

# The influence to lumbar lordosis after operation for lumbar disc herniation with or without fixation and fusion

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**Abstract:** To explore the influence to lumbar lordosis of different operation for lumbar disc herniation, as lumbar lordosis has a great effect on keeping the spine sagittal balance. 632 cases of lumbar disc herniation were treated in our hospital from December, 2010 to December, 2014, of which 331 male and 301 female, aged from 18-83 with the average age of 50.12, was followed up for 1-36 months with a mean follow-up of 5.29 months. According to the operation methods, we divided into 2 groups: fixation and fusion group, of which 584 cases, including 307 male and 277 female, aged from 18-83 with the average age of 50.81, was followed up for 1-36 months with a mean follow-up of 5.86 months, and non-fusion (percutaneous transforaminal endoscopic discectomy or traditional fenestration and discectomy) group, of which 48 cases, including 24 male and 24 female, aged from 21-77 with the average age of 41.67, was followed up for 1-24 months with a mean follow-up of 5.29 months. The preoperative and postoperative lumbar curvature of the two groups was measured by Cobb's angle. The conclusion is the lumbar curvature in fixation and fusion group has increased after surgery, especially in female, more than 50 years old, at last follow-up more than 6 months, and at operation level L4/5. The lumbar curvature of male patients in non-fusion group was increased more than which of female patients after surgery, and the lumbar curvature of non-fusion group was increased after surgery at operation level L5/S1.

**Keywords:** Lumbar disc herniation; Fusion; Non-fusion; Lumbar curvature

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## 1. Introduction

Under normal physiological conditions, lumbar lordosis can increase spinal capacity of shock buffer, while from the view of biomechanical, it play an important role in loading and maintaining the stability of waist and pelvis. with the more in-depth understanding of the sagittal balance, research found that lumbar lordosis is very important in maintaining the sagittal balance, change of the angle is one of the common varieties of the lumbar spine disease especially in lumbar disc herniation [1-3]. Once the lumbar lordosis angle changes, affecting the sagittal balance, our organism will start a variety of compensatory mechanisms to maintain the overall balance. This is a self-regulating process, it will lead to the increase of energy consumption, pain, limited mobility and other symptoms. When compensatory mechanism cannot maintain the overall balance, it will cause the body forward, intractable low back pain and fatigue symptoms, and even walking difficulties, affect patients' daily lives seriously. We take follow-up study of lumbar disc herniation fusion and non-fusion on influences of spinal curvature, investigate the changes of lumbar lordosis in patients.

## 2. Subjects and Methods

### 2.1. Subjects

Excluding secondary surgery, 632 cases of lumbar disc herniation were treated in our hospital from December, 2010 to December, 2014, of which 331 males and 301 female, aged from 18-83 with the

average age of 50.12. They were followed up for 1-36 months with a mean follow-up of 5.29 months.

Surgical indications: (1) Lumbar disc herniation with stubborn radiculopathy or conservative treatment via the system of 6 to 12 weeks cannot alleviate; (2) Merger lumbar spinal stenosis, seriously affecting daily life; (3) Patients with cauda equina syndrome or acute severe paresis or the progressive increase of paralysis.

Surgical approach: (1) Discectomy and fusion fixation, 584 cases, including 307 male and 277 female, aged from 18-83 with the average age of 50.81, was followed up for 1-36 months with a mean follow-up of 5.86 months, many of them are single-gap, 223 L45 and 151 L5S1; (2) Traditional fenestration and discectomy or percutaneous transforaminal endoscopic discectomy, 48 cases, including 24 male and 24 female, aged from 21-77 with the average age of 41.67, was followed up for 1-24 months with a mean follow-up of 5.29 months, 23 L45 and 23 L51.

### 2.2. Measurement of lumbar curvature

Using cobb angle measurements included five lumbar segments, the head end measuring line parallel to the L1 vertebral end plate, the end of the measuring line parallel to the S1 endplate [4-8]. All patients were taken standing X-ray, upper neutral position [9-11].

### 2.3. Statistical analysis

We take SPSS 17.0 for statistical analysis,

independent sample t- test and paired t- test for the two groups preoperative and postoperative follow-up in lumbar curvature for statistical analysis,  $P < 0.05$  has statistical significance difference.



