Mathematical Biosciences and Engineering

MBE, 16(6): 7829–7838.
DOI: 10.3934/mbe.2019393
Received: 21 March 2019
Accepted: 22 August 2019
Published: 27 August 2019

http://www.aimspress.com/journal/MBE

Research article

Full-endoscopic transforaminal procedure to treat the single-level adjacent segment disease after posterior lumbar spine fusion: 1–2 years follow-up

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Abstract: Adjacent segment disease (ASD) is one of the potential risks after lumbar spine surgery with instrumentation. Revision surgery needs to be performed on patients suffered from ASD. The traditional open surgery takes severe injury to the body. We investigated the clinical outcome of using full-endoscopic transforaminal procedure to treat the single-level adjacent segment diseases after posterior lumbar fusion. 33 patients (average 71 years, ranged 65–84 years old) underwent full-endoscopic transforaminal procedure were involved. The Oswestry Disability Index (ODI), Modified Japanese Orthopedic Association (mJOA) score and visual analogue scale (VAS) score were used to evaluate the clinical effect. The complication, hospital stay, hospitalization costs and blood loss were investigated according to the patient's records. The mean VAS score was 1.8 and mJOA score was 5.4 postoperatively. Improvement rate was 78%. The mean ODI was 14.6 postoperatively. The mean length of hospital stay, hospitalization costs and blood loss was 2.5 days, $3500 and 15 mL, respectively. No complication or recurrence was observed in any of the patients at the final follow-up. Full-endoscopic transforaminal procedure is a safe and effective technique. It is economical, acceptable and mini-invasive. Of course, it also can shorten the length of hospital stay and decrease bleeding. For revision surgery to treat ASD, this technique can achieve good clinical effects.

Keywords: adjacent segment disease; lumbar spine; full-endoscopic transforaminal; revision surgery; recurrence

Abbreviations: ASD: Adjacent segment disease; ODI: Oswestry disability index; JOA: Japanese orthopedic association; VAS: Visual analogue scale; PLF: Posterior lumbar fusion; PLIF: Posterior lumbar interbody fusion; FE-TF: Full-endoscopic transforaminal

1. Introduction

Posterior lumbar decompression and fusion surgery (PLF/PLIF) with instrumentation has been widely used to treat lumbar spine diseases. Solid internal fixation is regarded as the golden standard for lumbar spinal surgery. This procedure can markedly increase the rate and rapidity of fusion and primary stabilization [1,2], however, there is an increasing number of clinical cases indicate that lumbar fusion can accelerate the degeneration of adjacent segments [3,4]. The adjacent segment disease (ASD) contains two types: One was called "radiographical ASD", the other type "clinical ASD" refers to clinical symptoms and signs that appearing at the adjacent segment [2]. The patients usually suffered from "clinical ASD". Previously, a small portion of ASD patients reluctantly accepted the open-revision surgery and experienced more pain and additional costs. The traditional open-revision surgery increases trauma of surgery and unacceptable. This study which using mini-invasive technique to treat ASD is rare in the current English literature. The present study investigated a mini-invasive technique, the full-endoscopic transforaminal (FE-TF) approach to treat the single-level ASD.

2. Material and methods

2.1. Patients

We retrospectively analyzed 33 patients who underwent revision surgery by the corresponding authors using full-endoscopic transforaminal procedure in our institution between December 2013 and April 2016. These patients were enrolled according to the following criteria: 1) The patient underwent PLF or PLIF surgery and was diagnosed single-level "clinical ASD" based on their clinical symptoms and signs. The X-ray and MRI also tell us the disc height declining and disc herniation at the upper or lower adjacent segment (Figures 1 and 2); 2) Conservative treatment was not effective at least three months; 3) No deformity, tumor or trauma. There were 15 males and 18 females with an average age of 71.8 years (range, 65–84 years). The details were showed in the Table 1. All patients had the X-ray, CT scan and MR of lumbar spine examination preoperatively. Written informed consent was obtained from all patients prior to their enrollment in this study.

2.2. Surgery technique

All patients took a lateral position with local anesthesia (Figure 3). The FE-TF procedure was performed with 12 to 13 cm lateral far from the midline, an atraumatic spinal cannula was inserted via the 2.0 cm skin incision (Figure 4). After the insertion of a lead wire, the cannulated dilator was pushed in larger and larger. A part of the superior articular process was removed, and the intervertebral foramen was

expanded using burr drill. A work tube with beveled is placed, and the light and constant irrigation equipment were installed. Thereafter, decompression was performed while maintaining visual control and constant irrigation.

