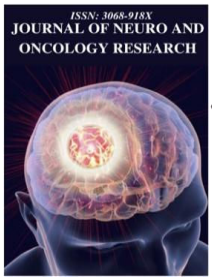

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Case Report

Aggressive Versus Limited Discectomy for Lumbar Disc Herniation: Implications for Recurrence and the Role of Fusion at Reoperation

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Abstract

Background: Recurrent Lumbar Disc Herniation (rLDH) remains a challenging complication after primary discectomy. Whether the extent of disc removal influences recurrence and the optimal strategy for revision surgery-fusion versus decompression alone-remains controversial. Objective: To evaluate recurrence patterns after aggressive versus limited discectomy and to analyze clinical outcomes following fusion-based revision surgery for rLDH.

Methods: A retrospective single-center cohort of 294 patients who underwent single-level lumbar discectomy between 2018 and 2025 was analyzed. All index procedures followed an aggressive discectomy strategy. Patients with confirmed same-level, same-side recurrence after a symptom-free interval of ≥6 months who underwent revision with interbody fusion (TLIF or ALIF) were included. A systematic review of comparative studies evaluating discectomy extent and revision strategies was also performed.

Results: Ten patients (3.4%) developed rLDH requiring revision fusion. Mean time to recurrence was 19.3 months. Recurrent patients were significantly younger than the overall cohort (34 vs 41.2 years, p = 0.004). All recurrent cases presented with radicular pain associated with significant axial back pain. ALIF was preferentially used at L5-S1 and TLIF at L4-L5. Only one postoperative complication occurred (retroperitoneal infection after ALIF). The systematic review included 10 studies and demonstrated no significant difference in recurrence between limited and aggressive discectomy, nor in clinical outcomes between fusion and non-fusion revision strategies. Conclusion: Aggressive discectomy was associated with a low recurrence rate in this cohort. When recurrence occurred, it was consistently associated with significant axial back pain and advanced disc degeneration, supporting the indication for fusion as a salvage strategy. rLDH should be regarded as a multifactorial condition rather than a simple technical failure.

Keywords: Recurrent Lumbar Disc Herniation; Aggressive Discectomy; Lumbar Fusion; Revision Spine Surgery

Abbreviations

rLDH: Recurrent Lumbar Disc Herniation; ALIF: Anterior Lumbar Interbody Fusion; TLIF: Transforaminal Lumbar Interbody Fusion; JOA: Japanese Orthopaedic Association score; ODI: Oswestry Disability Index; VAS: Visual Analog Scale; MRI: Magnetic Resonance Imaging; CSF: Cerebrospinal Fluid; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta Analyses; SD: Standard Deviation

Introduction

Recurrent Lumbar Disc Herniation (rLDH) is a known complication following primary discectomy, with recurrence rates ranging from 5% to 15% and tending to increase with longer follow-up periods. Although relatively uncommon, rLDH often leads to renewed symptoms, functional decline and the need for further surgical intervention [1].

In this study, recurrence is defined as a new herniation at the same intervertebral level and on the same side as the initial pathology, after a clinically significant pain-free interval of several months. This definition excludes early surgical failure or persistent symptoms from inadequate decompression [2].

Regardless of the surgical approach employed whether endoscopic, microsurgical or tubular the underlying surgical philosophy for lumbar disc herniation generally follows two main concepts. The first is limited discectomy, also referred to as fragmentectomy, sequestrectomy or extrusectomy, in which only the extruded or sequestered disc fragment is removed to preserve disc integrity and biomechanics. The second strategy is aggressive or extensive discectomy, which involves not only removal of the herniated fragment but also extraction of loose nucleus pulposus material from within the disc space using pituitary rongeurs, with the primary goal of minimizing the risk of recurrence [3].

At our institution, a more aggressive discectomy strategy is commonly adopted, as it is thought to potentially reduce the risk of recurrence. However, this approach may compromise disc height and segmental biomechanics, potentially predisposing some patients to increased postoperative axial low back pain [4].

In this study, we combined a systematic review of the literature with a retrospective analysis of a cohort of 294 patients who underwent surgery for lumbar disc herniation, among whom cases of recurrence and their subsequent management with fusion procedures (TLIF or ALIF) were identified and analyzed, aiming to better characterize clinical presentation, recurrence patterns and surgical decision-making in this challenging population.