Figure 1. Cobb angle measurements.

### 3. Results

#### 3.1. Comparison between fusion and non-fusion group of preoperative, early postoperative and final follow-up lumbar lordosis

**Table 1 Preoperative and early postoperative lumbar lordosis.**

	Fusion	Non-fusion
Preoperative average angle	28.21±12.44	25.16±14.72
Early postoperative average angle	27.64±10.50	24.95±12.21
	P=0.133	P=0.455

The preoperative lumbar curvature of fixation and fusion group was  $28.21 \pm 12.44$ , while  $27.64 \pm 10.50$  at early postoperative; The preoperative lumbar curvature of non-fusion group was  $25.16 \pm 14.72$ , while  $24.95 \pm 12.21$  at early postoperative. The preoperative and early postoperative lumbar curvature of fusion and non-fusion has no statistical significance ( $P=0.133$ ;  $P=0.455$ ). The last follow-up lumbar curvature of fixation and fusion group was  $29.92 \pm 10.83$ , while non-fusion group was  $25.97 \pm 13.82$ , has statistical significance ( $P < 0.01$ ). compared to preoperative, angles of two groups have increased in last follow-up, the curvature increase of fusion fixation group at the last follow-up compared with the preoperative, has statistical significance ( $P < 0.01$ ), while the non-fusion group has no statistical significance ( $P=0.527$ ). The preoperative and last follow-up angle changes of two groups has no statistical significance ( $P=0.436$ ).

**Table 2 Preoperative and final follow-up lumbar lordosis.**

	Fusion	Non-fusion	
Preoperative average angle	28.21±12.44	25.16±14.72	P=0.038
Early postoperative average angle	29.92±10.83	25.97±13.82	P<0.01
	P<0.01	P=0.527	

#### 3.2. Effects of different follow-up time on the lumbar lordosis angle

**Table 3 Different follow-up time lumbar lordosis angle.**

		Fusion	Non-fusion	
<6 month	Preoperative average angle	29.36±12.43	24.90±13.31	P=0.363
	Last follow-up average angle	30.04±10.74	26.04±12.25	P=0.072
		P=0.171	P=0.420	
≥6 month	Preoperative average angle	25.62±12.08	25.88±18.59	P=0.006
	Last follow-up average angle	29.68±11.05	25.78±17.95	P=0.011
		P<0.01	P=0.973	

Non-fusion group take less review of X-ray due to not using internal fixation, and there is no statistical significance between <6 months and >6 months in

fusion and fixation group ( $P=0.553$ ), the last postoperative follow up has no statistical difference ( $P=0.422$ ). There is no statistical significance between

<month and >6 month in non-fusion group (P=0.081), the last postoperative follow up has no statistical difference (P=0.163). According to the last follow-up time 6 month, we divided into two groups, fusion and fixation group follow-up time <6 months there have been 403 cases, 181 cases ≥6 months, non-fusion group follow-up time <6 months there have been 35 cases, 13 cases ≥6 months.

Follow-up time <6 month, fusion and fixation group average preoperative lumbar curvature is 29.36±12.43, 30.04±10.74 in the last follow up, preoperative and postoperative lumbar curvature changes have no statistically significant (P = 0.171); Non-fusion group average preoperative lumbar curvature is 24.90±13.31, 26.04±12.25 in the last follow up, preoperative and postoperative lumbar curvature changes have no

statistically significant(P=0.420). Between the two groups there is no statistically difference in preoperative and postoperative lumbar curvature (P=0.363, P=0.072).

