

# Middle-period curative effect of posterior lumbar intervertebral fusion (PLIF) and interspinous dynamic fixation (Wallis) for treatment of L45 degenerative disease and its influence on adjacent segment degeneration

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**Abstract. – OBJECTIVE:** To study middle period curative effect of posterior lumbar intervertebral fusion (PLIF) and interspinous dynamic fixation (Wallis) in the treatment of L45 degenerative disease and its influence on adjacent segment degeneration.

**PATIENTS AND METHODS:** 66 patients with lumbar L45 degenerative diseases were selected for study. The patients were randomly divided into PLIF operation group and Wallis operation group with 33 cases in each group. The patients were analyzed for T1 $\rho$  value, functional score and UCLA classification of L3/4 and L5/S1 segment in different periods of two groups of patients.

**RESULTS:** The level of T1 $\rho$  for L3/4 and L5/S1 segment in two groups between preoperative period and last follow-up showed a decreasing trend, while level of T1 $\rho$  value of L3/4 segment in PLIF operation group was significantly lower than Wallis group. Within group comparison, the level of T1 $\rho$  for L3/4 segment in PLIF operation group until the last follow-up was significantly lower than that before operation. While comparing two groups, ODI scores after operation for PLIF group and Wallis group was significantly lower than those before operation and JOA score was significantly higher than that before operation. The UCLA grade of L3/4 and L5/S1 segment of the two groups was significantly improved compared with that at the time of the last follow-up.

**CONCLUSIONS:** Both PLIF and Wallis methods are effective for the treatment of lumbar degenerative disease of L45. Wallis operation has slight advantage in slowing down the speed of intervertebral disc degeneration in the upper adjacent segment of the patient.

## *Key Words:*

PLIF (posterior lumbar interbody fusion), Wallis (interspinous dynamic fixation), L45 degenerative diseases, MRI.

## Introduction

Posterior lumbar interbody fusion (PLIF) is often used in clinic for the treatment of patients with lumbar degenerative disease and the effect of treatment is quite promising. But there are reports also pointed out that PLIF operation has great influence on the adjacent segment degeneration and could not fully protect the patient's lumbar spine<sup>1</sup>. In recent years, the application of interspinous dynamic fixation (Wallis) in developed countries has been widely used. Its main role is to restrict the occurrence of abnormal activity in the diseased segment and make sure that all the other sections are in a controllable range of security, finally reduce the probability of occurrence of adjacent segment degeneration<sup>2,3</sup>. In this study, we compared the efficacy and safety of PLIF and Wallis in mid term, by using T1 $\rho$ -MRI (T1 $\rho$ -Magnetic Resonance Imaging). We first detected the soft bone marrow nuclear protein polysaccharide of the patients and then evaluated the comparative degeneration of lumbar intervertebral disc.

## Patients and Methods

### *Patients and Selection Criteria*

66 patients with lumbar L45 degenerative disease in Traditional Chinese Medicine Hospital Zhengzhou were selected for treatment during Jan 2010 to May 2014. The cases include 35 males and 31 females, with age between 39-60 years and average age of 53.4 $\pm$ 2.7 years. The patient's inclusion criteria was as reported earlier<sup>4-5</sup>,

a) All the patients are to be consistent with the standard on diagnosis of WHO on lumbar degenerative disease. b) The X-ray and MRI diagnosis shows interbody angle greater than or equal to 11 degrees and slipping greater than 3mm and gliding less than 1 degree. c) All patients having symptom of lumbago that is difficult to tolerate. d) Preoperative University of California at Los Angeles grading (University of California, UCLA, Los Angeles, CA, USA) showing that it is less than or equal to level II. Exclusion criteria for patient's was- a) The preoperative degeneration or gliding and instability of the adjacent segment L3/4 and L5/S1 segment. b) The patients with other types of vertebral fractures. c) The patients without indication for surgery. d) The patients refused surgical treatment.

