

Early outcomes of open laminectomy with discectomy for single-level lumbar disc herniation

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ABSTRACT

Background: Lumbar disc herniation is a common cause of lumbosacral radiculopathy and functional disability. Although minimally invasive techniques are increasingly used, open laminectomy with discectomy remains common technique in resource-limited settings. Data on early postoperative outcomes are limited. This study aimed to evaluate the proportion of patients achieving clinically meaningful pain relief and functional improvement one month after open laminectomy with discectomy for single-level lumbar disc herniation.

Methods: This descriptive study was conducted at Department of Neurosurgery and Spine Surgery, Hayatabad Medical Complex, Peshawar, from February to May 2026. 127 patients aged 18–60 years with MRI-confirmed single-level lumbar disc herniation refractory to conservative treatment were enrolled consecutively and underwent open laminectomy with discectomy. Pain and disability were assessed preoperatively and at one month follow-up using the Visual Analogue Scale (VAS) and Oswestry Disability Index (ODI). Clinically meaningful improvement was defined as a $\geq 30\%$ reduction in VAS and a ≥ 15 -point reduction in ODI. Early postoperative complications were recorded.

Results: The mean age was 42.8 ± 9.7 years; 59.8% were male and 40.2% female. Mean VAS decreased from 7.9 ± 1.1 preoperatively to 2.3 ± 1.4 at one month, representing a 70.9% reduction ($p < 0.001$). Mean ODI decreased from 56.4 ± 11.8 to 21.7 ± 9.5 , representing a 61.5% improvement ($p < 0.001$). Overall, 93 patients (73.2%; 95% CI: 64.9–80.2%) achieved clinically meaningful improvement. Early complications occurred in 9 patients (7.1%), including wound infection, cerebrospinal fluid leak, recurrent disc herniation, and transient neurological deterioration. No mortality or permanent neurological deficits occurred.

Conclusion: Open laminectomy with discectomy produced substantial early improvement in pain and functional disability, with a low frequency of early postoperative complications. It remains a practical treatment option for single-level lumbar disc herniation in resource-limited settings.

Keywords: Discectomy, Intervertebral Disc Displacement, Laminectomy, Pain Measurement, Radiculopathy, Recovery of Function, Treatment Outcome

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Introduction

Lumbar disc herniation (LDH) is a common cause of low back pain and lumbosacral radiculopathy. LDH commonly affects working-age adults, it can result in substantial

functional, social, and economic consequences. These patients have a considerable loss of function and seek specialized care (1,2).

Lumbar disc herniation occurs when degeneration of the annulus fibrosus allows nucleus pulposus to break through the disc proper and beyond the disc perimeter. This situation leads to mechanical compression and inflammatory irritation of the spinal cord and nerve roots (3).

Many patients improve with conservative management, including analgesic medication, activity modification, physiotherapy, and, in selected cases, epidural steroid injections. (4). However, some patients continue to experience disabling radicular pain or develop neurological deficits despite appropriate conservative treatment. In appropriately selected patients, surgical decompression can provide more rapid symptom relief and functional recovery (5).

The connection between sciatica and lumbar disc herniation was made clear in 1934 when Mixter and Barr published a paper that started modern surgical interventions for lumbar disc disease (6). The first surgical techniques had to remove large amounts of bone in the back of the vertebral column to access and remove the disc. The next decades brought techniques that aimed to remove as little bone and tissue as possible. Techniques like microsurgical discectomy, developed in the late 1970s by Caspar and Yasargil, greatly diminished the issues of surgery and shortened recovery time (7,8). Traditional discectomy and laminectomy techniques that are both open and conventional are still used frequently, especially in poorer regions where the tools for these advanced techniques are not readily available.

An open laminectomy with discectomy is a well-established procedure for symptomatic lumbar disc herniation. The procedure offers

full access and direct visualization of the herniated disc and the adjacent neural structures, allowing for optimum disc fragment removal and neural decompression. The literature corroborates the procedure with significant reductions in pain and improvement in function and quality of life (9,10). The Spine Patient Outcomes Research Trial (SPORT) compared surgical and nonoperative treatment for lumbar disc herniation (11). The Spine Patient Outcomes Research Trial (SPORT) is an impactful study of the efficacy of surgical intervention that noted similar outcomes to the previously mentioned study. Following a discectomy, patients experienced long-lasting improvement in pain and physical function, and greater overall satisfaction (11, 12). Outcome studies like these have not only documented the efficacy of lumbar surgery, but highlighted the neurogenic symptoms experienced by patients as an indication for surgical management.