Follow-up time ≥6 month, fusion and fixation group average preoperative lumbar curvature is 25.62 ± 12.08, 29.68 ± 11.05 in the last follow up, preoperative and postoperative lumbar curvature increased has significant difference(P < 0.01); Non-fusion group average preoperative lumbar curvature is 24.90±13.31, 26.04±12.25 in the last follow up, preoperative and postoperative curvature change has no statistically significant(P=0.973). Between the two groups there is statistically difference in preoperative and postoperative angle (P=0.006, P=0.011)

**3.3. Lumbar lordosis comparison of different sexes**

**Table 4 Fusion and fixation group (Male 307 cases, Female 277 cases).**

	Male	Female	
Preoperative average curvature	27.76±12.05	28.72±12.87	P=0.503
Last follow-up average curvature	28.72±10.32	31.28±11.24	P=0.185
	P=0.082	P<0.01	

Male patients in fusion and fixation group, the average preoperative lumbar curvature is 27.76±12.05, the last follow up is 28.72±10.32, the increase of curvature has no significant difference. Female patients in fusion and fixation group, the average preoperative lumbar curvature is 28.72±12.87, the last follow up is 31.28±11.24, the increase of curvature has significant difference.

The average curvature of different sex has no significant difference between preoperative and the last follow up(P=0.503, P=0.185). The curvature of all male and female patients in fusion and fixation group increased in the last follow-up compare with preoperative, compared to the trend between the two groups, there is no significant difference.

**Table 5 Non-fusion group (Male 24 cases, Female 24 cases).**

	Male	Female	
Preoperative average curvature	25.52±14.83	24.81±14.91	P=0.608
Last follow-up average curvature	26.33±14.00	25.61±13.92	P=0.455
	P=0.716	P=0.539	

Male patients in non-fusion group, the average preoperative lumbar curvature is 25.52±14.83, the last follow up is 26.33±14.00, the increase of curvature has no significant difference. Female patients in non-fusion group, the average preoperative lumbar curvature is 24.81±14.91, the last follow up is 25.61±13.92, the increase of curvature has significant difference. The average curvature of different sex has no significant difference between preoperative and the last follow up (P=0.608, P=0.455).

The curvature of all male and female patients in non-fusion group increased in the last follow-up compare with preoperative, compared to the trend between the two groups, there is significant difference

(P=0.023), the curvature increased more in male patients than the female patients.

**3.4. Compare of lumber curvature in different age groups**

Because the age of patients in non-fusion group is fewer >60yrs, to facilitate group and statistical analysis can be performed, and between <50yrs group and >50yrs group the preoperative curvature in fusion and fixation group has no significant difference (P=0.521), so does the last follow up (P=0.412). Between <50yrs group and >50yrs group the preoperative curvature in non-fusion group has no significant difference (P=0.777), and the same with the last follow up (P=0.405). Using 50yrs as a limit, we

divided into two groups, there are 269 patients <50yrs, 315 patients >50yrs in fusion and fixation group, 35

patients <50yrs, 13 patients >50yrs in non-fusion group.

**Table 5 Comparison of lumbar curvature in different age groups.**

		Fusion	Non-fusion	
<50yrs	Preoperative average curvature	27.27±12.05	23.60±14.79	P=0.064
	Last follow-up average curvature	29.04±11.04	24.52±13.28	P=0.157
		P=0.005	P=0.591	
>50yrs	Preoperative average curvature	29.02±12.74	29.36±14.22	P=0.564
	Last follow-up average curvature	30.69±10.62	29.87±15.01	P=0.022
		P=0.002	P=0.684	

In fusion and fixation group, the average preoperative curvature of patients <50yrs is 27.27±12.05, and the last follow up is 29.04±11.04, the increase of angle has significant difference (P=0.005); the average preoperative curvature of patients >50yrs is 29.02±12.74, and the last follow up is 30.69±10.62, the increase of angle has significant difference (P=0.002).

In non-fusion group, the average preoperative curvature of patients <50yrs is 23.60±14.79, and the last follow up is 24.52±13.28, the increase of angle has no significant difference (P=0.591); The average preoperative curvature of patients >50yrs is 29.36±14.22 and the last follow up is 29.87±15.01, the increase of angle has no significant difference (P=0.684).

Comparing the preoperative and last follow-up curvature between different groups, we found only in >50yrs group, the increase of last follow-up curvature in fusion and fixation group is more than the non-fusion group, has significant difference.

**3.5. Comparison between different segmental lumbar curvature**

Because the surgical segments in fusion and fixation group and non-fusion group are mainly L45 (223 cases in fusion and fixation group, 23 cases in non-fusion group) and L5S1 (151 cases in fusion and fixation group, 23 cases in non-fusion group), so we count different segments of effects on lumbar curvature.

