

IJMA



INTERNATIONAL JOURNAL OF MEDICAL ARTS

Volume 7, Issue 10 (October 2025)



<http://ijma.journals.ekb.eg/>

P-ISSN: 2636-4174

E-ISSN: 2682-3780



Available online on Journal Website
<https://ijma.journals.ekb.eg/>
 Main Subject [¹Orthopedic Surgery]



Original Article

Adjacent Segment Disease after Lumbar Spine Fixation [A Systematic Review]

Muhammed A. Negm¹; Lotfy M. Shwitter¹; Ahmed R. Hamouda^{*2}

¹ Department of Orthopedic Surgery, Faculty of Medicine, Al-Azhar University, Cairo, Egypt.

² Department of Orthopedic Surgery, Faculty of Medicine, Mansoura University, Mansoura, Egypt.

Abstract

Article information

Received: 02-01-2023

Accepted: 18-04-2025

DOI: [10.21608/ijma.2023.240377.1826](https://doi.org/10.21608/ijma.2023.240377.1826).

*Corresponding author

Email: hazem.1.6.1993.aboelsoud@gmail.com

Citation: Negm MA, Shwitter LM, Hamouda AR. Adjacent Segment Disease after Lumbar Spine Fixation [A Systematic Review]. IJMA 2025 October; 7[10]: 6217-6222. doi: [10.21608/ijma.2023.240377.1826](https://doi.org/10.21608/ijma.2023.240377.1826).

Background: Disc degeneration is a common form of adjacent segment disease [ASD] that occurs less frequently than laxity, instability, stenosis, nucleus pulposus herniation, hypertrophic facet arthritis, and vertebral compression fractures.

The aim of the work: A systematic review for the determination of the prevalence of disease in adjacent segments after lumbar spine fixation.

Patients and Methods: In this systematic review, conducted during the period from January 2021 to January 2022 was searched up to 2022: 57 papers were included and 28 of these were excluded and only 19 papers were met our inclusion criteria.

Results: lumbar lordosis [degree] showed in 8 studies with highly significant differences [95% CI, -5.49[-7.58, -3.39]; [p value <0.0001]. Lumbopelvic mismatch [degree] reported in 2 studies with highly significant differences [95% CI, 4.55 [0.99, 8.16]; [p value <0.01]. Pelvic tilt incidence [degree] recorded in 4 studies with highly significant differences [95% CI, 3.59 [0.57, 6.69]; [p value <0.01]. Pelvic tilt [degree] reported in 5 studies and showed highly significant differences [95% CI, 3.19 [1.65, 4.69]; [p value <0.01] between ASD group and non-ASD group.

Conclusion: In this systematic review associated with a significant increase in detailed information on the prevalence of radiological and symptomatic ASD.

Keywords: ASD; Disc degeneration; symptomatic; lumbar spine fixation.



This is an open-access article registered under the Creative Commons, ShareAlike 4.0 International license [CC BY-SA 4.0] [<https://creativecommons.org/licenses/by-sa/4.0/legalcode>].

INTRODUCTION

Although efforts to preserve segmental motion in spine surgery are increasing, spinal fusion remains a standard surgical treatment for deformities, trauma, and degenerative diseases. Clinical and fusion success rates have increased due to improvements in bone graft material and instrumentation. On the contrary, several complications and problems associated with fusion surgery have been reported, with adjacent segment disease [ASD] being one of the most common [1]. Adjacent segment degeneration and adjacent segment disease are frequently diagnosed diseases after spinal fusion surgery, each with and without clinical symptoms. Although up to 43% of patients can develop postoperative ASD, the prevalence of ASD is much higher [~84%][2]. Mechano-biological role of altered biomechanics after fusion surgery was emphasized. These include postoperative changes in the range of motion of adjacent segments, changes in their anatomy, and intraoperative iatrogenic damage to the paraspinal muscles, which alters the overall alignment and loading of the spine and can cause/accelerate segmental dysfunction [TSA][3]. Fusion length [particularly three or more planes], preoperative sagittal deviation, facet damage/tropism, advanced age, increased body mass index [BMI], and preoperative documentation of degenerative head disease.[4]

Although instrumented fusions increased the fusion rate, this was not necessarily associated with better outcomes. In addition, dynamic stabilization techniques failed to protect patients from ASD.[5]

Jin C et al. [6] 164 months postoperatively, ASD occurred in 18.5% of instrumented patients, compared to significantly less than 5.6% in non-instrumented posterior fusions.