While many studies focus on lumbar discectomy as a whole, outcomes studies on one--level lumbar disc herniation can also provide important clinical insights. Focusing on single-level LDH provides a relatively homogeneous patient population for evaluating postoperative outcomes and reduces heterogeneity related to multilevel disease. Early postoperative outcomes occurring can be critical indicators of pain relief, functional improvement, and postoperative complications. Each of these outcomes can be helpful in assessing the risk-benefit ratio of lumbar discectomy, and provide insight into the clinical surgical options available to the patient (13).

Clinical outcomes continue to be excellent with conventional open discectomy when performed at appropriate indications, despite the growing demand for minimally invasive

and endoscopic procedures. Evidence from long-term studies of thousands of patients demonstrate open decompressive procedures provide sustained relief from symptoms and high patient satisfaction (14). The simplicity, reproducibility, and ease of access to open discectomy and laminectomy renders it very important to developing countries and tertiary care centers with resource limitations. Conventional open laminectomy and discectomy remain popular, especially in public hospitals in Pakistan, and there is very little recent local evidence on early postoperative outcomes based on standardized and validated measures. Most studies focus on long-term follow-up assessments or comparisons with minimally invasive approaches. There is limited analysis on the first month after surgery and the early postoperative phase. Most postoperative care in the first month after surgery is primarily for symptoms, and follow-up is usually unstructured with short contact intervals. This study captures the first recovery phase, and it will help develop the first month after surgery patient protocols and outlines expected surgical outcomes in low-resource settings, if successful.

This study aimed to evaluate the proportion of patients achieving clinically meaningful pain relief and functional improvement at one-month follow-up after open laminectomy with discectomy for single-level lumbar disc herniation.

Methods

This descriptive study was carried out in the Department of Neurosurgery and Spine Surgery at Hayatabad Medical Complex in Peshawar, Pakistan from February 2026 to May 2026. Ethical Approval was obtained from the Institutional Research Ethics Committee, under references number IREB 2925, dated 12th January 2026. Non-

probability sampling was used and consecutively recruited eligible patients. The sample size of 127 was determined at a 95% level of confidence that clinically meaningful early postoperative improvement would be reported for 70% of patients with a margin of error of 8% following open laminectomy with discectomy (11, 12). The sample size was calculated using the WHO sample size calculator.

The study used data from MRI-confirmed single level lumbar disc herniation cases at the L4-L5 and L5-S1 levels among individuals aged 18-60 of either gender. Subjects included had clinical presentations of sciatica and persistent leg pain for more than six weeks despite using conservative management comprises analgesic medications, physiotherapy, and, where indicated, epidural steroid injection. Patients with multi-level lumbar disc herniation, cauda equina syndrome, severe lumbar stenosis, rapidly progressive neurologic deficits and uncontrolled diabetes (HbA1C >8%) were excluded. Also, patients with coagulation disorders, systemic diseases, pregnancy, refusal of informed consent, and prior lumbar spine surgeries were excluded.

Informed consent was collected from the patients prior to treatment. Among the baseline demographic and clinical data collected, the following were noted: age, sex, BMI, symptoms duration and MRI findings. All the patients had undergone open laminectomy with discectomy. The procedure had been performed in line with the standard operating procedure of the department. Intraoperative variables included documentation of the level of disc herniation, surgical duration, estimated

intraoperative blood loss, and the incidence of iatrogenic durotomy.

Patients were seen for follow up one month postoperatively. Radicular leg pain intensity was assessed using the Visual Analogue Scale (VAS), and functional disability was assessed using the Oswestry Disability Index (ODI), preoperatively and at one-month follow-up. MRI was performed on patients only if there was a clinical suspicion of recurrent disc herniation. During all follow up visits, we assessed the occurrence of early postoperative complications, including wound infections, cerebrospinal fluid leaks, recurrent disc herniation, and deterioration of the neurological status.

