only approach to retrieve the cage and bone morphogenetic protein (BMP) with or without iliac crest bone graft [Table 1]. Anterior approaches were accomplished by an access surgeon through transperitoneal ($n$ = 18) or retroperitoneal ($n$ = 25) approach. Twenty-eight cases (61% male, 39% female) underwent a combined anteroposterior approach with exchange of posterior instrumentation and neurologic decompression. Nine cases underwent a posterior-only approach with or without decompression, augmentation of fusion, and application of morselized allograft and/or BMP on the lateral gutters. The selection of approach in any individual case was dependent on the surgeon's personal experience and preference. The revision procedure was performed in one stage in 40 cases, two stages in 11 cases, and three stages in 1 case.

There was one case of dural tear and cerebrospinal fluid leak in the anteroposterior approach group, one case of intradural hematoma and cauda equina following an anterior approach, one epidural hematoma after an anteroposterior approach, one fixed cage, one sacral fracture presented 2 days after an anteroposterior approach, and one iliac bone graft site infection.

There were no significant differences between various surgical approaches in terms of pain relief and functional improvement [Table 2]. The proportion of patients achieving MCID for ODI, back and leg pain was similar among the different approaches.

## Discussion

The outcome for revision following PLF has been addressed previously in the literature. In a cross-sectional

**Table 1: Summary of demographic and surgical data**

| | ALIF | PSF | ALIF+PSF | Sig. |
|---|---|---|---|---|
| | 15 | 9 | 28 | |
| Sex | | | | 0.009 |
| F | 12 | 2 | 11 | |
| M | 3 | 7 | 17 | |
| Smoking status | | | | 0.890 |
| Current | 4 | 3 | 6 | |
| Former | 7 | 3 | 11 | |
| Never | 4 | 3 | 11 | |
| ASA Grade | | | | 0.349 |
| 1 | 1 | 0 | 0 | |
| 2 | 2 | 4 | 11 | |
| 3 | 12 | 5 | 16 | |
| 4 | 0 | 0 | 1 | |
| Non-union level | | | | 0.319 |
| L2-L3 | 0 | 1 | 1 | |
| L3-L4 | 0 | 2 | 1 | |
| L3-L4-L5 | 0 | 0 | 1 | |
| L4-L5 | 5 | 2 | 7 | |
| L4-L5-S1 | 2 | 0 | 2 | |
| L4-S1 | 0 | 1 | 0 | |
| L5-S1 | 8 | 3 | 15 | |
| T12-L1, L2-L3 | 0 | 0 | 1 | |
| Number of levels | | | | 0.971 |
| 1 | 13 | 8 | 24 | |
| 2 | 2 | 1 | 4 | |

**Table 2: Patient reported outcomes**

| | ALIF | PSF | ALIF+PSF | Sig. |
|---|---|---|---|---|
| Pre-operative | | | | |
| ODI | 52.05 (17.01) | 55.78 (10.32) | 58.84 (14.18) | 0.350 |
| Back pain | 6.13 (2.39) | 7.22 (1.2) | 7.39 (1.83) | 0.126 |
| Leg pain | 4.93 (3.26) | 5.22 (2.82) | 5.96 (3.13) | 0.559 |
| Post-operative | | | | |
| ODI | 43.88 (22.29) | 45.14 (20.83) | 46.77 (21.44) | 0.913 |
| Back pain | 5 (2.85) | 5.44 (2.6) | 5.46 (2.96) | 0.873 |
| Leg pain | 4.33 (3.13) | 5.11 (3.1) | 4.21 (2.79) | 0.726 |
| Change | | | | |
| ODI | 8.17 (20.23) | 10.64 (19.63) | 12.06 (20.2) | 0.834 |
| Back pain | 1.13 (3.38) | 1.78 (2.17) | 1.93 (2.79) | 0.687 |
| Leg pain | 0.6 (4.31) | 0.11 (2.85) | 1.75 (3.12) | 0.370 |
| MCID | | | | |
| ODI | 5 (33%) | 3 (33%) | 12 (43%) | 0.781 |
| Back pain | 7 (47%) | 6 (67%) | 18 (64%) | 0.476 |
| Leg pain | 6 (40%) | 3 (33%) | 16 (57%) | 0.350 |