Therefore, in this systematic review, we aimed to assess the prevalence of adjacent segment disease after lumbar spine fixation.

PATIENTS AND METHODS

Search strategy: In this systematic review, led during the period from January 2021 to January 2022 was looked up to 2022: 57 papers were incorporated and 28 of these were rejected and just 19 papers were met our consideration models. Research technique data set utilized included PubMed, Google Researcher web crawler, EMBASE and Science Direct, Wiley Online Library, MESH and Huge Clinical Information base for explicit watchwords and terms: " Adjacent segment disease, Fixation, Lumbar and Spine". The review convention was gotten moral endorsement from the Exploration Morals Advisory group of the Staff of Medication, Al -Azhar College, Cairo

Study selection: Essential examinations, paying little mind to concentrate on plan, were qualified for consideration assuming they included patients who went through lumbar combination, assurance of hazard factors for ASD, and factual investigation of chance elements for ASD. Prominently, in light of the fact that the presence of preoperative degeneration of neighboring circles as well as features would influence the postoperative state of contiguous plates, just examinations that evaluated these variables were incorporated. Cadaveric examinations, case reports, editorials, audits, gathering procedures, concentrate on conventions, or non-English articles were prohibited. Also, ASD was operationally defined as the indicative degeneration of portions neighboring the worked vertebral levels regardless of reactivity and analyzed by both radio-graphic signs and clinical side effects.

Data extraction and Quality Assessment: Data connected with the members, record a medical procedure, ASD, and risk factors for ASD

was removed. Study-announced gauges connected with the relationship between different risk factors and ASD, or the MD of boundaries between patients with and without ASD, were extricated. Because all of the identified studies had either a review companion or a case-control plan, the gamble of inclination was surveyed by the particular Newcastle-Ottawa Scale [NOS] for partner and case-control studies, which are approved instruments for these review plans.

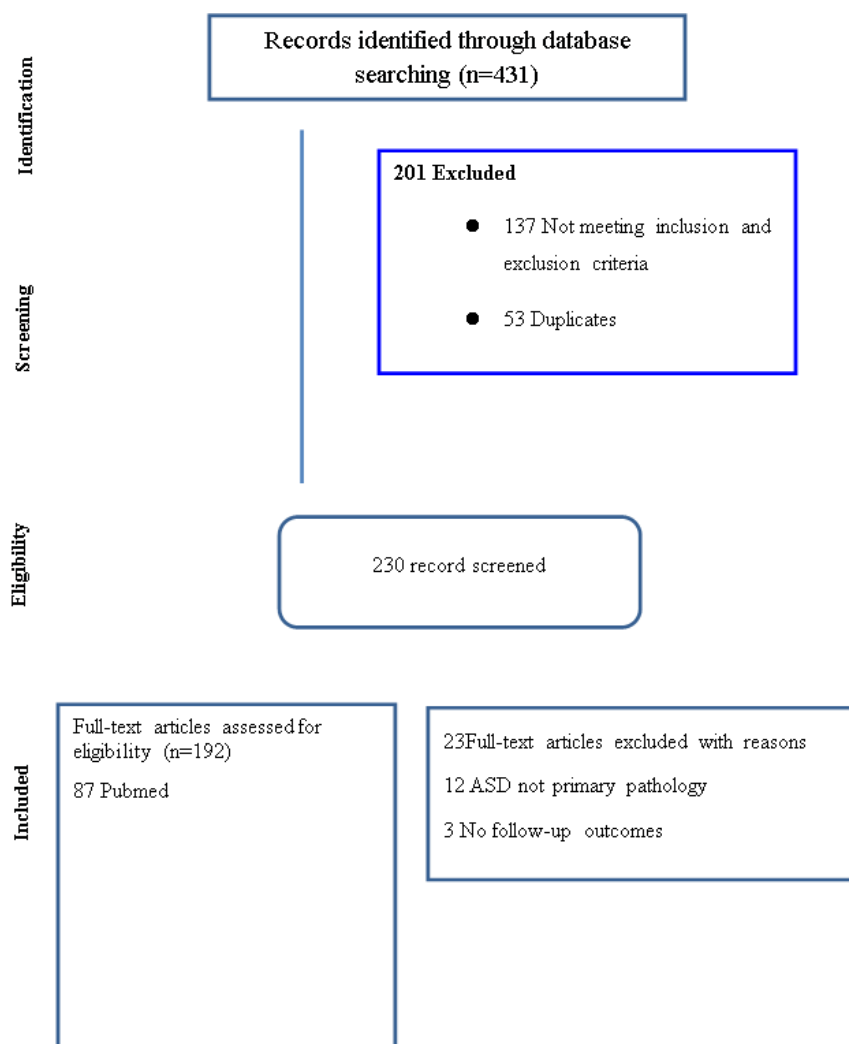
Strength of Evidence: Each hazard factor was assessed subjectively based on the consistency of measurable findings for a given gamble factor and the systemic nature of the important included studies. The strength of proof of each chance element was sorted areas of strength for as, restricted, extremely restricted, conflicting, or no evidence