Methodology

Case Series

We retrospectively identified patients from a total cohort of 294 who underwent revision surgery with lumbar fusion for recurrent lumbar disc herniation at a single academic institution between January 2018 and January 2025. Patients were eligible if they had undergone an initial single-level non-fusion lumbar discectomy performed using either conventional or tubular microdiscectomy techniques by one of three senior spine surgeons at our institution. In all cases, an extensive discectomy strategy was adopted at the index surgery, involving removal of the extruded disc fragment as well as extraction of all loose nucleus pulposus material prolapsing through the annular defect using pituitary forceps, rather than a limited extrusectomy or fragmentectomy. To meet inclusion criteria, patients were required to have a symptom-free interval of at least six months following the index procedure and to present with a confirmed recurrence at the same spinal level and on the same side as the original herniation, as demonstrated by concordant clinical symptoms and MRI findings. All patients subsequently underwent revision surgery using a lumbar interbody fusion technique, either TLIF or ALIF and had a minimum postoperative follow-up of 12 months, ranging from 1 to 7 years (mean 3.8 years). Patients were excluded if they had multilevel disease, progressive neurological deterioration without radiological confirmation of disc recurrence or required reoperation for indications other than recurrent herniation, such as spinal stenosis or adjacent segment disease. Clinical data, including symptom profile, imaging findings, surgical details and postoperative outcomes, were systematically collected. This study was conducted in accordance with institutional ethical standards and was approved by the Institutional Research Ethics Committee (COEP).

Systematic Literature Review

Search Strategy

A comprehensive literature search was conducted in PubMed (MEDLINE) and EMBASE (Elsevier) to identify studies reporting recurrence and reoperation after surgical treatment for single-level lumbar disc herniation. The search strategy was developed using a combination of controlled vocabulary terms (Medical Subject Headings [MeSH] for PubMed and Emtree terms for EMBASE) and free-text keywords to maximize sensitivity and ensure broad coverage of the available literature.

For PubMed, the following search strategy was applied:

("Intervertebral Disc Displacement"[Mesh] OR "Lumbar Vertebrae"[Mesh] OR "lumbar disc herniation"[tiab] OR "lumbar disc prolapse"[tiab] OR "lumbar disc extrusion"[tiab] OR "lumbar herniated disc"[tiab]) AND ("Reoperation"[Mesh] OR "reoperation"[tiab] OR "repeat surgery"[tiab] OR "recurrent surgery"[tiab] OR "revision surgery"[tiab]) AND ("Single-Level"[tiab] OR "single level"[tiab] OR "single segment"[tiab]).

For EMBASE, an equivalent strategy was applied using Emtree terms and relevant text words:
('lumbar disk herniation'/exp OR 'intervertebral disk displacement'/exp OR 'lumbar vertebra'/exp OR 'lumbar disc herniation':ti,ab OR 'lumbar disc prolapse':ti,ab OR 'lumbar disc extrusion':ti,ab OR 'herniated lumbar disc':ti,ab) AND ('reoperation'/exp OR 'repeat surgery':ti,ab OR 'reoperation':ti,ab OR 'revision surgery':ti,ab OR 'recurrent surgery':ti,ab) AND ('single level':ti,ab OR 'single-level':ti,ab OR 'single segment':ti,ab).

The search included studies published up to December 3rd, 2025, with no restrictions on publication year. Only articles published in English were included. Duplicates were removed using reference management software and titles and abstracts were screened independently by two reviewers according to predefined inclusion and exclusion criteria.

For the qualitative synthesis, we included retrospective cohort studies with more than 50 patients and all available prospective cohort studies and randomized controlled trials, as long as they reported a comparative analysis (e.g., limited vs aggressive discectomy or fusion vs non-fusion at reoperation).

Studies were included if they reported recurrence rates after surgical treatment for lumbar disc herniation, described the surgical technique in sufficient detail or analyzed factors associated with recurrence. Only studies involving single-level lumbar disc herniation treated with decompressive procedures either through microscopic or endoscopic approaches were considered eligible, provided that the surgical philosophy of disc removal (limited discectomy/fragmentectomy/sequestrectomy versus aggressive discectomy) was clearly described. Both prospective and retrospective comparative studies were included.