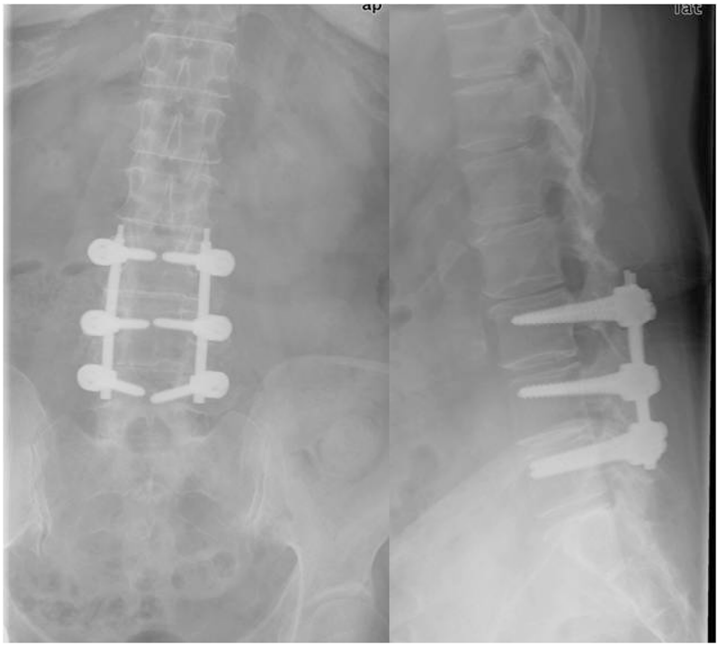

Figure 1. A 67-year-old women underwent PLF ten years ago, the right leg radicular pain for three years. The height of L5/S1 disc was declining on the X-ray image at the final follow-up.

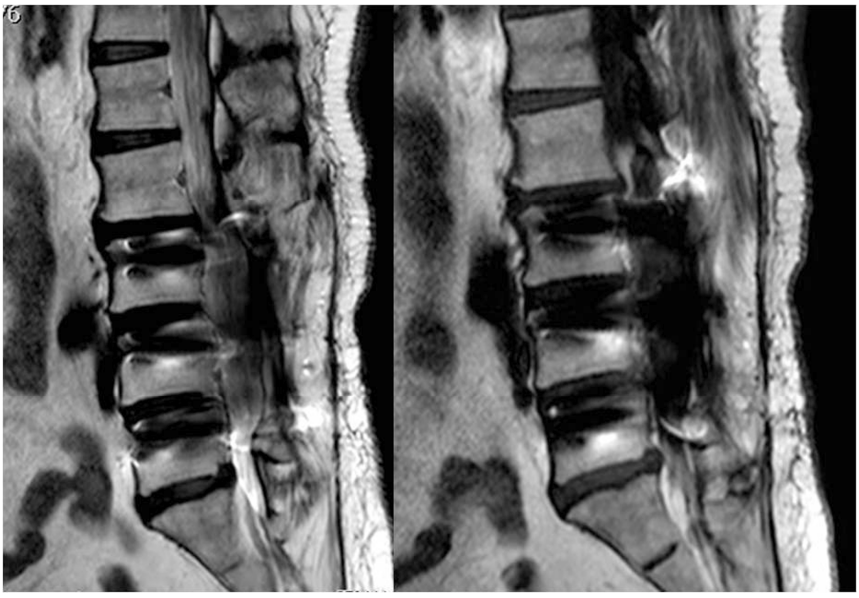

Figure 2. The disc herniation of L5/S1 was shown on the sagittal T1-and T2-weighted MR images (a 67-years-old women).

Table 1. Summary of patient demographics, pain levels and clinical symptoms.

	Number of Patients
Age	71.0 years (range, 65–84years)
Sex	
Male(N)	15
Female(N)	18
Involved level	
L3/4	6
L4/5	9
L5/S1	18
Patients symptoms*	
Radical pain (Right/Left legs)	19
Sphincter dysfunction	1
Lower limbs numbness/ weakness	21

* There were many patients have several clinical symptoms.