Data were analyzed using SPSS version 23.0 (IBM Corp., Armonk, NY, USA). The Shapiro-Wilk test was used to assess the normality of continuous variables. Normally distributed continuous variables were presented as mean $\pm$ standard deviation, whereas non-normally distributed variables were expressed as median and interquartile range. Categorical variables were summarized as frequencies and percentages. Changes in VAS and ODI scores between baseline and one-month follow-up were described using mean or median differences with 95% confidence intervals. The proportion of patients achieving clinically meaningful improvement, defined as a $\geq 30\%$ reduction in VAS score and a ≥ 15 -point reduction in ODI score, was calculated with corresponding 95% confidence intervals. Paired t-tests or Wilcoxon signed-rank tests were applied, as appropriate, to evaluate within-subject changes in VAS and ODI scores over time. Fisher's exact test was used to assess the association between early postoperative complications and clinically meaningful improvement. Univariable and multivariable binary logistic regression

analyses were performed to assess factors associated with clinically meaningful improvement at one month. The outcome was coded as improved = 1 and not improved = 0. Results were reported as crude and adjusted odds ratios with 95% confidence intervals. A p-value of <0.05 was considered statistically significant.

Results

A total of 127 patients with symptomatic single-level lumbar disc herniation underwent open laminectomy with discectomy and completed the one-month follow-up assessment. The mean age of the study population was 42.8 ± 9.7 years (range: 21–60 years). There were 76 (59.8%) males and 51 (40.2%) females. The mean body mass index (BMI) was 27.1 ± 3.8 kg/m², while the median duration of symptoms prior to surgery was 14 weeks (IQR: 10–20 weeks). The most commonly affected disc level was L4–L5, accounting for 73 (57.5%) cases, followed by L5–S1 in 54 (42.5%) patients.

Table 1. Baseline Demographic and Clinical Characteristics (n = 127)

Variable	Value
Age (years), mean $\pm$ SD	42.8 ± 9.7
Male, n (%)	76 (59.8)
Female, n (%)	51 (40.2)
BMI (kg/m ²), mean $\pm$ SD	27.1 ± 3.8
Duration of symptoms (weeks), median (IQR)	14 (10–20)
L4–L5 disc herniation, n (%)	73 (57.5)
L5–S1 disc herniation, n (%)	54 (42.5)
Preoperative VAS score, mean $\pm$ SD	7.9 ± 1.1
Preoperative ODI score, mean $\pm$ SD	56.4 ± 11.8

The mean operative time was 72.6 ± 14.3 minutes, while the mean estimated blood loss was 118.4 ± 42.7 mL. Intraoperative durotomy occurred in 2 (1.6%) patients.

Table 2. Operative Characteristics (n = 127)

Variable	Value
Operative time (minutes), mean $\pm$ SD	72.6 $\pm$ 14.3
Estimated blood loss (mL), mean $\pm$ SD	118.4 $\pm$ 42.7
Intraoperative durotomy, n (%)	2 (1.6)

Marked improvement in both pain intensity and functional disability was reported one-month after surgery. The average VAS score fell from 7.9 ± 1.1 before the surgery to 2.3 ± 1.4

1.4 after the surgery. This equates to a mean drop of 5.6 (95% CI: 5.3–5.9), a significant ($p < 0.001$) 70.9% drop from the baseline score.

The mean ODI score also improved from 56.4 ± 11.8 preoperatively to 21.7 ± 9.5 at 1 month, resulting in a mean difference of 34.7 points (95% CI: 32.6 – 36.8) which corresponds to a 61.5% improvement from the baseline ($p < 0.001$).

Table 3. Comparison of Preoperative and One-Month Postoperative Outcomes

Outcome Variable	Preoperative Mean $\pm$ SD	One-Month Mean $\pm$ SD	Mean Difference (95% CI)	Percentage Change	p-value
VAS Score	7.9 $\pm$ 1.1	2.3 $\pm$ 1.4	5.6 (5.3–5.9)	70.9% reduction	<0.001
ODI Score	56.4 $\pm$ 11.8	21.7 $\pm$ 9.5	34.7 (32.6–36.8)	61.5% improvement	<0.001