Exclusion criteria comprised case reports, animal studies and studies involving elderly populations with a mean age above 70 years. In addition, studies addressing other spinal pathologies, such as lumbar spinal stenosis, spondylolisthesis, deformity/instability, infection, tumor or trauma, were excluded. Studies that did not clearly differentiate true disc recurrence from reoperation for other causes were also excluded.

Results

Between January 2018 and January 2025, a total of 294 patients underwent surgery for refractory single-level lumbar disc herniation or disc herniation associated with neurological deficit at our institution. The cohort had a mean age of 41.2 years (SD ± 5.8). Regarding the operated level, the majority of cases involved the lower lumbar segments, with 134 patients (45.6%) operated at the L4-L5 level and 129 patients (43.9%) at the L5-S1 level, while 36 patients (12.2%) were treated at other lumbar segments. From this overall cohort, 10 patients (3.4%) developed a confirmed recurrent lumbar disc herniation and subsequently underwent revision surgery with lumbar fusion, which constituted the study population of the present analysis (Table 1). The mean time to recurrence was 19.3 months (median 18.5 months; range 6-39 months).

Patient	Age	Gender	Level	Side	Fusion Type	Months to Reop
1	31	Female	L4-L5	Right	TLIF	17
2	27	Female	L5-S1	Right	ALIF	24
3	37	Female	L4-L5	Right	TLIF	12
4	35	Male	L5-S1	Left	ALIF	17
5	34	Female	L4-L5	Left	ALIF	26
6	28	Male	L5-S1	Right	ALIF	6
7	37	Male	L4-L5	Left	TLIF	39
8	26	Male	L4-L5	Right	TLIF	20
9	43	Female	L4-L5	Right	TLIF	11
10	42	Male	L4-L5	Right	TLIF	21

Table 1: Demographic and surgical data of patients treated with lumbar fusion for recurrent disc herniation.

The mean age of patients who required revision surgery for recurrent lumbar disc herniation was 34 years (SD ± 5.98). Normality testing using the Shapiro-Wilk test confirmed a normal distribution of age in this group ($p = 0.548$). A one-sample t-test

comparing the recurrence group to the overall surgical cohort mean age of 41.2 years demonstrated a statistically significant difference (t = -3.81, df = 9, p = 0.004), indicating that patients who developed recurrence requiring fusion were significantly younger than the general population of surgically treated patients (Fig. 1).

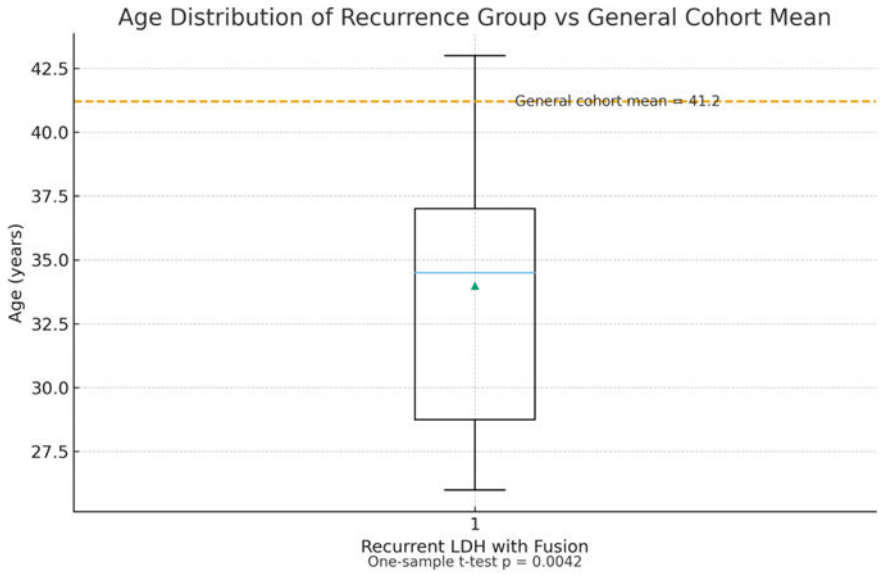

Figure 1: Boxplot of age distribution in patients undergoing fusion for recurrent lumbar disc herniation, compared with the mean age of the overall cohort (dashed line).