### ***Patients' Grouping***

According to the digital method, patients were randomly divided into two groups, the PLIF operation group and Wallis operation group with 33 cases included in each group. There were 18 males and 15 females in the PLIF operation group, aged between 39-58 years old with average age of  $52.9 \pm 3.3$  years. There was 4-26 months' time from beginning of symptoms to operation, with average time of  $16.2 \pm 3.4$  months. There were 16 cases of L4/5 disc herniation and 17 cases of lumbar spinal stenosis. There were 17 males and 16 females in the Wallis operation group, being aged 40-60 years and average age of  $52.7 \pm 3.1$  years. The time was 4-28 months from symptoms starting to beginning of operation, with an average interval of  $16.5 \pm 3.7$  months. There were 19 cases of L4/5 disc herniation and 14 cases of lumbar spinal stenosis. The gender, age and time from symptom starting to operation time and the condition of the two groups of patients were compared and the difference observed was not statistically significant ( $p > 0.05$ ), which is comparable.

### ***Research Method***

After anaesthesia of patient, prone and middle posterior position was selected for operation. For PLIF group, lower limb nerve symptoms side was selected for inter laminar decompression by fenestration. Subsequently, back nerve root was released and nucleus pulposus was removed. After scrapping the cartilage plate of the adjacent vertebral body, it was foisted into autogenous bone to intervertebral fusion cage. As posterior interbody is fused, internal fixation was performed with

pedicle screws. For Wallis group, the spine of the lesion area was opened on the opposite side of affected area. The excision of the yellow ligament was performed after the removal of the spines. If disc herniation is more evident, decompression was performed by fenestration on the lamina located in root symptoms side. The nucleus pulposus was removed, the upper and lower margin of the spike was trimmed, lamina was polished and spine pad was inserted with suitable model after testing model through spreader.

The bundle was allowed to close the upper or lower margin of the spine as it passes through the fixed segment of the spine. When the lock was firmly fixed, the bundle was locked in clockwise manner. Once it is successful, towel was punched in the upper and lower spine, separated ligamenta supraspinale was sewed, catheter was drained and finally surgical cut was closed. Two groups were treated with antibiotics for first day of operation and 5 days after operation patients' were recommended for out of bed activity. The patients' were recommended to avoid bending for up to 3 months and later on they can resume normal activities.

### ***Observation Index***

X-ray and lumbar spine MRI was performed 1 month before and 1 year after operation until the last follow-up. Philips 1.5 Tesla MR was implemented for examination of patients. The short echo time T1WI: TE was 8 ms, TR was 540 ms, vision FOV was 200 mm and the thickness of 2-3 mm was used for analysis. In addition, T2WI: TE was 100 ms and TR was 1900 ms. After collecting data, T1 $\rho$  value map through processing with postprocessing software and T1 $\rho$  value (ms) was determined by using Image J software, selecting the average value after determination for 3 times.

### ***Effect Evaluation***

The recovery condition of patients is accessed through Oswestry dysfunctional index (ODI) and Japanese Orthopaedic Association Scores (JOA)<sup>6,7</sup>. Among them, lower ODI score and higher JOA score was found to be beneficial for patients.

### ***Statistical Analysis***

SPSS13.0 statistical software analysis (SPSS Inc., Chicago, IL, USA) was adopted for comparing data by using  $\chi^2$  test. Measurement data was expressed by (Mean $\pm$ SD), providing *t*-test.  $p < 0.05$  was considered as statistically significant.

**Table I.** The comparison of level obtained from T1 $\rho$  value between with two groups of patients in different periods for L3/4 and L5/S1 segment (e.g., Mean $\pm$ SD).