Statistical Analysis: The related 95% meeting stretches [CIs] were accounted for. Risk factors for ASD were contrasted among patients and without ASD. Arbitrary impacts models were utilized to investigate all pooled risk factors. The homogeneity among studies was assessed by measurement. Significance was set at $p < 0.05$.

RESULTS

Characteristics of the included studies were analyzed in [Table 1]. In preoperative, body mass index there were 3 studies compared patients with ASD and without ASD observed that there were highly significant differences [95% CI, 2.66 [1.67, 3.84]]; Test for overall effect: $z = 4.97$ [p value < 0.0001] [Table 2]. Facet joint violation there were 2 studies compared patients with ASD and without ASD observed that there were highly significant differences [95% CI, 31.29 [16.61, 51.10]]; Test for overall effect: $z = 12.34$ [p value < 0.0001] [Table 3]. lumbo-sacral sagittal plumb line distance [mm] there were 4 studies compared patients with ASD and without ASD observed that there were highly significant differences [5 studies; 95% CI, 7.10 [4.69, 9.06]]; Test for overall effect: $z = 6.17$ [p value < 0.0001] [Table 4]. Lumbar lordosis[degree] there were 8 studies compared patients with ASD and without ASD observed that there were highly significant differences [95% CI, -5.51[-7.95, -3.49]]; Test for overall effect: $z = 6.17$ [p value < 0.0001] [Table 5]. adjacent disc degeneration [pfirman Grade ≥ 3] there was 8 studies compared patients with ASD and without ASD observed that there were highly significant differences [95% CI, 1.81 [1.91, 3.60]]; Test for overall effect: $z = 2.96$ [p value < 0.0002] [Table 6]. Adjacent disc height [mm] there were 4 studies compared patients with ASD and without ASD observed that there were highly significant differences [95% CI, -0.68 [-1.25, 0.10]]; Test for overall effect: $z = 2.34$ [p value < 0.0002] [Table 7]. lumbo-sacral sagittal plumb line distance [mm] there were 8 studies compared patients with ASD and without ASD observed that there were highly significant differences [95% CI, 3.89 [2.64, 5.94]]; Test for overall effect: $z = 5.12$ [p value < 0.0001] [Table 8].

In postoperative lumbar lordosis [degree], there were 8 studies compared patients with ASD and without ASD observed that there were highly significant differences [95% CI, -5.49[-7.58, -3.39]]; Test for overall effect: $z = 5.17$ [p value < 0.0001] [Table 9]. Lumbopelvic mismatch [degree] there were 2 studies compared patients with ASD and without ASD observed that there were highly significant differences [95% CI, 4.55 [0.99, 8.16]]; Test for overall effect: $z = 2.47$ [p value < 0.01] [Table 10]. Pelvic tilt incidence [degree] there were 4 studies compared patients with ASD and without ASD observed that there were highly significant differences [95% CI, 3.59 [0.57, 6.69]]; Test for overall effect: $z = 2.47$ [p value < 0.01] [Table 11]. Pelvic tilt [degree] there were 5 studies compared patients with ASD and without ASD observed that there were highly significant differences [95% CI, 3.19 [1.65, 4.69]]; Test for overall effect: $z = 2.47$ [p value < 0.01] [Table 12].