Recurrence was confirmed by MRI imaging studies in all patients. At the time of recurrence, all patients reported radicular symptoms and all also complained of axial low back pain. In six patients, low back pain was the predominant symptom, whereas in four patients, leg pain was the dominant complaint. ALIF was preferentially performed at the L5-S1 level, whereas TLIF was predominantly used for L4-L5 fusions.

Complications

No postoperative neurological deterioration or cerebrospinal fluid leakage was observed in this reoperation cohort. One patient in the ALIF group developed a postoperative abdominal infection associated with a retroperitoneal fluid collection, which required surgical drainage and reintervention. The patient subsequently achieved full recovery and was discharged without further complaints.

Systematic Review and Meta-Analysis

A systematic literature search was performed in MEDLINE (PubMed) and EMBASE (Elsevier). A total of 319 records were identified from PubMed and 228 from EMBASE, yielding 547 studies. After application of the inclusion criteria, which required cohorts of at least 50 patients and comparative designs evaluating limited versus aggressive discectomy and fusion versus non-fusion at reoperation, 10 studies were included for qualitative synthesis. Of these, six were randomized or prospective studies evaluating recurrence rates after limited versus aggressive discectomy and four compared revision surgery using fusion versus non-fusion techniques (Fig. 2) [5-14].

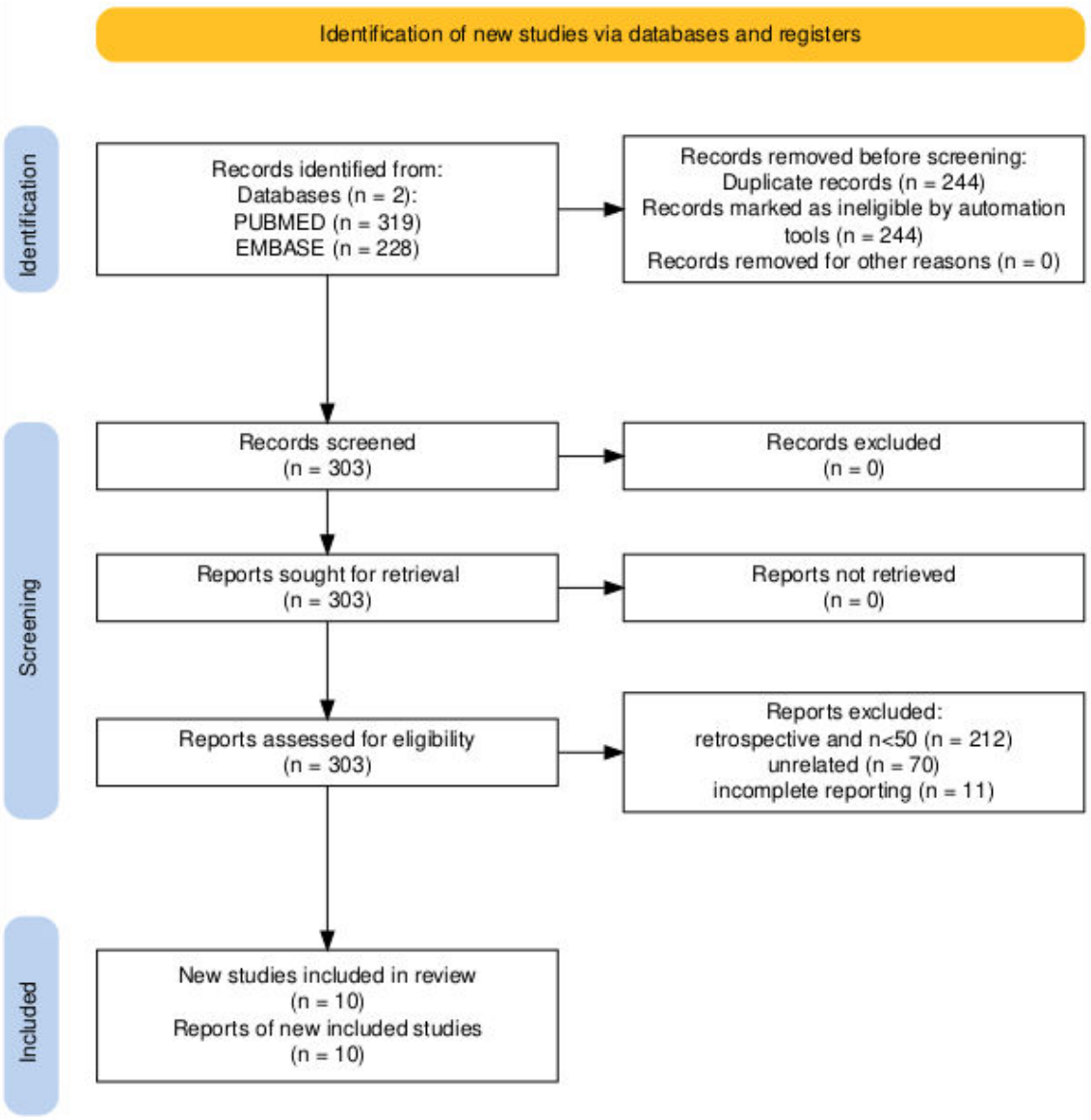

Figure 2: PRISMA 2020 flow diagram of study selection, showing identification, screening, eligibility and inclusion of 10 studies.

Recurrence Patterns Across Different Discectomy Strategies

Six prospective and randomized controlled studies evaluated recurrence risk by comparing limited discectomy (fragmentectomy/sequestrectomy) with more aggressive discectomy [5-10]. According to the available literature, no significant difference in recurrence rates was demonstrated between these techniques (Fig. 3).

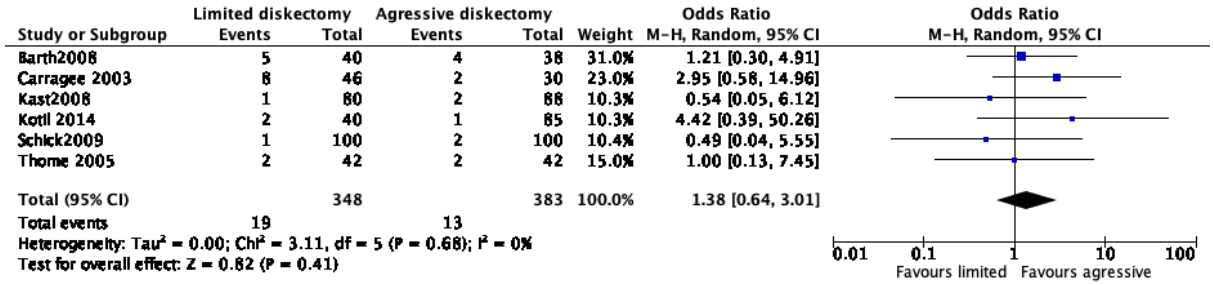

Figure 3: Forest plot comparing recurrence following limited and aggressive discectomy, with no significant difference observed between techniques.

Clinical Outcomes According to Revision Strategy: Fusion Versus Non-Fusion

Postoperative outcomes were assessed using the JOA score, ODI, axial VAS and the incidence of cerebrospinal fluid leakage and neurological injury. No statistically significant differences were observed between the fusion and decompression-only groups across any of these outcomes (Fig. 4-6).

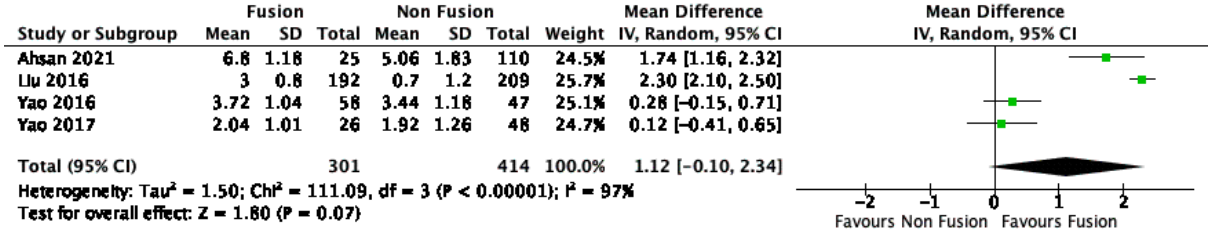

Figure 4: Forest plot comparing the pre-postoperative difference in axial VAS scores between fusion and non-fusion revision strategies, showing no statistically significant difference between groups.