**Table 6 Comparison between fusion and non-fusion in L45.**

	Fusion L45	Non-fusion L45
Preoperative average curvature	29.39±12.39	26.75±12.79
Last follow-up average curvature	31.66±9.99	24.83±13.54
	P=0.001	P=0.273

The average preoperative lumbar curvature of fusion and fixation group in L45 segment is 29.39±12.39, and postoperative lumbar curvature is 31.66±9.99, compare with preoperative curvature, the increase of postoperative lumbar curvature has significant

difference (P=0.001). The preoperative curvature of non-fusion group is 26.75±12.79, postoperative curvature is 24.83±13.54, compare with preoperative curvature, the decrease of postoperative lumbar curvature has no significant difference.

**Table 7 Comparison between fusion and non-fusion in L5S1.**

	Fusion L5S1	Non-fusion L5S1
Preoperative average curvature	27.99±12.20	23.65±17.03
Last follow-up average curvature	28.48±10.80	27.80±14.76
	P=0.572	P=0.037

The average preoperative lumbar curvature of fusion and fixation group in L5S1 segment is 27.99±12.20,

and postoperative lumbar curvature is 28.48±10.80, compare with preoperative curvature, the increase of

postoperative lumbar curvature has no significant difference ( $P=0.572$ ). The preoperative curvature of non-fusion group is  $23.65 \pm 17.03$ , postoperative curvature is  $27.80 \pm 14.76$ , compare with preoperative curvature, the increase of postoperative lumbar curvature has significant difference ( $P=0.037$ ).

#### 4. Discussion

With the study of sagittal balance more deeply, we realize that lumbar lordosis has a very important role in the maintenance of sagittal balance. Under normal physiological conditions, lumbar lordosis has a very wide range, but the mean can only be referenced, which mainly affected by lumbar corpus vertebra and intervertebral disc morphology [12]. Akira Hioki [13] found that the maintenance and recovery of the postoperative lumbar curvature was positively correlated with JOA score, so maintaining normal lumbar lordosis after surgery has very important significance in relieving postoperative back pain, increasing the buffering capacity of the spine, and maintaining the spine weight-bearing.

##### 4.1. The effect of different operation and follow-up time on lumbar curvature

The most of lumbar disc herniation patients can obtain a very good effect by a conservative treatment, and when lumbar disc herniation with stubborn radiculopathy or conservative treatment via the system of 6 to 12 weeks cannot alleviate; Merger lumbar spinal stenosis, seriously affecting daily life; Patients with cauda equina syndrome or acute severe paresis or the progressive increase of paralysis, a surgical treatment should be taken timely, operation mainly is minimally invasive non-fusion, considering the age and work nature of the patients, a fusion and fixation operation adapt to patients who suffer from lumbar instability, lumbar spinal stenosis, separation of lumbar vertebral epiphysis and other lumbar diseases. Djurasovic MO [14] proposed in posterior fusion operation, if there was a reduction in postoperative lumbar curvature, it will lead to the adjacent segment degeneration, and increased sagittal imbalance. Le Huec J [15] suggested lumbar fusion can reduce lumbar curvature and SS, leading to pain and pseudarthrosis caused by postoperative imbalances. Akira Hioki [13] found that lumbar curvature increased 6 months later after PLIF, and then it is not reduced in the subsequent time period. Jay Jagannathan [16] found TLIF can effectively restore lumbar curvature, and the effect of double segment TLIF is better than single segment TLIF.

Our research shows that the early postoperative lumbar curvature reduced in fusion and non-fusion group of lumbar disc herniation, but with the increase of follow-up time, the lumbar curvature will increase, it has significant difference in fusion and fixation group, the curvature of fusion and fixation group increased obviously in a follow up time more than 6

months. We believe that the decline of the early postoperative lumbar curvature may relative to soft tissue injury not recovery, and the poor muscle strength balance, in fusion and fixation group, the oppression is lifted, disc and cartilage endplate are cleaned, relied on the early stress of rod, intervertebral disc restored height as far as possible after bone grafting, while maintaining a slight wedge high to low, especially reaching bony fusion after 6 month, may cause a significant increase in postoperative follow-up lumbar curvature. And in non-fusion group, the height of lumbar interbody decreased, intervertebral space degenerated obviously, the height of disc is almost the same, even caused lumbar instability, so the lumbar curvature in the last follow-up time will not change significantly [17].

