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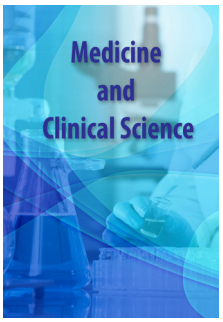

Extreme Lateral Interbody Fusion (XLIF) Including the Segment L5/S1 for Multi-level Lumbar Spondylodesis

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Abstract

Study Design: *This is a single centre retrospective study of 24 cases of multilevel degeneration of the lumbar spine treated with the XLIF procedure including the level L5/S1.*
Objective: *The purpose of this study is to report the feasibility of including the L5/S1 segment in treating the degenerative lumbar spine using the XLIF procedure and demonstrating the preoperative conditions necessary to do so.*
Summary of background data: *In the last decades, more and more elderly patients suffer from pain and disability due to degenerative instability of the lumbar spine. Spinal fusion procedures, including XLIF, have proven good results despite significant complication and revision rates.*
Methods: *24 patients (mean age 66 years, range 32 – 89 years) who would be candidates for XLIF surgery at L5/S1 were included. Preoperative anatomical assessment of the iliac crest in relation to the L5/S1 disc space was performed. All patients were operated with the aid of neuromonitoring using a mini-invasive XLIF approach with direct visualisation of the psoas muscle. Complication rates, surgery time, and blood loss were calculated as well as clinical results using the VAS score preoperative, and at 6 weeks, 3 months and 1 year postoperative.*
Results*: The mean postoperative VAS score improved from 7.8 preoperative to 3.1 at one-year follow-up. There was one case of pseudoarthrosis at the L5/S1 level. There were no new neurological deficits postoperatively. We report a total complication rate of 29%.*
Conclusion: *The XLIF procedure for multilevel lumbar spine fusion is feasible at the L5/S1 level in patients with certain anatomical prerequisites, predominantly in females. The procedure should be done under direct visualization. The clinical outcome and revision rate is comparable to other multilevel fusion techniques.*

Introduction

The Extreme Lateral Interbody Fusion (XLIF) is a less-invasive technique for the operative treatment of degenerative lumbar spine diseases like degenerative scoliosis and degenerative disc disease [1–4] Advantages of XLIF includes avoiding the vascular and visceral risks associated with ALIF [5,6] and the neural complications common to both PLIF and TLIF [7–9]. Further advantages include decreased blood loss, shortened operative times and quicker hospital stays. This procedure requires traversing the psoas muscle which puts the lumbosacral plexus nerve roots at risk if a good anatomical exposure is not performed. 2

The L5/S1 segment was formerly thought to be contraindicated for the XLIF approach due to anatomical considerations of the iliac crest, iliac vessels, and the exiting L5 nerve root. Because of this, only a small number of cases involving the L5-S1 segment operated by have been documented in the literature [10,11]

In order to further broaden the application of XLIF and to show that this is a reliable and reproducible operation in the segment L5/S1, we present 24 cases of multilevel degenerative instability of the lumbar spine treated with XLIF procedures including the L5/S1 level.

Materials and methods

From March 2018 to August 2021, we selected 24 patients (mean age 66 years, range 32 – 89 years) who would be candidates for XLIF surgery at L5/S1. This assessment was based on the preoperative standing lateral radiograph, with the iliac crest located below the vertical midline of the L5 vertebra. The anatomy of the iliac vessels was analysed based on preoperative MRI, and their relation to neural structures was described in our prior study [10]. In the 24 patients, interbody fusion was performed in 60 total levels. A mean of 2.5 levels were fused per patient. Seven patients had prior lumbar surgery. 8 patients (33%) had osteoporosis and 2 (1%) osteopenia. The mean BMI was 28.8 (29-45).

Thorough preoperative preparation was crucial. Under general anaesthesia and neuromonitoring, patients were placed in a

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true lateral position. Depending on the AP radiograph and the convexity of the scoliosis, we choose right approach for 15 and left approach for 9 patients. For a better exposure, we bent the operative table and fluoroscopically confirmed that the L5/S1 intervertebral space was exposed without obstruction by the iliac crest.