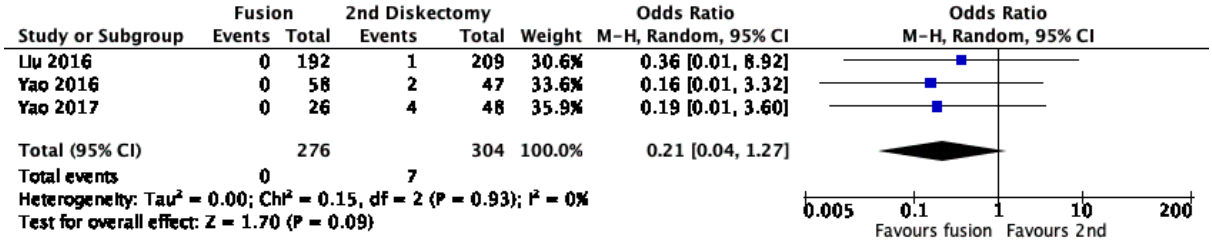

Figure 5: Forest plot comparing the incidence of postoperative neurological injury between fusion and non-fusion revision strategies, with no significant difference observed between groups.

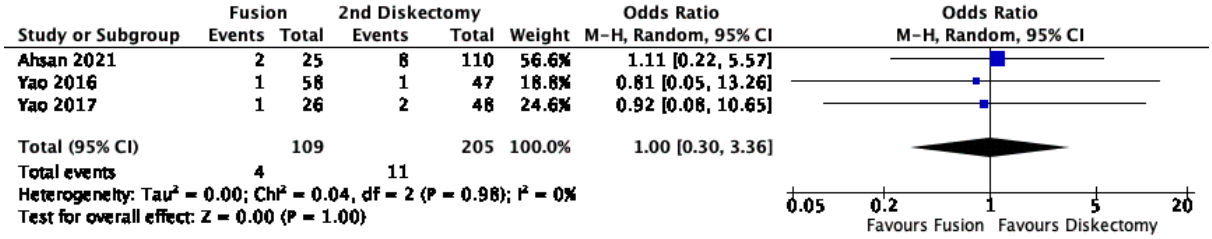

Figure 6: Forest plot comparing the incidence of cerebrospinal fluid leakage between fusion and non-fusion revision strategies, demonstrating no significant difference between groups.

Discussion

The incidence of recurrent lumbar disc herniation remains a subject of ongoing debate, as it lies at the intersection between the natural history of disc degeneration and the effects of surgical intervention. While a substantial proportion of patients with primary disc herniation can achieve satisfactory outcomes with conservative treatment, surgery becomes necessary in selected cases with severe, progressive or refractory symptoms. Even after apparently successful surgery, however, recurrence at the same level continues to represent a complex therapeutic challenge. Multiple patient-related and biomechanical factors have been implicated in recurrence, including age, diabetes mellitus, smoking status, body mass index, the degree of pre-existing disc degeneration, occupational biomechanical demands and rehabilitation protocols [15]. From a surgical perspective, one of the most relevant modifiable factors is the extent of disc removal at the index procedure. Limited discectomy-often termed fragmentectomy, sequestrectomy or extrusectomy-is increasingly favored in modern minimally invasive and endoscopic techniques, as it preserves disc height and segmental motion. However, several studies have suggested that partial disc removal may be associated with higher recurrence rates, particularly when long-term follow-up is considered, likely due to persistent residual nucleus pulposus within the disc space [6,8,16]. The study with the longest follow-up comparing limited versus aggressive discectomy was conducted by Kotil8, with a five-year follow-up period. This study demonstrated a clear difference in favor of aggressive discectomy regarding the recurrence rate of lumbar disc herniation, with recurrence observed in 1.5% of patients undergoing aggressive discectomy compared with 4.1% in those treated with sequestrectomy. These findings