TDR, total disc replacement; ASD, adjacent spinal disease; PRISMA

Figure [1]: Flow diagram of search strategy results conducted per PRISMA guidelines

Table [1] - Characteristics of the included studies

Author	Year	Country	No. Of participants ASD	Total	Follow up time [years]	Study type
Lin ^[7]	2017	Japan	20	100	5	Retrospective
Mi ^[8]	2014	Japan	32	200	4	Retrospective
Wang ^[9]	2017	Japan	15	90	6	Retrospective
Liang ^[10]	2014	Japan	20	100	7	Retrospective
Makino ^[11]	2018	Japan	30	90	3	Retrospective
Heo ^[12]	2015	Japan	10	50	4	Retrospective
Zhong ^[13]	2017	Korea	30	90	5	Retrospective
Ma ^[14]	2019	Japan	10	150	5	Retrospective
Ushio ^[15]	2019	Japan	15	150	6	Retrospective
Bagheri ^[16]	2019	Hind	18	60	7	Retrospective
Bae ^[17]	2018	Japan	20	100	8	Retrospective
Cho ^[18]	2019	Japan	32	200	4	Retrospective
Soh ^[19]	2020	Japan	15	90	3	Retrospective
Anandjwala ^[20]	2021	Japan	20	100	2	Retrospective
Chen ^[21]	2021	Japan	20	200	3	Retrospective
Weishi ^[22]	2018	Japan	20	100	4	Retrospective
Guo ^[23]	2020	Japan	32	200	5	Retrospective
Park ^[24]	2014	Canada	15	90	6	Retrospective
Lawrence ^[25]	2018	Canada	20	100	5	Retrospective

Table [2] - Body Mass Index [Kg/m²]

Study	ASD Mean±SD	Non-ASD Mean±SD	Weight	IV, Random, 95% CI	Year
Lin ^[7] 2017	23.25±2.52	25.68±2.36	26.6%	1.46 [-0.11, 2.32]	2017
Wang ^[9] 2017	26.6 ± 2.1	23.2±2.1	38.5%	2.61 [2.65, 3.63]	2017
Makino ^[11] 2018	26.8±2.4	24.2±2.2	34.9%	2.60 [1.59, 3.81]	2018
Total [95% CI]			100%	2.66 [1.67, 3.84]	

Table [3] - Preoperative facet joint violation

Study	ASD event	Non-ASD event	Weight	IV, Random, 95% CI	Year
Lin ^[7] 2017	54	42	84.5%	33.66 [17.07, 58.31]	2017
Makino ^[11] 2018	13	37	15.5%	21.76 [4.44, 75.84]	2018
Total [95% CI]			100%	31.29 [16.61, 51.10]	

Table [4] - Preoperative lumbo-sacral sagittal plumb line distance [mm]

Study	ASD Mean±SD	Non-ASD Mean±SD	Weight	IV, Random, 95% CI	Year
Zhong ^[13]	21.14±8.2	15.34±8.1	87.5%	6.70 [4.55, 8.89]	2017
Ma ^[14]	28.9 ± 28.8	21.4±23.7	4.5%	7.50 [-3.43, 17.45]	2019
Ushio ^[15]	43.8±75.2	22.1±83.4	0.5%	22.69 [-12.40, 54.79]	2019
Bagheri ^[16]	23.7±17.4	14.3±16	7.5%	8.50 [1.05, 17.71]	2019
Total [95% CI]			100%	7.10 [4.69, 9.06]	

Table [5] - Preoperative lumbar lordosis [degrees]

	ASD Mean±SD	Non-ASD Mean±SD	Weight	IV, Random, 95% CI	Year
Bae ^[17]	31.34±10.2	39.70±3.2	23.5%	6.70 [4.55, -8.89]	2018
Cho ^[18]	39.9±11.8	44.9±9.10	11.5%	-7.50 [-8.65, 5.08]	2019
Soh ^[19]	40.05±12.9	47.2±8.78	7.5%	-4.60 [-10.57, -0.67]	2021
Anandjwala ^[20]	55.9±13.5	52.9±9.8	10.5%	-8.80 [-14.08, 3.51]	2021
Chen ^[21]	49.1±11.60	45.9±4.8	9.5%	-6.90 [-12.3, -0.88]	2021
Weishi ^[22]	39.76±12.60	38.7±10.9	11.5%	-5.91 [-10.40, -1.32]	2018
Guo ^[23]	32.9±10.2	39.9±10.1	12.5%	-6.49 [-12.01, -1.93]	2020
Park ^[24]	45.9±11.9	36.5±11	13.5%	12.50 [-1.54, 23.54]	2014
Total [95% CI]			100%	-5.51 [-7.95, -3.49]	

Table [6] - Preoperative adjacent disc degeneration [pfirman Grade ≥3]