Then, a 5-7cm incision was made in the centre of the surface projection of the planned fusion. For example, at the Level L4/L5 when the fusion was planned for L3-S1. Once the incision was made, blunt dissection of the external oblique, internal oblique, and transverse abdominal muscles was performed, and the transverse fascia was opened under direct visualisation. The surgeon then traverses the retroperitoneal space in order to reveal the psoas major muscle. The psoas muscle is traversed bluntly layer by layer in the anterior third of the muscle. After confirming that no blood vessels or nervous structures were blocking access to the lateral intervertebral space, the expansion channel could be placed and discectomy was performed. All steps were performed under neuromontoring for SSEP and MEP. Importantly, the contralateral annulus was left intact to prevent the cage from injuring the contralateral vessels or nerves. The cages used were pre-filled with allograft (13 patients) or autologous iliac crest bone graft (11 Patients). After performing the same procedure at the other planned levels with closure of the lateral wound, the patient was placed in prone position and posterior pedicle screw instrumentation was performed under fluoroscopic guidance. Thromboprophylaxis was administered only during the hospitalisation (Figure 1).

Figure 1: *Pre- and postoperative x-rays showing the iliac crest to L5 and the correct position of the material.*

Statistical analyses

Descriptive statistics were used to report means, standard deviations, and ranges of data, where applicable. Between-group comparisons were done using two-tailed Student's t-test and chi-square test with p-values of <0.05 defined as statistically significant.

Results

Of the 24 patients included, 20 patients were female (83%) and 4 were male. During the XLIF procedure, the patients had a recorded estimated blood loss of 300ml or less. Mean operative time was 212 minutes per surgery (125-373 minutes) including the dorsal instrumentation. Mean time per segment including the dorsal instrumentation was 92 min. Mean length of hospital stay was 8.5 days (4-19). Twenty-two of the 24 patients (92%) were available for 12-month clinical and radiological follow-up. The other two patients died during the follow-up period of the study. Preoperative, 6-weeks, 3-months and 1-year postoperative VAS score was measured as demonstrated in figure 2. The mean

