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Efficacy of conservative and surgical strategies in managing incidental durotomy following lumbar microdiscectomy

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Abstract

Background: Incidental durotomy is a well-recognized complication of lumbar microdiscectomy that, if not appropriately managed, may result in cerebrospinal fluid (CSF) leakage, prolonged hospitalization, and neurological morbidity. This study aimed to evaluate the effectiveness of intraoperative multimodal repair techniques and structured conservative postoperative strategies in managing incidental durotomy.

Methods: A retrospective cohort study was conducted on 400 patients who underwent lumbar microdiscectomy at King Hussein Medical Center between January 2022 and December 2023. Patient demographics, the incidence of incidental durotomy, intraoperative repair techniques, postoperative management protocols, and clinical outcomes were assessed.

Results: The overall incidence of incidental durotomy was 8.25%, rising to 16% among patients with recurrent disc herniation. Immediate intraoperative identification and layered repair—including dural suturing, fibrin sealants, and fat grafting—enabled successful conservative management in 93.9% of cases. Only two patients required surgical re-intervention due to persistent CSF leakage. At both 1-month and 6-month follow-ups, no patients exhibited persistent CSF leaks, wound infections, pseudomeningocele, or new neurological deficits.

Conclusion: Prompt intraoperative recognition of incidental durotomy, followed by meticulous multimodal repair and structured conservative management, effectively minimizes complications. Vigilant postoperative monitoring and timely surgical re-intervention remain critical for ensuring optimal outcomes, particularly in high-risk revision cases.

Keywords: Incidental durotomy; Lumbar microdiscectomy; Cerebrospinal fluid leak; Conservative management; Surgical repair; Spine surgery complications; Recurrent disc herniation

1. Introduction

Lumbar microdiscectomy is a commonly performed surgical procedure aimed at relieving symptoms associated with lumbar disc herniation. Although this operation is generally effective, it is not without potential complications—one of the most significant being incidental durotomy, an accidental tear or perforation of the dura mater during surgery, which may lead to cerebrospinal fluid (CSF) leakage. The reported incidence of incidental durotomy varies widely, ranging from 3.5% in primary discectomy to as high as 13.2% in revision discectomy procedures [1].

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Several factors have been identified as increasing the risk of incidental durotomy. These include advanced age, female gender, revision surgeries, and procedures involving multiple spinal levels [2]. Additionally, anatomical features such as degenerative spondylolisthesis and juxtafacet cysts have also been associated with a higher incidence of dural injury [3].

Effective management of incidental durotomy is essential to prevent postoperative complications such as persistent CSF leakage, pseudomeningocele formation, meningitis, and neurological deficits. While primary dural suturing remains the cornerstone of repair, various adjunctive methods—including sealants, autologous grafts, and subfascial drains—are often employed to enhance dural closure. However, the efficacy of these supplementary techniques continues to be debated [4].

Postoperative strategies, particularly those concerning patient mobilization, also play a crucial role in managing durotomy. Traditionally, prolonged bed rest was advised to minimize CSF leakage. Recent evidence, however, suggests that early ambulation does not increase complication rates and may, in fact, reduce the risk of venous thromboembolism and shorten hospital stays [5,6].

Given the significant morbidity that can follow incidental durotomy, this study aims to evaluate its incidence, associated risk factors, and clinical outcomes, with a focus on comparing primary and revision lumbar microdiscectomy cases at King Hussein Medical Center.

2. Methods

2.1. Study Design and Setting

This retrospective cohort study was conducted at King Hussein Medical Center, Amman, Jordan. It included all patients who underwent lumbar microdiscectomy procedures between January 2022 and December 2023. The study was approved by the institutional review board, and all data were anonymized in compliance with ethical standards.

2.2. Patient Selection

A total of 400 patients were included in the study. All had received lumbar microdiscectomy for symptomatic lumbar disc herniation. Patients were excluded if they had a history of spinal infection, spinal trauma, known preoperative dural abnormalities, or incomplete medical records. This ensured a consistent and reliable dataset for analysis.