	ASD Event	Non-ASD Event	Weight%	IV, Random, 95% CI	Year
Bae ^[17]	18	21	13.5%	0.68 [0.53, 2.10]	2018
Cho ^[18]	46	137	16.5%	2.75 [2.71, 5.86]	2019
Soh ^[19]	9	64	10.5%	0.75[0.42, 2.82]	2020
Anandjwala ^[20]	15	77	9.5%	2.10 [0.39, 4.53]	2021
Chen ^[21]	20	115	13.5%	3.03 [1.34, 8.02]	2021
Weishi ^[22]	26	188	12.5%	0.80 [0.83, 7.20]	2018
Guo ^[23]	22	20	11.5%	0.70 [0.37, 2.21]	2020
Park ^[24]	15	15	12.5%	2.33 [1.92, 8.95]	2014
Total [95% CI]			100%	1.81 [1.91, 3.60]	

Table [7] - Preoperative adjacent disc height [mm]

Study	ASD Mean±SD	Non-ASD Mean±SD	Weight	IV, Random, 95% CI	Year
Zhong ^[13]	7.4±2.3	7.3±2.1	22.5%	-019 [-133, 0.93]	2017
Ma ^[14]	7.9±1.6	8.4±1.7	37.5%	-0.49 [-134, 0.31]	2019
Ushio ^[15]	8.7±2.4	10.3±2.1	23.5%	-1.59 [-2.96, -0.49]	2019
Bagheri ^[16]	9.4±1.9	9.9±1.7	16.5%	-0.48 [-1.86, 0.86]	2019
Total [95% CI]			100%	-0.68 [-1.25, 0.10]	

Table [8] - Postoperative lumbo-sacral sagittal plumb line distance [mm]

Study	ASD Mean±SD	Non-ASD Mean±SD	Weight	IV, Random, 95% CI	Year
Zhong ^[13]	17.23±6.7	14.40±3.9	92%	3.80 [2.22, 5.74]	2017
Ma ^[14]	28.9 ± 28.8	21.1±24.5	2%	7.50 [-3.33, 18.45]	2019
Ushio ^[15]	38.5±67.1	22.5±60.9	2%	15.08 [-11.29, 34.25]	2019
Bagheri ^[16]	16.5±17.1	13.5±13	4%	3.01 [-4.45, 10.47]	2019
Total [95% CI]			100%	3.89 [2.64, 5.94]	

Table [9] - Postoperative lumbar lordosis [degrees]

	ASD Mean±SD	Non-ASD Mean±SD	Weight	IV, Random, 95% CI	Year
Bae ^[17]	31.34±10.1	39.70±3.2	23.5%	-7.73 [-9.56, -5.90]	2018
Cho ^[18]	39.9±11.8	44.9±9.10	11.5%	-4.49 [-9.75, 0.75]	2019
Soh ^[19]	40.05±12.9	47.2±8.78	7.5%	-8.79[-15.90, -2.15]	2020
Anandjiwala ^[20]	55.9±13.5	52.9±9.8	10.5%	-6.51 [-11.13, -0.10]	2021
Chen ^[21]	49.1±11.60	45.9±4.8	9.5%	-0.39 [-6.65, -5.57]	2021
Weishi ^[22]	39.76±12.60	38.7±10.9	11.5%	-5.69 [-10.86, -0.27]	2018
Guo ^[23]	32.9±10.2	39.9±10.1	12.5%	-6.49 [-11.16, -1.38]	2020
Park ^[24]	45.9±11.9	36.5±11	13.5%	11.49 [-1.44, 23.54]	2014
Total [95% CI]			100%	-5.49[-7.58, -3.39]	

Table [10] - Postoperative lumbopelvic mismatch [degrees]

Study	ASD event	Non-ASD event	Weight	IV, Random, 95% CI	Year
Lin ^[7] 2017	8.89±9.69	5.49±13.39	51.5%	3.39 [-1.61, 8.41]	2017
Makino ^[11] 2018	13.20±13.39	7.29±9.29	49.5%	5.79 [0.59, 10.89]	2018
Total [95% CI]			100%	4.55 [0.99, 8.16]	

Table [11] - Postoperative pelvic incidence [degrees]