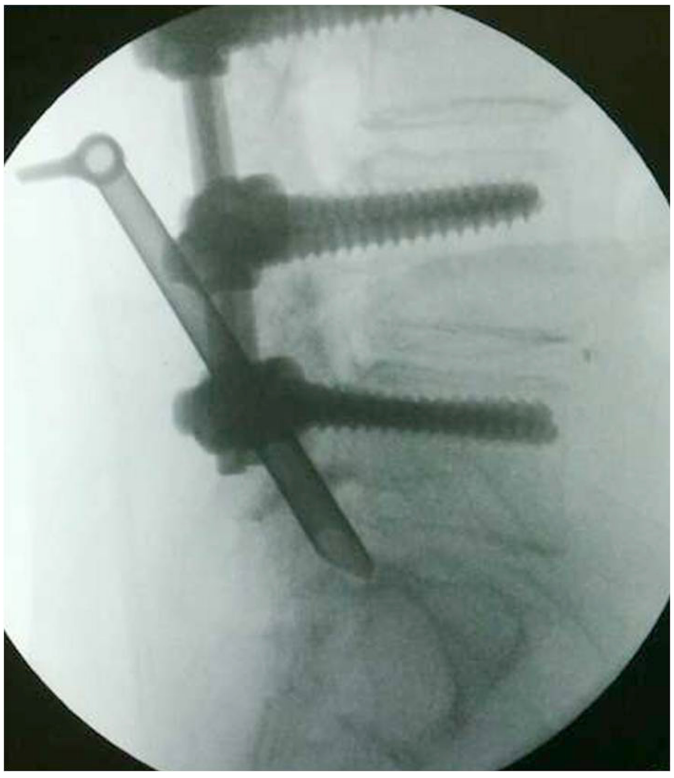

Figure 3. All patients positioned on the lateral position with local anesthesia.

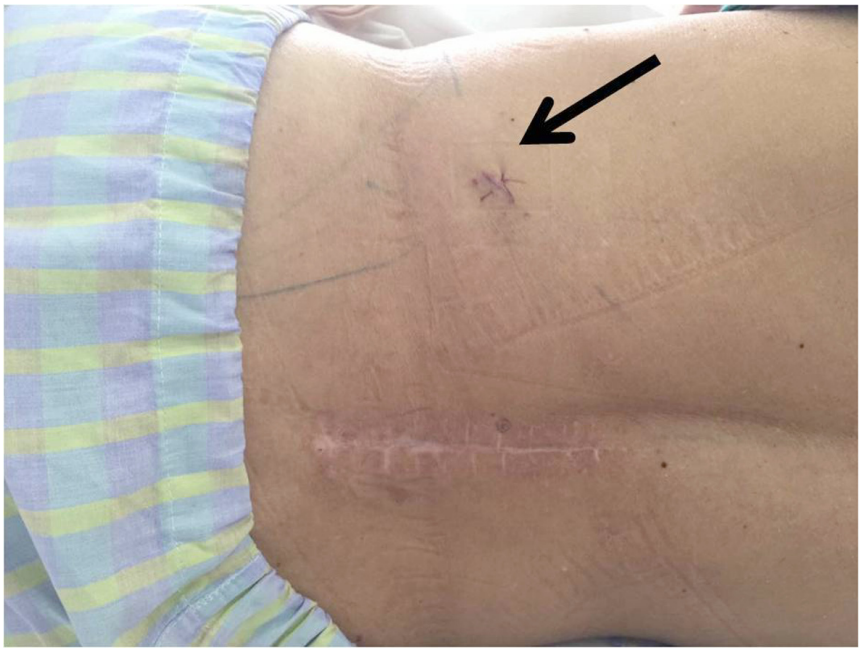

Figure 4. The skin incision was only 2.0 cm which was used to place the work tube.

2.3. Statistical analysis

33 patients (average 71 years, ranged 65–84 years old) underwent full-endoscopic transforaminal procedure were involved. The improvement was analyzed using paired-samples *t* test pre- and post-operatively. Statistical significance was set at $p < 0.05$. All tests were performed using the statistical program SPSS (version 19.0, SPSS, Inc.).