##### 4.2. Changes of postoperative lumbar curvature in different genders and ages

Several research found that the angle of lumbar lordosis has no significant difference between different genders [8,18,19], Akira Hioki [13] found that the lumbar curvature in fusion segments and in non-fusion segments has a negative correlation, that is, in order to maintain the lumbar curvature stable, the curvature of the non-fusion segments may vary with the change of curvature of the fusion segments. Jee- Soo Jang [20] also found the strength of spinal muscle, especially sacrospinal muscle played a role in the compensatory of lumbar curvature, and proposed postoperative intractable low back pain may be related to muscle fatigue failure. Leonid Kalichman [8] found that people with weak multifidus muscle may have greater lumbar lordosis. Our study shows that lumbar curvature increase significantly in female patients who take fusion and fixation operation; compare to female patients, the lumbar curvature in male patients who take non-fusion operation increase more significantly. We believe that the low back muscle strength of female patients may be weaker than male patients, lumbar curvature has a poor ability of self-regulation, after fused and fixed, the corresponding non-fusion segments have a poor ability to regulate themselves, so lumbar curvature in female patients may increased significantly, and in the non-fusion patients, because of the good ability of non-fused segments and back muscles compensatory and adjustment, it is more easier in male patients to restore the physiological lumbar curvature.

Studies have reported that lumbar curvature reduced relevantly with age. Korovessis [21] found that lumbar curvature reduced significantly in people over the age of 60 with age. lumbar lordosis angle depends on the strength of the vertebral body and the support of surrounding soft tissues, lumbar curvature tend to be stable after middle age, non-progressive reduction, may be self-protection mechanism of the lumbar, while the elderly combined spinal degenerative changes, thickened ligaments, spinal stenosis, the reduction of

lumbar lordosis may vicariously increase canal volume [22]. We found that in patients older than 50yrs, compare to non-fusion, fusion can better increase the lumbar curvature. Because the lumbar spine degenerated with age, the compensatory ability of non-fusion segments and back muscle strength decreased, fusion and fixation can obtain a better lumbar curvature. In non-fusion surgery, because the degeneration problem of diseased segment is not radical improved, the diseased segment cannot be restored to a normal height and curvature, and the compensatory capacity of lumbar decreased with age, and therefore the postoperative lumbar curvature is poorly recovered.

#### 4.3. Postoperative lumbar curvature in different surgical segments

It is reported that SS can increase to the sacrum relative vertical position after L5S1 fusion, although there are better fusion rate, it lead to sagittal imbalance, reduction of lumbar lordosis[14]. For lumbar surgery, the fusion operation is not the only way to solve the problem. The key is to relieve pressure at the same time to strike a balance by surgery. We found that lumbar curvature significantly increased after L45 segmental fusion and fixation, and lumbar curvature did not significantly increased after L5S1 segment fusion, the fusion of L5S1 lead to the change of SS angle and affect the lumbar lordosis. Leonid Kalichman [8] found that the degree of intervertebral wedge and the disc height had a negative correlation, usually the degree of L5S1 intervertebral wedge is larger, after the non-fusion surgery, because there is no distraction and grafting, disc height decreased, so the extent of the intervertebral wedge definitely increased, thereby increased the lumbar curvature. This is similar to our result, lumbar curvature can significantly increase after the non-fusion surgery of L5S1 segment.

#### 5. Conclusion

In summary, the lumbar curvature can increase by fusion and fixation, curvature increase mainly appears in the follow-up time more than 6 months. After the fusion of female patients, lumbar curvature increased significantly; The lumbar curvature of male patients, compared with female patients, increased significantly after non-fusion surgery. Patients elder than 50 yrs is recommended fusion and fixation, compared with non-fusion, it can better increase lumbar curvature. The lumbar curvature can significantly increase after L45 segmental fusion and fixation, while the non-fusion surgery can significantly increase the lumbar curvature in L5S1 segment

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