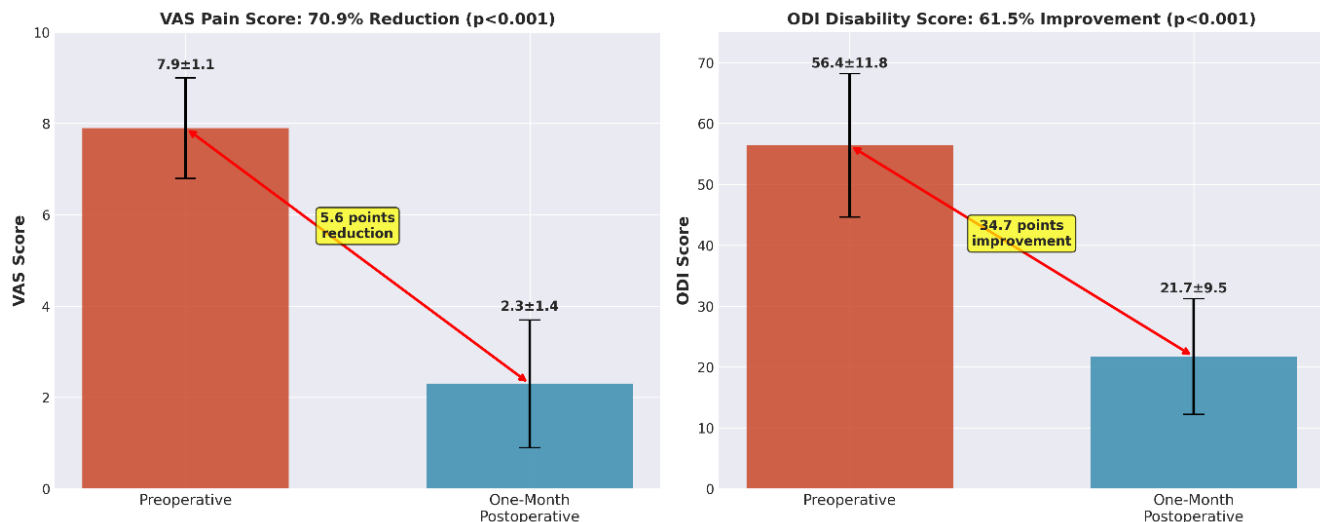


Figure 1. Comparison of Preoperative and Postoperative Outcomes

The primary outcome analysis showed a total of 93 patients (73.2%; 95% CI: 64.9%–80.2%) showed clinically meaningful improvement one month after surgery, demonstrated by a VAS score decrease of $\geq 30\%$ and an ODI score decrease of ≥ 15 points. The remaining 34 patients (26.8%) did not achieve meaningful improvement as defined.

Table 4. Clinically Meaningful Improvement at One Month (Primary Outcome)

Outcome	Frequency (n)	% age	95% CI
Achieved clinically meaningful improvement	93	73.2	64.9–80.2
Did not achieve clinically meaningful improvement	34	26.8	19.8–35.1
Total	127	100	–

Complications early post-surgery was not common. In total, 9 (7.1%) patients had one or

more complications in the one-month follow-up. There was a wound infection in 3 (2.4%) patients, leakage of cerebrospinal fluid in 2 (1.6%) patients, recurrent disc herniation in 2 (1.6%) patients, and transient deterioration in the nervous system of 2 (1.6%) patients. Each affected patient experienced only one recorded early postoperative complication; therefore, the complication categories were mutually exclusive. There were no total losses or long-standing nervous system injuries.

Table 5. Early Postoperative Complications (n = 127)

Complication	Frequency (n)	Percentage (%)
Wound infection	3	2.4
Cerebrospinal fluid leak	2	1.6
Recurrent disc herniation	2	1.6

Transient neurological deterioration	2	1.6
No complications	118	92.9
Total	127	100

Clinically meaningful improvement was achieved by 90 of 118 patients (76.3%) without early postoperative complications, compared with 3 of 9 patients (33.3%) who developed complications. This association was statistically significant on Fisher's exact test ($p=0.011$), indicating that patients who developed an early postoperative complication were less likely to achieve clinically meaningful improvement at one month.