2.4. Evaluation of clinical effect

The Visual Analogue Scale (VAS) score between 0 (no pain) and 10 (maximal pain), Modified Japanese Orthopedic Association (mJOA) score (Table 2) [5,6], and Oswestry Disability Index (ODI) were used to evaluate the clinical effects. For all participants, The VAS, mJOA and ODI were measured mainly at two points in time: Pre-operative and one year after surgery. The hospital stay, hospitalization costs and blood loss were investigated according to the patients' records.

3. Results

All patients' symptoms were released significantly at the first day of follow-up after surgery. The mean VAS was 1.8 postoperatively while it was 8.4 preoperatively. The mean mJOA score was 5.4 postoperatively while it was 24.6 preoperatively. Improvement rate was 78.0%. The mean ODI was 14.6 postoperatively while it was 89.2 preoperatively. All patients were discharged after average 2.5 days of hospital stay. The mean hospitalization cost was $3500.0 (according to 1 dollar = 6.5 RMB). The mean blood loss was 15 mL. There was no complication and recurrence occurred at the final follow-up. The details were showed in Table 3.

Table 2. Summary of modified Japanese Orthopaedic Association (mJOA) score for low-back pain.

Parameter	mJOA score
Subjective symptoms	6
Low back pain or leg pain	
none	0
occasional mild pain	1
frequent mild or occasional severe pain	2
frequent or continuous severe pain	3
Numbness	
none	0
occasional numbness	1
frequent numbness, alleviate spontaneously	2
continuous numbness	3
Objective signs	12
Paravertebral tenderness	
none	0
mild	1
moderate	2
severe	3
Myodynamia	
5	0
4–5	1
3–4	2
< 3	3
Straight leg raise (Lasegue sign)	
> 70° Bragard sign (–)	0
> 45° Bragard sign (+)	1
> 30° Bragard sign (+)	2
< 30° Bragard sign (+)	3
Radicular pain	
none	0
hip or thigh	1
calf	2
foot	3
Restriction of activities of daily living	12
Bending down and lifting heavy objects	
bending down normal, lifting > 3 kg	0
bending down ok, lifting < 3 kg	1
unable to bend down, lifting < 3 kg	2
unable to bend down or lifting heavy objects	3

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Parameter	mJOA score
Gait	
able to walk > 1000 m or > 60 min	0
able to walk > 500 m or > 30 min	1
able to walk > 100 m or > 10 min	2
able to walk < 100 m	3
Bed rest time	
10 h	0
10–12 h	1
12–16 h	2
> 16 h	3
Work ability	
full-time work	0
able to work, need occasional rest	1
able to work, need frequent rest	2
unable to work	3

Total score is 30. Improvement rate (IR) = (preoperative JOA scores–postoperative JOA scores)/preoperative JOA scores *100%. The excellent result is IR > 75%; good: 50–75%; ordinary: 25–50%; bad: < 25%.

Table 3. Summary the average mJOA score, VAS and ODI, preoperatively and Postoperatively. The average hospital stay, hospitalization cost and blood loss.

	Pre-op	Post-op	P value
Average mJOA score	24.6 ± 8.4	5.4 ± 2.3	< 0.001
IR*	78%		
Average VAS	8.4 ± 2.8	1.8 ± 0.6	< 0.001
Average ODI	89.2 ± 17	14.6 ± 12	< 0.001
Hospital stay (day)	2.5 ± 1.2		
Hospitalization Cost (dollar)	3500.0 ± 234		
Blood loss (mL)	15.0 ± 3.6		
Complications (at the final follow-up)	None		
Recurrence (at the final follow-up)	None		

*The IR = improvement rate = (preoperative JOA scores–postoperative JOA scores)/preoperative JOA scores *100%. The excellent result is IR > 75%.

4. Discussion

PLF/PLIF with instrumentation has been widely accepted by spine surgeons to treat lumbar spine disease all over the world. PLF and PLIF are now standard procedures in the spinal surgeons' armamentarium for treatment of degenerative lumbar spine diseases [7–9]. Solid internal fixation is regarded as the gold standard for lumbar spinal decompression because it can provide primary

stabilization [1,2]. However, there is a growing number of clinical cases indicate that lumbar fusion can accelerate degeneration of adjacent segments. Harrop et al. [10] reported that 34% of patients developed radiographical ASD and the symptoms of degeneration manifested in 14% of patients by a systematic review. It makes a lot of sense to investigate the risk factors for developing ASD after lumbar fusion with instrumentation in addition to evaluate the incidence of ASD. Many risk factors have been reported to accelerate the developing of ASD in previous studies, such as age, gender, osteoporosis and menopause. Aota et al. [11] emphasized that it showed much higher incidence of ASD in older patients (> 55 years old). Etebar et al. [12] claimed that the incidence of ASD was higher in females. However, Anandjiwala et al. [13] showed that there is no significant difference in the rate of degeneration at adjacent segments by age and gender in 68 cases after lumbar fusion, and this study arrived at the same conclusion.