underscore the critical importance of follow-up duration in the assessment of recurrence outcomes, as shorter follow-up periods may substantially underestimate the true long-term recurrence risk. Conversely, more aggressive discectomy may reduce the reservoir of remaining nucleus material and theoretically lower the risk of recurrence, albeit at the cost of accelerated disc height loss, altered biomechanics and a greater propensity for axial low back pain [4,5,9]. Nevertheless, several previous systematic reviews and meta-analyses have reached similar conclusions, indicating that sequestrectomy or limited discectomy does not appear to be associated with a higher recurrence rate when compared with more aggressive discectomy. This apparent discrepancy across individual long-term series and pooled analyses further highlights the complexity of recurrence as a time-dependent and multifactorial outcome [1,3]. In our individual cohort, despite the adoption of an aggressive discectomy strategy at the index surgery and a relatively low overall recurrence rate of 3.4%, nearly all patients who did recur presented with a significant axial low back pain component in addition to radicular symptoms. This reinforces the notion that recurrent herniation often reflects a more complex degenerative process rather than a simple mechanical re-extrusion of a disc fragment. Accordingly, all patients in our series who required revision surgery were Treated with Lumbar Interbody Fusion (TLIF or ALIF), aiming to achieve both neural decompression and mechanical stabilization. This strategy is consistent with the growing body of evidence suggesting that fusion may provide superior outcomes in patients presenting with combined axial and radicular pain or with imaging features of advanced segmental degeneration, such as reduced disc height [14,17].

Although our meta-analytic comparisons did not demonstrate statistically significant differences between fusion and non-fusion strategies in terms of axial VAS improvement, cerebrospinal fluid leakage or new neurological deficit, graphical trends marginally favored fusion for both axial pain relief and neurological safety. From a theoretical standpoint, this observation is biomechanically and surgically plausible. Fusion procedures-particularly ALIF and, to some extent, TLIF-allow decompression through alternative surgical corridors that avoid the prior midline scar, epidural fibrosis and compromised dura typically encountered in revision posterior decompressions. By preferentially avoiding previously scarred central canal tissues, these approaches may theoretically be associated with a lower risk of incidental durotomy and iatrogenic neurological complications. Postoperative rehabilitation and return-to-activity protocols further contribute to the multifactorial nature of recurrence. Aggressive rehabilitation, poor core muscle conditioning, early resumption of high-demand physical activities and inadequate patient adherence to activity restrictions may all exacerbate residual segmental stress and promote recurrent degeneration or instability [18]. Taken together, our findings support the concept that recurrent lumbar disc herniation should not be interpreted merely as a technical failure of the index procedure, but rather as a multifactorial syndrome influenced by biological degeneration, biomechanical instability, surgical strategy and postoperative care. The revision strategy-whether repeat decompression or fusion-must therefore be individualized, taking into account the predominant pain pattern, imaging evidence of disc and segmental degeneration and the mechanical integrity of the involved motion segment.

Study Limitations

This study has several limitations. First, the index surgeries were not performed by a single surgeon; however, all surgeons shared the same surgical philosophy, favoring aggressive discectomy rather than limited fragmentectomy. Second, revision procedures were performed using different fusion techniques, which may have introduced heterogeneity in surgical outcomes. Third, although the mean time to recurrence exceeded three years, the postoperative follow-up after revision surgery remains relatively short, limiting the assessment of long-term consequences. Regarding the systematic review, there was significant difficulty in accurately categorizing different surgical strategies for disc removal (limited discectomy/sequestrectomy versus aggressive discectomy), as definitions varied across studies. In addition, the lack of high-quality randomized controlled trials and the wide variability in follow-up duration among the included studies represent important limitations, particularly given that recurrence rates are known to be time-dependent.

Conclusion

This study supports the use of an aggressive discectomy strategy at the index surgery, rather than a limited fragmentectomy or sequestrectomy, as a means of reducing the risk of recurrent lumbar disc herniation. In our overall cohort, the observed recurrence rate was low (3.4%), which may reflect the effectiveness of this more extensive disc removal approach. However, among the small subset of patients who did develop recurrence, a higher prevalence of axial low back pain and radiological signs of advanced disc degeneration was observed, which consistently led to the indication for lumbar fusion at revision. Therefore, while aggressive discectomy may effectively minimize recurrence, fusion appears to be the most appropriate salvage strategy in patients who recur with significant disc degeneration and axial pain.

Conflict of Interest

The authors declare no material or financial conflict of interest related to this study.

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