Study	ASD event	Non-ASD event	Weight	IV, Random, 95% CI	Year
Lin ^[7] 2017	58.9±8.3	57.9±9.6	28.5%	2.9 [-2.03, 6.23]	2017
Makino ^[11] 2018	54.9±9.60	53.61±10.9	26.5%	1.42 [-3.25, 6.12]	2018
Ushio ^[15]	65.5±12.1	62.3±14.9	25%	3.10 [-2.99, 9.35]	2019
Bagheri ^[16]	59.4±9.9	51.5±10.3	20%	7.70 [3.39, 12.19]	2019
Total [95% CI]			100%	3.59 [0.57, 6.69]	

Table [12] - Postoperative pelvic tilt [degrees]

Study	ASD event	Non-ASD event	Weight	IV, Random, 95% CI	Year
Lin ^[7] 2017	22.2±8.6	21.2±7.6	17%	0.99 [-2.67, 4.67]	2017
Makino ^[11] 2018	26.5±5.9	22.5±7.7	25%	3.79 [0.75, 6.83]	2018
Ushio ^[15]	25.7±7.45	22.9±8.9	23%	4.19 [0.15, 8.25]	2019
Park ^[24]	24.9±6.9	22.9±8.1	15%	2.69 [-0.95, 6.35]	2014
Bagheri ^[16]	22.3±6.9	17.9±5.9	20%	3.79 [0.90, 6.65]	2019
Total [95% CI]			100%	3.19 [1.65, 4.69]	

DISCUSSION

Consistent with some clinical findings, radiographic ASD can progress to symptomatic ASD, and symptomatic ASD can result in severe pain, dysfunction, or the need for additional surgery^[15]. In this systematic review, conducted during the period from January 2021 to January 2022 was searched up to 2022: 57 papers were included and 28 of these were excluded and only 19 papers met our inclusion criteria. Weishi *et al.*^[16] revealed that the radiological meaning of ASD fluctuated from one review to another, however the definition proposed Guo *et al.*^[17] arranged ASD into 4 phases relying upon X-ray.

A common surgical procedure used to treat degenerative spinal diseases is posterior lumbar fusion. According to previous research by Park *et al.*^[18] the incidence of ASD following posterior lumbar fusion surgery was 18.6% [ranging from 8.5 to 69.4%] in this study. ASD continues to be a concern for spine surgeons. The pooled results from this systematic review proposed that orientation of patients, history of diabetes, BMD, preoperative ODI and JOA, the sort of combination [PLIF versus TLIF], kind of bone join [auto-versus allograft], combination to S1 [versus non-combination to S1], analyze [lumbar circle herniation, lumbar spinal stenosis, lumbar spondylolisthesis], preoperative PT, LL and SS, post-employable SS, PT, and PI were not were related with a critical expansion in the occurrence of ASD. However, a significant increase in the incidence of ASD was linked to older age, BMI, a history of smoking and hypertension, preoperative adjacent disc degeneration, long-segment fusion, superior facet violation, high lumbosacral joint angle, pre- and post-operative L1-S1 SVA, post-operative LL, and preoperative PI. A significant correlation was found between the prevalence of ASD and long fusion with more

than three levels. Soh *et al.*^[19] and Anandjiwala *et al.*^[20] found that compared to single-level fusion, multilevel fusion was three times more likely to have ASD. The diminished versatility and expanded firmness of the lumbar section brought about by the long combination makes it challenging to recognize biomechanical changes in the contiguous movement fragment, including pressure fixation and intradiscal pressure that favor degeneration in the nearby portion. Chen *et al.*^[21] showed that sagittal arrangement boundaries were not related to the improvement of ASD. Despite the fact that, Lawrence *et al.*^[36] patients with postoperative ASD have a measurably higher probability to develop ASD, Guo *et al.*^[37] in line with our findings demonstrated a strong correlation between ASD development and partial sagittal parameters. Moreover, past concentrate by Weishi *et al.*^[22] showed that patients with typical C7 opposite arrangement had a lower occurrence of nearby plane removals after lumbar spine combination, and one more past concentrate by Guo *et al.*^[23] found that patients with ordinary C7 Opposite arrangement to postoperative sagittal arrangement of the lumbar spine had a lower occurrence of ASD. In addition, park *et al.*^[24] and Lawrence *et al.*^[25] concentrated on patients with cervical radiculopathy after ACDF or back foraminotomy without combination. 39% of patients developed a post-fusion ASD after a median follow-up of four years, while fifty percent of patients who underwent a posterior foraminotomy also developed an adjacent and operated ASD.