2.3. Data Collection

Data were obtained from both electronic and paper-based medical records. Collected variables included demographic details (age, sex), clinical comorbidities, disc herniation type (primary or recurrent), occurrence of incidental durotomy, intraoperative repair strategies, and postoperative outcomes. These data were processed confidentially and used exclusively for research purposes.

2.4. Surgical Procedures

All surgeries were performed by board-certified spine neurosurgeons using a standard posterior approach under general anesthesia. In cases of incidental durotomy, intraoperative repair was immediately undertaken. The multimodal repair strategy included microsurgical direct suturing of the dura, autologous fat graft application, fibrin sealant reinforcement, and gelatin sponge placement. Following repair, multilayered closure of the fascial and subcutaneous tissues was performed to enhance dural integrity and minimize CSF leak risk.

2.5. Postoperative Management Protocol

Patients who sustained incidental durotomy were managed with a structured conservative protocol. This included strict bed rest for 48 to 72 hours in a mild Trendelenburg position (lower limbs elevated by 10–15 cm), broad-spectrum antibiotics with central nervous system penetration, nutritional support, and frequent wound inspection. Closed suction drains were maintained for an average of 7.1 ± 0.5 days, with daily monitoring of drainage volume, appearance, and signs of ongoing CSF leakage. Drain removal was determined based on cessation of drainage, absence of neurologic symptoms, and a dry, well-healed wound on inspection.

2.6. Outcome Measures

The primary outcomes assessed were the resolution of CSF leakage and the requirement for reoperation due to persistent leakage. Secondary outcomes included wound infection, pseudomeningocele formation, neurological deficits, symptom recurrence, and length of hospital stay. Follow-up evaluations were conducted at 1-month and 6-month intervals postoperatively to monitor long-term recovery and complications.

2.7. Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics version 26 (IBM Corp., Armonk, NY, USA). Continuous variables were reported as means ± standard deviations (SD), while categorical variables were expressed as frequencies and percentages. Between-group comparisons were conducted using the independent samples t-test for continuous variables and the chi-square test or Fisher's exact test for categorical variables. A p-value < 0.05 was considered statistically significant.

3. Results

The study included a cohort of 400 patients who underwent lumbar microdiscectomy at King Hussein Medical Center from January 2022 to December 2023. Analysis of the demographic data of the patients showed a mean age of 49.98 ± 10.02 years, with a majority of male patients (57.5%, n = 230), consistent with the current epidemiological reports of increased frequencies of lumbar disc herniation surgery among the male population. The cohort was divided into two clinical groups according to the indication for surgery: 350 patients (87.5%) were treated for primary disc herniation, whereas 50 patients (12.5%) had recurrent herniation that required revision microdiscectomy. Notably, incidental durotomy was encountered in 33 patients, giving an overall rate of 8.25%, a figure consistent with the upper limit rates reported in recent literature related to spinal surgery and highlights this complication as a recurring issue despite the improvements in surgical instruments and visualization techniques.