Table 6. Association Between Early Postoperative Complications and Clinically Meaningful Improvement at One Month

Early postoperative complications	Improved, n (%)	Not improved, n (%)	Total, n	Fisher's exact p-value
No	90 (76.3)	28 (23.7)	118	
Yes	3 (33.3)	6 (66.7)	9	0.011
Total	93 (73.2)	34 (26.8)	127	

Note: Percentages in the "Improved" and "Not improved" columns are calculated within each complication-status row. Fisher's exact test was used because of the small number of patients with complications ($p = 0.011$).

On univariable analysis, L5-S1 disc level, higher preoperative ODI score, and early postoperative complications were significantly associated with clinically meaningful improvement. After accounting for the other variables included in the model, L5-S1 disc level remained associated with lower odds of improvement (OR = 0.23; 95% CI: 0.05–0.98; $p = 0.047$),

whereas a higher preoperative ODI score was associated with greater odds of improvement (OR = 1.29 per one-point increase; 95% CI: 1.16–1.44; $p < 0.001$). The association between early postoperative complications and improvement was no longer statistically significant (OR = 0.45; 95% CI: 0.02–8.99; $p = 0.602$) (Table 7).

Table 7. Logistic Regression Analysis of Factors Associated with Clinically Meaningful Improvement at One Month

Variable	Crude OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Age, per one-year increase	1.03 (0.99–1.07)	0.154	1.03 (0.97–1.10)	0.355
Male sex vs female	1.06 (0.48–2.36)	0.887	2.66 (0.62–11.35)	0.185
BMI, per 1 kg/m ² increase	1.03 (0.93–1.14)	0.569	0.99 (0.82–1.18)	0.881

Symptom duration, per one-week increase	1.04 (0.99-1.10)	0.124	1.00 (0.91-1.10)	>0.999
L5-S1 vs L4-L5	0.34 (0.15-0.77)	0.009	0.23 (0.05-0.98)	0.047
Preoperative VAS, per one-point increase	1.33 (0.92-1.91)	0.129	1.22 (0.64-2.33)	0.551
Preoperative ODI, per one-point increase	1.27 (1.16-1.38)	<0.001	1.29 (1.16-1.44)	<0.001
Early postoperative complication: yes vs no	0.16 (0.04-0.66)	0.012	0.45 (0.02-8.99)	0.602

Note: The outcome evaluated in the logistic regression was clinically meaningful improvement at one month (achieved = 1; not achieved = 0). For categorical variables, males were compared with females, L5-S1 with L4-L5, and patients with early postoperative complications with those without complications. Crude ORs were obtained from univariable analyses, whereas adjusted ORs were obtained from the multivariable model. OR = odds ratio; CI = confidence interval; BMI = body mass index; VAS = Visual Analogue Scale; ODI = Oswestry Disability Index.

Discussion

In this single-center descriptive study of 127 patients 73.2% of patients met the prespecified criteria for clinically meaningful improvement in pain and functional disability at one-month follow-up with single-level lumbar disc herniation. This happened after open laminectomy with discectomy. Mean VAS and ODI scores decreased markedly from baseline. Early postoperative complications were recorded in 7.1% of patients, with no deaths or permanent neurological deficits.

The demographic data of our patients were broadly consistent with previously reported populations undergoing surgery for lumbar disc herniation. The present study average for age is noted to be 42.8. This study is in agreement with previous studies with the noted age groups of patients with herniated disks in the 4th and 5th decades with the majority of patients in this age range that are in the workforce and with the increased

physical activity (15, 16). The data of patients being male with the percentage being 59.8% agrees with the majority of studies where the incidence of herniated lumbar discs is noted to be higher in males (15, 17). The majority of patients having L4-L5 and L5-S1 disc herniations is in alignment with the disc levels where the majority of herniated lumbar discs are stressed the most (13).

A major discovery of this research was the notable lessening of pain after surgery. The average VAS score dropped from 7.9 ± 1.1 before the operation to 2.3 ± 1.4 at one month after the surgery indicating that the post-op pain was 70.9% less than the pre-op pain. The level of improvement we noticed was similar to the level of improvement in recent studies that analyzed the pain after the surgery to treat a lumbar disc herniation. Ke et al. documented a large drop for both back pain and associated lumbosacral radicular pain had experienced after performing lumbar disc surgery for single level disc herniation where majority of the patients had achieved significant improvement in pain during the early post-op follow up. Yang et al. similarly reported substantial reductions in VAS scores following discectomy for lumbar disc herniation (19, 20).

