

Early Adjacent Segment Degeneration after Short Lumbar Fusion

S.V. Masevnin¹,
D.A. Ptashnikov¹,
D.A. Michaylov¹,
O.A. Smekalenkov¹,
N.S. Zaborovskii¹,
O.A. Lapaeva¹, Z. Mooraby²

Abstract

Study design: Retrospective cohort study.

Object: To assess the factors that may be important in the early adjacent segment disease (ASD) development after one level lumbar fusion.

Summary: Today in a review of the world literature there is no consensus about the main risk factors importance for this disease, as well as the terms and conditions of its occurrence. And today there are more and more questions about the reasons for the early development of ASD in the event of a short fixation.

Methods: This study evaluated 146 patients who underwent one level 360° fusion lumbar surgery for degenerative lumbar disease between 2005 and 2012. We compare 2 groups according to the presence and extent of initial degenerative changes in the adjacent upper segment. These groups were comparable in terms of main risk factors for ASD such as obesity, age, smoking, menopause, global balance disturbance. Patients in both groups had no significant differences in sex and age composition, the level of quality of life and daily physical activity. First group include 86 patients with no pre-existing or 1 to 3 stage degenerative changes by Pfirrmann modified, second group include 60 patients with initial adjacent disk degenerative changes of stage 4 and above according Pfirrmann modified classification. The average follow-up period was 42.2 months (range, 28–112 months).

Results: In the I group symptomatic ASD was found in 14 (16,3%) cases and ASD average development time was 35 (8-56) months. In the II group during the follow-up period 24 (40%) patients had ASD with average development time 21,5 (3-46) months.

Symptomatic adjacent segment pathology was significantly more frequent in the II group ($p < 0.05$). The analysis of the symptomatic ASD timing has been obtained statistically significant data on the earlier development of this disease in the second group ($p < 0.05$).

Conclusion: Patients with pre-existing degenerative changes in adjacent levels above stage 3 by Pfirrmann must be assigned to a high risk group for early ASD development even in the short lumbar fusion.

Keywords: Fusion; Adjacent segment disease; Sagittal balance

- 1 Vreden Russian Research Institute of Traumatology and Orthopedics (195427 A.Baykova str. 8, Saint-Petersburg, Russia)
- 2 Mechnikov North-West State University

Corresponding author: Sergei Masevnin

✉ drmasevnin@gmail.com

195427 A.Baykova str. 8, Saint-Petersburg, Russia

Tel: +79117531145

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For today lumbar spinal fusion has become a common procedure

for treating serious degenerative pathology of the lumbar spine like instability and spinal stenosis, but despite on successful fusion there is the risk of adverse outcomes of treatment in the long term follow-up.

It should be noted that a significant role among the negative results at the late postop period is due to adjacent-segment disease with degenerative decompensation and low back pain recurrence [1, 2].

Unfortunately, spinal fusion alters the normal biomechanics of the spine, and a loss of motion at the fixed segments is compensated for by increased motion at the unfused levels. The additional stress on the normal segments above and below the fusion can lead to degenerative changes [3-8].

Today in a review of the world literature there is no consensus about the main risk factors importance for this disease, as well as the terms and conditions of its occurrence. And the most contradictory data are found in terms the development of clinically significant manifestations of ASD [9-11].

However it is obvious that the timing of the symptomatic ASD occurrence are determined by many factors ranging from the operative technique and global balance disturbance to the level of patient activity in the postoperative period and the genetically determined predisposition to the development of degenerative diseases [6, 12, 13].

It would be logical to suppose that early development of the ASD should be associated with the wrong tactics of treatment and regarded as a complication of surgery.

And today there are more and more questions about the reasons for the early development of ASD in the event of a short fixation. So if in the case of a long fusion this problem is largely due to a significant redistribution of the load by eliminating several motion segments, the early symptomatic ASD occurrence in a short fixation is not so clear.

In our previous study, we showed some dependence the ASD frequency development in patients with short lumbar fusion of initial changes the previous presence in this segment. However, to draw final conclusions on this relationship is not entirely appropriate in view of the lack of randomized comparison groups [14].