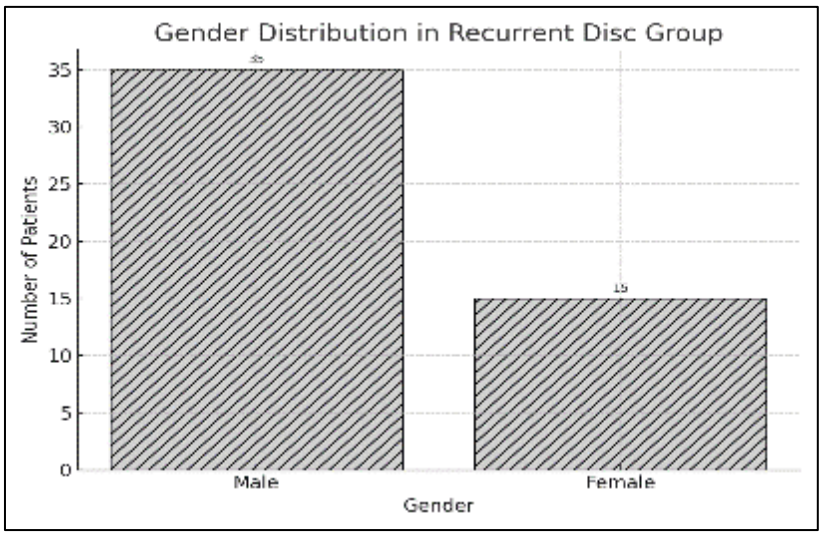

Figure 1 Gender Distribution in Recurrent Disc Group. Males constituted the majority of patients undergoing revision microdiscectomy for recurrent disc herniation

Gender analysis revealed a predominance of males in the recurrent disc group. This aligns with the general trend observed in lumbar pathology requiring revision intervention. Figure 1 displays the gender distribution in patients presenting with recurrent herniation.

3.1. Incidence of Incidental Durotomy by Type of Disc Herniation

A key objective of this study was to evaluate the influence of disc herniation type—primary versus recurrent—on the likelihood of incidental durotomy. A chi-square test of independence demonstrated a statistically significant association between disc type and durotomy occurrence ($\chi^2 = 4.91$, $p = 0.026$), as presented in Table 1 and visualized in Figure 1.

Table 1 Incidence of Incidental Durotomy by Disc Type

Disc Type	Durotomy (Yes)	Durotomy (No)	Total
Primary	25	325	350
Recurrent	8	42	50
Total	33	367	400

The total incidence of durotomy in the study cohort was 8.25%, falling within the upper range reported in the literature. *Figure 2 illustrates the proportion of patients who sustained incidental durotomy versus those who did not.*

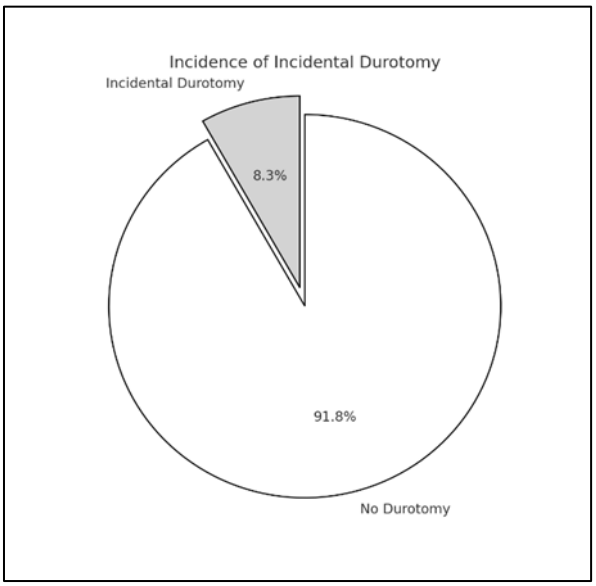

Figure 2 Incidence of Incidental Durotomy. Among 400 patients who underwent lumbar microdiscectomy, 33 (8.3%) experienced incidental durotomy, while 367 (91.8%) did not

The findings of this study lend credence to the hypothesis that a history of multiple prior spinal operations is associated with a significantly increased risk of iatrogenic dural laceration. The relationship can be explained through examination of the underlying mechanisms involving tissue plane disruption, the formation of epidural fibrosis, and the generally limited anatomical visibility inherent in reoperative procedures. Clinically, the findings highlight the importance of increased intraoperative vigilance and may support the use of additional imaging modalities, such as intraoperative ultrasonography or microscopic magnification, in the treatment of recurrent disc disease. The findings also suggest that multiple surgical procedures are inherently more complicated and highlight the importance of the surgeon's experience and careful surgical planning in reducing the risk of complications.

3.2. Outcomes of Conservative vs. Surgical Management Following Durotomy

Of the 33 patients who sustained incidental durotomy, 28 (84.8%) were successfully managed conservatively, while 2 (6.1%) required surgical re-exploration. To assess whether management outcomes differed significantly by the type of disc herniation, a chi-square test was conducted (Table 2), which yielded non-significant results ($\chi^2 = 1.01$, $p = 0.316$).