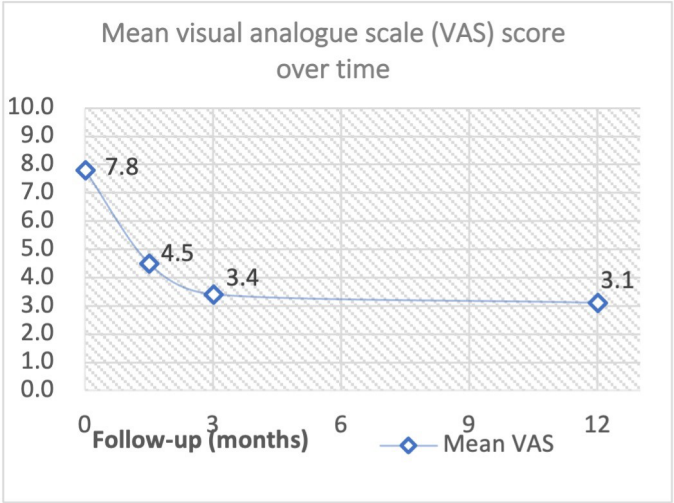

Figure 2: *VAS Score over time for the complete study group.*

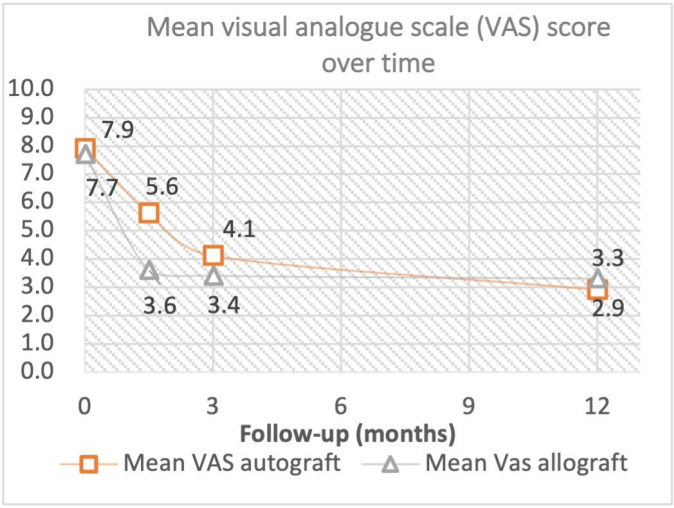

Figure 3: *VAS Score over time comparing patients who received auto- versus allograft.*

postoperative VAS score improved at one-year follow-up from 7.8 preoperative to 3.1, which was statistically significant ($p < 0.01$).

There were differences in the VAS scores in patients who received auto- and allograft as seen in figure 3. At the 6-week and 3-months follow-up, the VAS in the autograft group (5.6 and 4.1) was higher in comparison to the allograft group (3.6 and 3.4). One year after the operation, the trend in VAS was reversed: 2.9 for the autograft and 3.3 for the allograft groups. However, none of these values were statistically significant.

21 patients (88%) were satisfied with their outcome and stated that they would repeat the surgery.

There were no new postoperative neurological deficits. There was one case of pseudoarthrosis at the level L5/S1. We had an overall revision rate of 6 patients (25%) during the 2 years follow up. One patient (4%) underwent revision for pseudoarthrosis. The other five patients had revisions due to adjacent segment degeneration mainly due to the pre-existing poor bone quality. There were no cases of psoas hematoma, visceral or vascular injury. There were also no cases of postoperative infection.

Discussion

As planned based on preoperative anatomy, all patients could successfully undergo multilevel spondylodesis including the segment L5/S1. As shown in prior studies, lateral access to the spine under direct visualisation can prevent complications such as nerve root damage or bowel perforation, more common where percutaneous access before surgical exposure is performed [12] Interestingly, the female anatomy with a lower iliac crest is more favorable to allowing an XLIF approach at the L5/S1 level [13]. The operative time was comparable to other procedures for lumbar fusion but the mean blood loss of 300ml was less [11]. The clinical outcome was satisfying in 88% of the cases. The pain reduction from 8 to 3 on the VAS scale was statistically significant. As expected, the group where iliac-crest autograft was used had more pain at the beginning, which is known from other studies14 but after one year the results at the autograft group were even better but not statistically different compared to the allograft group. The mean hospital stay of 8.5 days was comparable to the described length of stay in other studies [15].

There was an overall revision rate of 25%. Poor bone quality and the length of the initial spondylodesis were the main reasons for the revisions, comparable with other studies [16]. At the L5/S1 level, there was one case (4%) of pseudoarthrosis which required a revision surgery. The pseudoarthrosis rate of 4% is also comparable to other studies [12,15,17]. The study population was too small to show a difference regarding the pseudoarthrosis rate between the auto- and allograft group.

There are some limitations regarding this study. First, the study group of 24 patients is relatively small for statistical analysis, although it represents one of the largest groups including the L5/S1 segment operated by XLIF. Second, the follow-up time of 2 years is relatively short regarding further adjacent segment degeneration.

Conclusion

It is feasible to include the L5/S1 segment in multilevel XLIF lumbar spondylodesis in patients with certain anatomical prerequisites, predominantly in females. The procedure should be done under direct visualization. The clinical outcome and revision rate is comparable to other multilevel fusion techniques.

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Author contributions statement

Panev SS: Acquisition of data, drafting of the manuscript Schmid SL: Conception and design, acquisition of data, supervision, drafting of the manuscript; Krappel FA: Critical revision of the manuscript for important intellectual content, supervision; Zegarek G: Revision of the manuscript Perrig WN: acquisition of data, supervision.

All authors have read and approved the final submitted manuscript.

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