Conclusion: Significant increase in detailed information on the prevalence of radiological and symptomatic ASD.

Financial and non-financial activities and relationships of interest: None

REFERENCES

- Mummaneni PV, Dhall SS, Eck JC, Groff MW, Ghogawala Z, Watters WC 3rd, et al. Guideline update for the performance of fusion procedures for degenerative disease of the lumbar spine. Part 11: interbody techniques for lumbar fusion. *J Neurosurg Spine*. 2014 Jul;21[1]:67-74. doi: 10.3171/2014.4.SPINE14276.
- Hashimoto K, Aizawa T, Kanno H, Itoi E. Adjacent segment degeneration after fusion spinal surgery-a systematic review. *Int Orthop*. 2019 Apr;43[4]:987-993. doi: 10.1007/s00264-018-4241-z.
- Ebrahimkhani M, Arjmand N, Shirazi-Adl A. Biomechanical effects of lumbar fusion surgery on adjacent segments using musculoskeletal models of the intact, degenerated and fused spine. *Sci Rep*. 2021 Sep 9;11[1]:17892. doi: 10.1038/s41598-021-97288-2.
- Epstein NE. Adjacent level disease following lumbar spine surgery: A review. *Surg Neurol Int*. 2015 Nov 25;6[Suppl 24]:S591-9. doi: 10.4103/2152-7806.170432.
- Maserati MB, Tormenti MJ, Panczykowski DM, Bonfield CM, Gerszten PC. The use of a hybrid dynamic stabilization and fusion system in the lumbar spine: preliminary experience. *Neurosurg Focus*. 2010 Jun;28[6]:E2. doi: 10.3171/2010.3.FOCUS1055.
- Jin C, Xie M, He L, Xu W, Han W, Liang W, Qian Y. Oblique lumbar interbody fusion for adjacent segment disease after posterior lumbar fusion: a case-controlled study. *J Orthop Surg Res*. 2019 Jul 16;14[1]:216. doi: 10.1186/s13018-019-1276-9. PMID: 31311556; PMCID: PMC6636144.
- Lin H, Zhaopeng C, Keng C, et al. Retrospective analysis of preoperative risk factors of adjacent segment degeneration after posterior lumbar interbody fusion. *J Clin Orthop Res*. 2017;2[1]:1-5. Quoted from: Wang T, Ding W. Risk factors for adjacent segment degeneration after posterior lumbar fusion surgery in treatment for degenerative lumbar disorders: a meta-analysis. *J Orthop Surg Res* 15, 582 [2020]. <https://doi.org/10.1186/s13018-020-02032-7>
- Mi H, Yu M, Xiaoguang L. Correlative factors for adjacent segment degeneration after lumbar spinal fusion. *Chin J Spine Spinal Cord*. 2014;24[3]:199-203.
- Wang H, Ma L, Yang D, Wang T, Liu S, Yang S, Ding W. Incidence and risk factors of adjacent segment disease following posterior decompression and instrumented fusion for degenerative lumbar disorders. *Medicine [Baltimore]*. 2017 Feb; 96 [5]: e6032. doi: 10.1097/MD.0000000000006032.
- Liang J, Dong Y, Zhao H. Risk factors for predicting symptomatic adjacent segment degeneration requiring surgery in patients after posterior lumbar fusion. *J Orthop Surg Res*. 2014 Oct 12;9:97. doi: 10.1186/s13018-014-0097-0.
- Makino T, Honda H, Fujiwara H, Yoshikawa H, Yonenobu K, Kaito T. Low incidence of adjacent segment disease after posterior lumbar interbody fusion with minimum disc distraction: A preliminary report. *Medicine [Baltimore]*. 2018 Jan; 97 [2]: e9631. doi: 10.1097/MD.0000000000009631.
- Heo Y, Park JH, Seong HY, Lee YS, Jeon SR, Rhim SC, Roh SW. Symptomatic adjacent segment degeneration at the L3-4 level after fusion surgery at the L4-5 level: evaluation of the risk factors and 10-year incidence. *Eur Spine J*. 2015 Nov;24[11]:2474-80. doi: 10.1007/s00586-015-4188-3.