Materials and Methods

This retrospective study evaluated 146 patients who underwent one level 360° fusion lumbar surgery for degenerative lumbar disease between 2005 and 2012. The follow-up rate was 86%. The subject population was 61% female. The average age was 58 years (range, 23–76 years), and the average follow-up period was 42.2 months (range, 28–112 months). All patients were divided into 2 groups according to the presence and extent of initial degenerative changes in the adjacent upper segment. These changes were measured by MRI, and evaluated according to the Pfirrmann modified classification (**Table 1**).

So we compared two groups: the first group included 86 patients with no pre-existing or 1 to 3 stage degenerative changes by Pfirrmann modified. Among them, 23 patients had degenerative spondylolisthesis, 17 patients had single level spinal stenosis, and 46 patients had herniated lumbar discs with segmental instability.

The second group consisted of 60 patients with initial adjacent disk degenerative changes of stage 4 and above according Pfirrmann modified classification. This group included patients with single level degenerative spondylolisthesis (18), a herniated lumbar disc

with segmental instability (28), and degenerative single level spinal stenosis (14). MRI evaluation of the adjacent segment's condition was performed during the preoperative and follow-up visits.

Futhermore for exclusion the adjacent-level instability, preoperatively all patients were performed flexion and extension lumbar radiography. Patients were followed up at 3, 6, 12, 18, and 24 months postoperatively, and, thereafter, annually.

Thus the results of comprehensive preoperative examination, we received two similar groups of major risk factors for ASD, such as obesity, age, smoking, menopause, global balance disturbance. Patients in both groups had no significant differences in sex and age composition, the level of quality of life and daily physical activity (**Table 2**). It should also be noted that patients with complications such as the pseudarthrosis and/or fixation instability, requiring revision surgery were excluded from the study. Patients with L5-S1 fusion were also excluded from the study due to the peculiarities of the biomechanics of the segment. So we got two randomized comparison groups.

Generally, patients who were included in the both groups had single-level degenerative pathology between L-2 and L-5, back and/or leg pain, an ODI score $\geq 40\%$, and ineffective conservative treatment for at least 3 months.

Statistical Analysis

Mann-Whitney *U*-test and Student's *t*-test were used for group comparisons and for comparing the timing of the ASD development in the postoperative period. P values of <0.05 were considered statistically significant.

Results

ASD includes the development of adjacent instability (22), spinal stenosis (4) and herniated disks (12). Segments of adjacent pathology included the neighboring upper level in 35 cases and the neighboring lower level in 3 cases. The average interval between the fusion and ASD development was 28,3 months (range 3–56 months). 26 cases received subsequent surgery for adjacent instability and spinal stenosis.

Symptomatic adjacent segment pathology was significantly more frequent in the second group ($p < 0.05$).

The analysis of the symptomatic ASD timing has been obtained statistically significant data on the earlier development of this disease in the second group ($p < 0.05$).

Regarding the development of the adjacent pathology in the first year after surgery a statistically significant difference between the groups was not available due to the small size of them. However it shows a definite tendency in the early ASD development in a presence of initial degenerative changes in the conditions of the above third stage by Pfirrmann (**Table 3**).

Also there were no significant differences in other risk factors between the groups with ASD (**Table 4**).

Discussion

Today adjacent segment disease has been known as an important type of failed back surgery syndrome [15].

Table 1 Modified Pfirrmann Grading System of Lumbar Disc Degeneration.

Grade	Signal From Nucleus and Inner Fibers of Annulus	Distinction Between Inner and Outer Fibers of Annulus at Posterior Aspect of Disc	Height of Disc
1	Uniformly hyperintense (equal to CSF)	Distinct	Normal
2	Hyperintense (>presacral fat and <CSF)	Distinct	Normal
3	Hyperintense (<presacral fat)	Distinct	Normal
4	Mildly hyperintense (slightly >outer fibers of annulus)	Indistinct	Normal
5	Hypointense (= outer fibers of annulus)	Indistinct	Normal
6	Hypointense	Indistinct	<30% reduction of disc height
7	Hypointense	Indistinct	30% to 60% reduction of disc height
8	Hypointense	Indistinct	>60% reduction of disc height

Table 2 Characteristics of Patients Before Operation.