Group name	L3/4				L5/S1			
	Before operation	1 month after operation	1 year after operation	Last follow-up	Before operation	1 month after operation	1 year after operation	Last follow-up
PLIF operation	115.5 $\pm$ 8.8	111.4 $\pm$ 11.9	105.8 $\pm$ 10.6	91.4 $\pm$ 10.5	95.5 $\pm$ 7.6	94.7 $\pm$ 9.9	93.2 $\pm$ 7.5	91.2 $\pm$ 12.4
Wallis operation group (n=33)	112.3 $\pm$ 9.7	107.6 $\pm$ 8.3	106.8 $\pm$ 10.2	106.5 $\pm$ 13.9	96.8 $\pm$ 8.4	95.3 $\pm$ 7.6	93.8 $\pm$ 8.8	92.4 $\pm$ 10.6
<i>t</i> value	1.404	1.505	0.391	4.979	0.659	0.276	0.298	0.423
<i>p</i> value	0.165	0.137	0.698	0.000	0.512	0.783	0.767	0.674

## Results

Comparison of levels of T1 $\rho$  in two groups of patients for different periods of L3/4 and L5/S1 segment is shown in Table I. The level of T1 $\rho$  value of L3/4 and L5/S1 segment in two groups between preoperative period and the last follow-up showed a decreasing trend. The level of T1 $\rho$  value of L3/4 segment in PLIF operation group until the last follow-up is significantly lower than that of Wallis operation group (Table I). When the level of T1 $\rho$  value of L3/4 segment 1 year before and after operation between two groups and the level of T1 $\rho$  value of L5/S1 segment between two groups between preoperative period and last follow-up was compared, the difference is not statistically significant ( $p > 0.05$ ). Within group comparison, the level of T1 $\rho$  value of L3/4 segment in PLIF operation group until the last follow-up is significantly lower than that before operation (Table I). Comparison of functional scores of two groups of patients with different periods is shown in Table II. The ODI score and

JOA score are compared between the two groups during the preoperative period and the last follow-up and the difference is not statistically significant ( $p > 0.05$ ). Within group comparison, the ODI scores after 1 month of operation, after 1 year of operation and at the time of last follow-up in PLIF operation group and Wallis operation group were significantly lower than those before operation and the JOA scores of those were significantly higher than those before operation.

Comparison of UCLA standard grade of two groups of patients before operation and at the time of the last follow-up is shown in Table III. The UCLA grade of L3/4 and L5/S1 segment of the two groups was significantly improved compared with that at the time of last follow-up. But there is no significant difference of the comparison between the two groups ( $p > 0.05$ ) as shown in Table III.

While comparing surgical complications and follow-up time of two groups, there was 1 case of dural laceration in the PLIF operation group.

**Table II.** Comparison of functional scores of two groups of patients with different periods (data is shown as Mean $\pm$ SD)

Group name	ODI score				JOA score			
	Before operation	1 month after operation	1 year after operation	Last follow-up	Before operation	1 month after operation	1 year after operation	Last follow-up
PLIF operation group (n=33)	35.8 $\pm$ 10.2	13.9 $\pm$ 8.4	8.9 $\pm$ 5.2	8.6 $\pm$ 6.1	13.2 $\pm$ 3.5	15.1 $\pm$ 3.9	15.2 $\pm$ 4.2	15.9 $\pm$ 5.1
Wallis operation group (n=33)	36.7 $\pm$ 8.3	11.2 $\pm$ 6.6	8.7 $\pm$ 3.4	7.9 $\pm$ 5.2	12.8 $\pm$ 3.1	15.0 $\pm$ 5.2	15.3 $\pm$ 5.5	15.8 $\pm$ 4.9
<i>t</i> value	0.393	1.452	0.185	0.502	0.491	0.088	0.083	0.081
<i>p</i> value	0.696	0.151	0.854	0.618	0.625	0.930	0.934	0.936

**Table III.** Comparison of UCLA standard grade of two groups of patients before operation and at the time of the last follow-up.