Functional disability also improved substantially at one-month follow-up after surgery. The mean ODI score improved from 56.4 ± 11.8 to 21.7 ± 9.5 one-month post-surgery, a 61.5% improvement. This aligns with Rajadurai et al. they noted improvements in post open lumbar discectomy ODI scores, with improved physical function and quality of life (21). Likewise, Decompression surgery

demonstrated better short-term outcomes for function compared to conservative management. This finding is consistent with systematic reviews reporting favorable short-term functional outcomes following surgical decompression in appropriately selected patients with lumbar disc herniation and radiculopathy. (21, 22)

According to the primary result of the study, 73.2% of the patients experienced clinically meaningful improvement, described as a 30% decrease in VAS score combined with a 15-point decrease in ODI score. This result is clinically relevant as it captures an actual benefit to the patients by going beyond statistically significant results. Recent studies exploring patient-reported outcomes in the context of lumbar decompression surgery have reported that a large number of patients experience large clinical benefits in the early weeks to months after surgery (17, 23).

The early safety profile emerging from this study was very positive. In the early postoperative period, complications occurred in 7.1% of patients. These complication rates are, in general, consistent with complication rates associated with standard lumbar discectomy reported in the literature. In studies that have compared open and minimally invasive discectomy techniques, it has been reported that when open discectomy is performed by a skilled and experienced surgeon, the rates of major complications are very low (18, 20, 24). Moreover, systematic reviews have reported that even when minimally invasive techniques are compared to open techniques, the outcomes from open discectomy are often excellent, and the complication rates from open discectomy are very acceptable (21, 25).

Open laminectomy and discectomy remain an important treatment option in developing countries. Endoscopic and minimally invasive

procedures are gaining popularity but result in increased costs and higher training requirements for surgeons. Some recent studies comparing conventional open surgery to minimally invasive surgery have noted reductions in perioperative metrics such as time in the operating room and post-operative recovery. However, improvements in pain and function are often similar between the two techniques (18, 20, 25). Therefore, open laminectomy with discectomy provides a practical and reliable surgical option in developing countries and in situations where the healthcare system cannot afford to purchase the best available spinal technologies.

Limitations of study:

This study has a number of limitations, the first of which is that the study's design is descriptive and single-center, which constrains the study's ability to form a rationale for causative relationships and also has the potential to affect the study's conclusions on the generalizability of the findings. The second limitation is that the study's follow-up was only for one month, and therefore there is no information on the long-term outcomes, recurrence rates, or sustained functional recovery. The absence of a control group also did not allow the study to evaluate the consequences of open surgery compared to the consequences of minimally invasive or conservative surgery.

The study findings add useful local evidence regarding the early recovery of patients treated with conventional open surgery. However, the results should be interpreted in light of the study's single-center, non-comparative design and relatively short follow-up period.

Conclusion

The current research substantiates open laminectomy with discectomy as a safe and

effective technique for managing symptomatic single-level lumbar disc herniation. One-month post-surgery, patients experienced reduced pain and improved function, shown by notable reductions in VAS and ODI scores. Although there is a trend toward the use of techniques that are less invasive, conventional open discectomy has a positive effect on early post-surgical function and is a technique that is still valuable and clinically relevant, especially in contexts where there is limited access to advanced surgical methods.

Recommendations

1. For those with symptomatic single-level lumbar disc herniation who do not respond to conservative treatment, open laminectomy with discectomy remains an appropriate surgical option.
2. Objective evaluation of early postoperative VAS and ODI scores, followed by targeted postoperative care, should become standard practice.
3. Factors related to demographics, patient selection, and postoperative care should be the focus for improving surgical outcomes and recovery.
4. In resource-limited healthcare systems, the current study provides the first registered local evidence that can support the refinement of healthcare for lumbar disc herniation via the establishment of institutional protocols and outcome registries.

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Conflict of Interest:

None.

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Data Availability Statement:

The data used in this study are not publicly accessible because they include confidential clinical information about individual patients. However, the data may be obtained from the corresponding author upon reasonable request.

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