- Zhong ZM, Deviren V, Tay B, Burch S, Berven SH. Adjacent segment disease after instrumented fusion for adult lumbar spondylolisthesis: Incidence and risk factors. *Clin Neurol Neurosurg*. 2017 May;156:29-34. doi: 10.1016/j.clineuro.2017.02.020.
- Ma Z, Huang S, Sun J, Li F, Sun J, Pi G. Risk factors for upper adjacent segment degeneration after multi-level posterior lumbar spinal fusion surgery. *J Orthop Surg Res*. 2019 Mar 28;14[1]:89. doi: 10.1186/s13018-019-1126-9.
- Ushio S, Hirai T, Yoshii T, Inose H, Yuasa M, Kawabata S, Okawa A. Preoperative Risk Factors for Adjacent Segment Degeneration after Two-Level Floating Posterior Fusion at L3-L5. *Spine Surg Relat Res*. 2019 Apr 26;4[1]:43-49. doi: 10.22603/ssrr.2019-0003.
- Bagheri SR, Alimohammadi E, Zamani Froushani A, Abdi A. Adjacent segment disease after posterior lumbar instrumentation surgery for degenerative disease: Incidence and risk factors. *J Orthop Surg [Hong Kong]*. 2019 May-Aug;27[2]:2309499019842378. doi: 10.1177/2309499019842378.
- Bae JS, Lee SH, Kim JS, Jung B, Choi G. Adjacent segment degeneration after lumbar interbody fusion with percutaneous pedicle screw fixation for adult low-grade isthmic spondylolisthesis: minimum 3 years of follow-up. *Neurosurgery*. 2010 Dec;67[6]:1600-7; discussion 1607-8. doi: 10.1227/NEU.0b013e3181f91697.
- Cho KS, Kang SG, Yoo DS, Huh PW, Kim DS, Lee SB. Risk factors and surgical treatment for symptomatic adjacent segment degeneration after lumbar spine fusion. *J Korean Neurosurg Soc*. 2009 Nov;46[5]:425-30. doi: 10.3340/jkns.2009.46.5.425.
- Soh J, Lee JC, Shin BJ. Analysis of risk factors for adjacent segment degeneration occurring more than 5 years after fusion with pedicle screw fixation for degenerative lumbar spine. *Asian Spine J*. 2013 Dec;7[4]:273-81. doi: 10.4184/asj.2013.7.4.273. Epub 2013 Nov 28. PMID: 24353843; PMCID: PMC3863652.
- Anandjiwala J, Seo JY, Ha KY, Oh IS, Shin DC. Adjacent segment degeneration after instrumented posterolateral lumbar fusion: a prospective cohort study with a minimum five-year follow-up. *Eur Spine J*. 2011 Nov;20[11]:1951-60. doi: 10.1007/s00586-011-1917-0.
- Chen BL, Wei FX, Ueyama K, Xie DH, Sannohe A, Liu SY. Adjacent segment degeneration after single-segment PLIF: the risk factor for degeneration and its impact on clinical outcomes. *Eur Spine J*. 2011 Nov;20[11]:1946-50. doi: 10.1007/s00586-011-1888-1.
- Weishi L, Zhouran S, Guo Y, et al. Effect of spinopelvic sagittal alignment on the development of adjacent segment degeneration after posterior lumbar fusion: investigation on cases with a minimum of 6 years of follow up. *Chin J Spine Spinal Cord*. 2018;28[10]:865-72.
- Guo Y, Zhouran S, Siyu Z, et al. The effect of pre-existing degeneration at adjacent segment on postoperative adjacent segment degeneration and surgical clinical outcome. *Spine Spinal Cord*. 2020;30[2]:103-10
- Park P, Garton HJ, Gala VC, Hoff JT, McGillicuddy JE. Adjacent segment disease after lumbar or lumbosacral fusion: review of the literature. *Spine [Phila Pa 1976]*. 2004 Sep 1;29[17]:1938-44. doi: 10.1097/01.brs.0000137069.88904.03.
- Lawrence BD, Wang J, Arnold PM, Hermsmeijer J, Norvell DC, Brodke DS. Predicting the risk of adjacent segment pathology after lumbar fusion: a systematic review. *Spine [Phila Pa 1976]*. 2012 Oct 15;37[22 Suppl]:S123-32. doi: 10.1097/BRS.0b013e31826d60d8.

IJMA



INTERNATIONAL JOURNAL OF MEDICAL ARTS

Volume 7, Issue 10 (October 2025)



<http://ijma.journals.ekb.eg/>

P-ISSN: 2636-4174

E-ISSN: 2682-3780