Group name	L3/4						L5/S1				
	Before operation		Last follow-up				Before operation		Last follow-up		
	I	II	I	II	III	IV	I	II	I	II	III
PLIF operation group ( n=33 )	19	14	7	14	8	4	24	9	17	10	5
Wallis operation group ( n=33 )	18	15	5	13	12	3	22	11	19	11	3
Z value	1.178	2.036	1.125	1.984							
p value	0.164	0.089	0.334	0.277							

After the implementation of the repair, there was no cerebrospinal fluid leakage. There were 2 cases of urinary tract infection, while there was 1 case of urinary tract infection after operation in Wallis operation and recover after treatment with antibiotics. The follow-up period of the PLIF operation group was 6 to 26 months and the average follow-up time is 15.4±3.3 months. The follow-up period of the Wallis operation group is 7 to 28 months and the average follow-up time is 15.6±4.2 months.

Imaging analysis of two groups of patients with different preoperative and the last follow-up is shown in Figures 1 and 2. Figure a and figure b shows degenerative instability combined with mild slipping of PLIF for preoperative L4/5 segment. L3/4 and L5/S1 segment are classified as grade III and IV by UCLA grade. Figure c and figure d shows that the fixation position is better at the time of the last follow-up after performing

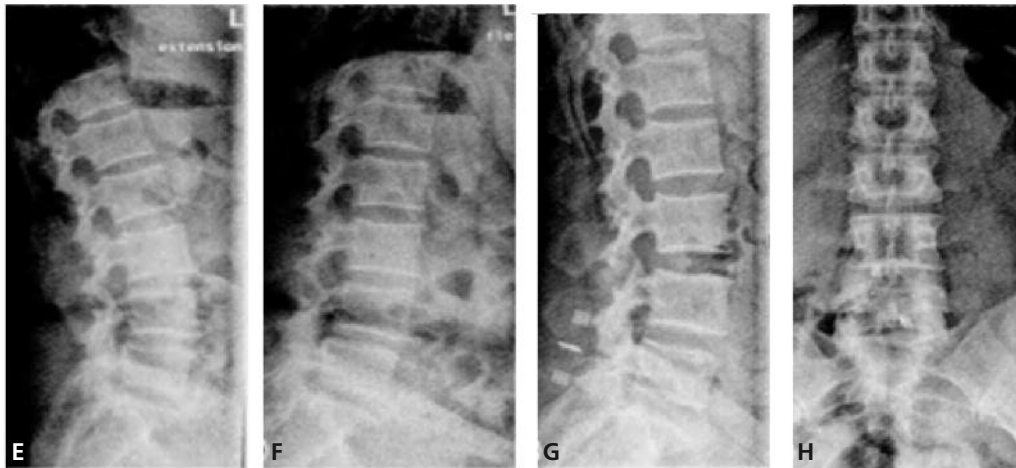
PLIF operation and intervertebral fusion is satisfied. Figure e and figure f display that Wallis preoperative L4/5 segment appears degenerative instability. Figure g and figure h show that the fixation position is better at the time of the last follow-up after performing Wallis operation and section stability effect is satisfied.

### Discussion

Lumbar spine is an important for supporting human body as well as for trunk movement. Almost all of the body's activity increases the burden on the lumbar spine and excessive activity, overload can accelerate the aging of the lumbar spine, resulting in formation of secondary pathological changes, which ultimately brings severe pain for patients. For more serious lumbar degenerative diseases, the clinical treatment is mainly



**Figure 1.** The imaging before and after PLIF operation is shown in Figure A-D. Figure a shows before operation, Figure B is 1 month after operation, Figure C is 1 year after operation and figure d is last follow up.



**Figure 2.** The imaging before and after Wallis operation is shown in Figure E-H. Figure a shows before operation, Figure B is 1 month after operation, Figure C is 1 year after operation and Figure D is last follow up.

treated by surgery and PLIF and Wallis are included in the application of the surgical plans which are more common in usage. Both of the two methods provide good curative effect and pays close attention to them at home and abroad<sup>8,9</sup>. However, for the comparison of the efficacy of PLIF and Wallis treatment of vertebral L45 degenerative disease and the effect on the adjacent segment degeneration, there is no relevant report available in clinic. Considering this, we designed this study to provide more comprehensive data of operation for treatment of degenerative disease of L45.