study of fusion outcomes, Glassman *et al.*[22] found that the least amount of improvement, based on ODI at 2-year follow-up, was seen in patients with non-union of a prior fusion (5.5 points). Dede *et al.*[5] demonstrated that outcomes after revision surgeries for lumbar non-union are mostly associated with the primary diagnosis for initial fusion surgery. Among patients with a primary diagnosis of degenerative disc disease or spondylolisthesis, despite high fusion rates after revision, the self-reported clinical outcomes were worse in patients with degenerative disc disease. Adogwa *et al.*[23] demonstrated that both back pain scores and ODI improved after surgery for non-union; however, the improvements either barely or never reached MCID values. They concluded that independent factors including age, BMI, symptom duration, smoking, comorbidities, severity of pre-operative pain, disability, pre-operatively high ZCS score, and also pre-operative depression were significantly associated with lower 2-year improvement in disability (ODI) after revision surgery in elderly patients with symptomatic non-union.

Carpenter *et al.*[4] evaluated the radiographic and clinical outcomes of revision procedures in 84 patients with PLF non-union and at least 2 years of follow-up. A solid fusion was ultimately achieved in 94% of the cases. Despite the high rate of fusion after revision procedures, only 26% eventually expressed a good or excellent outcome on questionnaires, 19% reported a fair result, and 54% a poor result. The functional outcome questionnaire revealed that these patients were still quite limited in their functional abilities and had a noticeable amount of pain. Gertzbein *et al.*[7] reviewed 25 patients treated with circumferential fusion after non-union following attempted PLF. Despite a 100% fusion rate, at an average follow-up of 2.7 years, only 52% had considerable pain relief, 41% were still taking narcotics, and 53% had returned to work. They discovered a strong correlation between poor functional outcome and chronic low back pain, history of prior surgeries, and smoking.

TLIF is now the most commonly used surgical technique for lumbar fusion in patients with degenerative disease,[24] and although the fusion rate may be slightly better than PLF, non-union is still a relatively common problem. Segmental non-union following single or multilevel TLIF may result in the recurrence of pre-operative symptoms or new onset radicular pain necessitating surgical intervention.[8] Revision often includes resection of the TLIF cage. TLIF cages may be extracted using an anterior or lateral approach and can be replaced with larger anterior or lateral lumbar interbody fusion (ALIF or LLIF) cages.[10,12] If a posterior approach is used for cage resection with failed TLIF, considerable manipulation is required to release the adhesive scar from dura or nerve roots, increasing the risk of dural tear, nerve injury, neurological deficit, and delayed wound healing.[18] If the geometry and orientation of the original TLIF cage allow for insertion of a second cage, revision TLIF can be performed using a contralateral approach.[17] It has also been proposed that TLIF non-union cases that are relatively stable from a biomechanical standpoint may simply require a PLF.[6]

Vargas-Soto *et al.*[15] reported the results of revision ALIF in 38 patients with non-union after TLIF. Only ALIF and ALIF with posterior screw fixation were compared. In both the groups, the clinical results improved after revision surgery. The transperitoneal approach provided wide exposure for lumbosacral junction, whereas the retroperitoneal approach facilitated access to the upper lumbar levels with less likely abdominal hernia or injury of abdominal contents.[17]

The current study showed that improvement of clinical symptoms and functional outcome were less than

50%, regardless of the surgical approach type. A low percentage of individuals experienced aggravation of leg pain, back pain, or dysfunction. There was also no distinctive advantage for any individual approach in TLIF revision. The frequent dissatisfaction following TLIF revision raises the questions about various contributing factors such as psychological issues, smoking, metabolic abnormalities, chronic disability, prior surgeries, and workers' compensation.[14]

All these reviewed challenges in diagnosis, surgical technique, and clinical or radiographic results of TLIF salvage surgery warn the surgeon to apply optimal vigilance during initial surgery to avoid failure of intervertebral fusion.[19] Surgeons should also practice caution when counseling a patient with TLIF non-union pre-operatively, including a meaningful attempt at conservative treatments such as intensive rehabilitation and conditioning before the revision procedure.[4]

The limitations of this study are its retrospective nature, small sample size, lack of CT scan evaluation of fusion, and absence of a control group. Derman and Singh[6] suggest that each case of TLIF non-union is unique and should be treated individually. It seems intuitive that surgeons should be familiar with different approaches, so that they can tailor operative plans, but unfortunately clinical outcome does not appear to be strongly technique-dependent. As with revision of PLF, the clinical results of TLIF revision appear to be challenging and unreliable. This should be addressed in pre-surgical counseling and planning of TLIF non-union. The type of surgical approach did not generate significant differences in clinical outcomes.

## Financial support and sponsorship
Nil.

## Conflicts of interest
There are no conflicts of interest.

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