	No. (%)		P Value
	1 group (n=86)	2 group (n=60)	
Sex (m:f)	34 : 52	23 : 37	> 0.05
Age (y)	57,2 ± 7,2	59,1 ± 6,9	> 0.05
FUSION LEVEL			
L2-L3	16 (18,6)	10 (16,7)	> 0.05
L3-L4	25 (29,1)	18 (30)	> 0.05
L4-L5	45 (52,3)	32 (53,3)	> 0.05
Degenerative spondylolisthesis	23 (26,7)	18 (30)	> 0.05
Spinal stenosis	17 (19,8)	14 (23,3)	> 0.05
Herniated disc	46 (53,5)	28 (46,7)	> 0.05
ODI	44,2 ± 6,4	42,1 ± 5,7	> 0.05
VAS	6,3 ± 1,2	6,1 ± 1,4	> 0.05
BMI (kg/m ²)	26,2 ± 4,8	27,9 ± 4,2	> 0.05
Smoking	37 (43)	23 (38,3)	> 0.05
Sagittal disbalance			
Positive	16 (18,6)	10 (16,7)	> 0.05
Very Positive	8 (9,3)	4 (6,6)	> 0.05
Follow-up (mo)	41,1 (28 – 106)	43,3 (32 – 112)	> 0.05

Table 3 ASD development results.

	No. (%)		P Value
	1 group (n=86)	2 group (n=60)	
Follow-up (mo)	41,1 (28 – 106)	43,3 (32 – 112)	> 0.05
symptomatic ASD	14 (16,3)	24 (40)	< 0.05
ASD average development time (mo)	35 (8-56)	21,5 (3-46)	< 0.05
1st year ASD development	2 (2,3)	8 (13,3)	>0.05

According to several authors, risk factors such as female gender, age over 60 years, menopause, obesity and smoking are significant in the development of symptomatic ASD [12, 13, 16]. However, the results of our study this dependence has not been confirmed.

However in the world literature there is obviously not enough attention to the problem of early ASD in a short fusion, although its development in these conditions should be regarded as a complication of surgery.

Schlegel et al., showed that in the spine surgery in which instrumentation was not used, the average time to symptomatic next segment failure was more than 13 years [6].

S. Etebar et al., reported results from the 4-year follow-up of a retrospective clinical study, noting that after fusion with instrumentation is performed in the lumbar spine, the average time to symptomatic next segment failure was 26,8 months (3-84 months). Patients who underwent long fusion had a significantly higher risk of ASD development. It should also be noted that patients with extensive lumbar fixation had earlier clinically significant symptoms of ASD compared with a short fixation cases [12].

Later, these results were confirmed on the basis of many studies [17-19]. However, analyzing the studies in recent years on this problem cannot be ignored cases of early development of ASD in patients with a short fusion [12].

Table 4 Risk factors significance in the ASD development.

	No. (%)		P Value
	1 group ASD (n=14)	2 group ASD (n=24)	
Sex (m:f)	4 : 10	6 : 18	> 0.05
Age (y)	56,3 special issue 4,2	58,2 special issue 3,9	> 0.05
BMI (kg/m ²)	27,1 special issue 3,8	26,8 special issue 3,2	> 0.05
Smoking	4 (28,6)	6 (25)	> 0.05
ODI	43,1 special issue 5,4	42, special issue 4,6	> 0.05
Sagittal disbalance			
Positive	3 (21,4)	3 (16,7)	> 0.05
Very Positive	2 (9,3)	1 (6,6)	> 0.05

In our study we attempted to continue our previous study within the research of the pathological changes in the conditions of short fixation and especially in cases of its early decompensation.

According to our data none of the studied risk factors except the previous degenerative changes had any statistically significant influence on the development of symptomatic ASD in cases of short fusion. Concerning the early development of the symptomatic ASD in the short fusion the statistically significant effect had only initial degenerative changes above the stage 3 by Phirrmann.

In our view critical belongs to decompensation rather significant changes in the conditions of increased load in the adjacent segment after fusion.

Conclusion

Our research hadn't identified significant correlation between risk factors (age, sex, smoking, sagittal disbalance, BMI, etc.) and a high incidence of ASD development.

As a result of only pre-existing degenerative changes in adjacent levels above stage 3 by Pfirrmann must be assigned to a high risk group for early ASD development even in the short lumbar fusion.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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