We found that the level of T1 $\rho$  value of L3/4 and L5/S1 segment in two groups between preoperative period and the last follow-up showed a decreasing trend, but the level of T1 $\rho$  of L3/4 segment in PLIF operation group until the last follow-up was significantly lower than that of Wallis operation group. The level of T1 $\rho$  for L3/4 segment in PLIF operation group until the last follow-up was significantly lower than that before operation, while the difference of the Wallis operation group was not significant. Wallis dynamic fixation in comparison to PLIF operation slowed down the speed of intervertebral disc degeneration in the upper adjacent segment. It also confirms the hypothesis that when using dynamic fixed system to limit the abnormal activity of the segment in a controllable range, changing the mode of self-loading of the moving segment is beneficial to reduce the proportion of the intervertebral disc degeneration of adjacent segment after the operation. In the past, there

were reports that<sup>10,11</sup> in the process of conventional MRI imaging, the use of metal internal fixation devices may lead to a decrease in image quality, thus, affecting the detection results. Because the echo time has an important influence on the image quality, we used short echo time in scanning and selection of the center of median sagittal plane of same area of nucleus to record as a region of interest, supplementing the method of increasing the bandwidth to scan. The results showed that when comparing between the groups, the level of T1 $\rho$  for L3/4 segment 1 year before and after operation and the level of T1 $\rho$  for L5/S1 segment between preoperative period and the last follow-up were compared, and the difference was not statistically significant, which shows that the metal fixation needle does not significantly affect the level of measurement of MRI-T1 $\rho$ value. It also shows that T1 $\rho$ -MRI technology has high feasibility for the evaluation of the status of the intervertebral disc degeneration in the condition of internal fixation.

In addition, we also found that there is no significant difference in ODI and JOA scores between the two groups before operation and till the last follow-up. Within group comparison, the ODI scores after 1 month of operation, 1 year of operation and the last follow-up of PLIF operation group and Wallis operation group were significantly lower than those before operation, and JOA score was significantly higher than that before operation. This suggests that two surgical procedures may result in a certain degree of adjacent segment degeneration of the intervertebral

disc, conforming to relevant report results of foreign people such as Dario et al<sup>12</sup> and Zhang<sup>13</sup>. The UCLA grade of L3/4 and L5/S1 segment at the time of the last follow-up in the two groups was significantly improved in comparison with before operation. But the difference was not significant between the groups. This suggests that the effect of lumbar internal fixation on the degeneration of intervertebral disc is relatively small, which mainly involves the upper adjacent intervertebral disc. In Table III, 3 cases of PLIF operation group and 4 cases of Wallis operation group are reported. The progress is UCLA IV grade, conforming again to this. This also suggests that PLIF and Wallis can obtain better medium-term effects.

The patients' operative complications and the follow-up time of the two groups were compared and the difference was not significant. This suggests that the safety of PLIF and Wallis was better, which coincides with earlier reports<sup>14-16</sup>. The mechanism could be that in both PLIF and Wallis operation the aim is to reduce the stress of the intervertebral disc and intervertebral joint at the same time. This can restrict the local activity of the spine. Wallis dynamic fixation system has also the advantages of simple operation, less trauma, etc.<sup>17-20</sup>. While PLIF was applied widely and the fixed effect were better. Although the two will cause the upper adjacent segment degeneration but the difference is not significant. So actually both have higher safety<sup>21,22</sup>.

## Conclusions

Both PLIF and Wallis operation are beneficial for the treatment of lumbar degenerative disease of L45, having high security. Wallis operation has a slight advantage in slowing down the speed of intervertebral disc degeneration in the upper adjacent segment of the patient.

## Conflict of Interest

The Authors declare that they have no conflict of interests.

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