Although the mechanism of ASD still remains controversial, the incidence and severity of ASD cannot be ignored. What is the best choice to treat ASD for surgeons while the patients suffered from it? Traditionally, open posterior techniques would usually be used for revision surgery. However, these techniques require extensive tissue and can cause atrophy of muscles. At the clinical follow-up, the muscle atrophy, loss of function, and increased pain always been evidenced [14]. The traditional open-procedure takes severe injury and is unacceptable for patients. Many patients usually reluctantly accepted the open-revision surgery because they don't want to experience the long skin incision and pain caused by surgery. The extension of the fusion often be used in the spine surgery, but transpedicular fixation should be considered, given that Whitecloud et al. reported an 80% pseudarthrosis rate in a small cohort of patients fused without instrumentation. Many patients sill complained about pain after undergoing surgery for ASD. Fourteen patients accepted decompression and extension of fusion reported by Whitecloud et al. However, most showed no improvement or only modest improvement of discomfort with persistent functional limitations and continued need for pain medications [15]. Schlegel et al. further investigate 37 patients who underwent either decompression alone or decompression and extension of fusion [16]. At 2 years follow-up, 26 of 37 patients had good-to-excellent improvement in back and leg pain, and 7 of the 37 patients eventually required another operation. In another study specifically showed surgery for symptomatic stenosis, 11 of 26 patients were either neutral or dissatisfied with their results, even though leg symptoms were generally improved [17]. Decompression was performed on all 26 of these patients, but fusion extension was limited to 22 patients. Chen et al. recently reported modestly improved outcomes compared to previously reported results for treating 39 patients with adjacent segment instability and stenosis [18]. At 5 years follow-up, 77% of the patients achieved good-to-excellent results. For revision-surgery, aggressive surgeons often use extensive removal of the medial facets and foraminotomies and transpedicular fixation. Most patients may develop disease at the succeeding adjacent segment after having been undergone successful fusion across the adjacent segment. It may take the risk for recurrent ASD on long-term prognosis [19].

The FE-TF technique is a new procedure and develops rapidly in recent years. When taking the appropriate criteria into account, the FE-TF surgery is a sufficient and safe supplementation and alternative to treat the ASD. In the current literature, there were many papers reported the FE-TF can achieve the similarly satisfactory clinical outcomes and is less invasive. Lee et al [20]. Reported that the mean operating time and hospital stay of the FE-TF group was 45.8 minutes and 0.9 day, respectively. And they were significantly shorter than that in the open-surgery group. Another study reported that FE-TF and open-surgery achieved similar clinical outcomes, but the FE-TF is less

invasive than open surgery in selected cases [21].

In our study, all patients using local anesthesia and the patients' symptoms were released markedly at the first day after operation and discharged in mean 2.5 days. There was no recurrence at the final follow-up. The mJOA scores have significantly improved postoperatively and at the final follow-up. The VAS scores also showed a significant decrease from 8.4 preoperatively to 1.8 postoperatively. The mean ODI was 14.6 at the final follow-up. The mean hospitalization cost and blood loss was $3500 and 15 mL, respectively. No complication was found in selected patients. Full-endoscopic transforaminal approach is a safe and effective technique. It is economical, mini-invasive and acceptable for patients. Of course, it also can shorten the length of hospital stay and decrease bleeding. However, this technique needs very experienced surgeon.

5. Conclusion

Although the FE-TF procedure is a new technique and needs a long learning curve, it is a safe and effective approach to treat the ASD on the basis of selecting the appropriate patients. Meanwhile, it also needs more deep research, large sample scale and long-term follow-up.

Acknowledgements

Supported by Pudong health bureau of shanghai (No. PW2017F-1) and Natural Science Foundation of Shanghai, China (No. 19ZR1441700).

Conflict of interest

All authors declare no conflicts of interest in this paper.

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