Table 2 Management Outcome by Disc Type

Disc Type	Conservative Success	Reoperation Required	Total
Primary	21	2	23
Recurrent	7	0	7
Total	28	2	30

In primary herniation with durotomy, conservative management was sufficient in 21 of 23 cases (91.3%). In the situation of recurrent cases, all 7 durotomies were successfully managed conservatively, with no further complication. These findings provide strong evidence for the efficacy of a well-structured conservative management protocol, consisting of rigorous bed rest, Trendelenburg positioning, prophylactic antibiotic therapy, nutritional support, and careful observation of wound drainage, regardless of the patient's surgical history. The incidence of incidental durotomy classified by disc herniation type is shown in Figure 3.

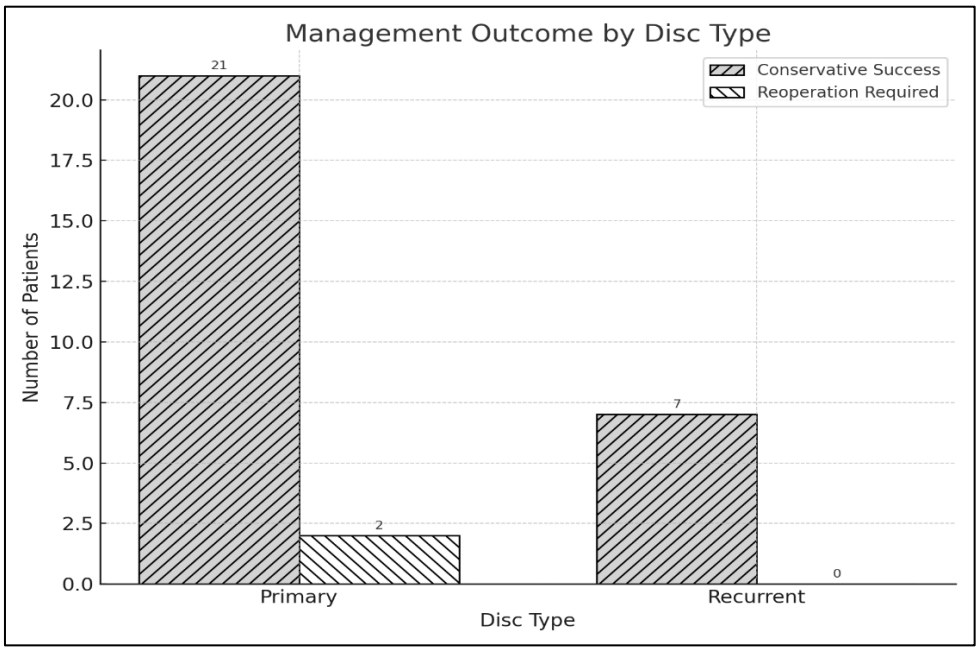

Figure 3 Management Outcome by Disc Type. Conservative success and reoperation rates in primary versus recurrent lumbar disc herniation patients who sustained incidental durotomy

The high success rates seen in the two cohorts add further support for the effectiveness of the intraoperative multimodal closure method used in this study, which consisted of direct dural mater suturing, use of biological sealants (fibrin glue in this case), fat graft reinforcement, and use of gelatin sponge buffering. These multimodal approaches are increasingly recognized in the medical literature as best practices in durotomy closure, and our results confirm further their success in achieving primary watertight closure with decreased need for secondary procedures.

3.3. Age as a Risk Factor for Incidental Durotomy

To interrogate the role of patient age in the pathogenesis of durotomy, an independent samples t-test was employed to compare the mean age of patients who sustained durotomy versus those who did not. The mean age among durotomy patients was 50.67 ± 10.09 years, compared to 49.91 ± 9.99 years in non-durotomy patients, yielding a non-significant p-value of 0.712 (Table 3).

Table 3 Age Comparison Between Durotomy and Non-Durotomy Groups

Group	Mean Age (years)	Std. Deviation	n
Durotomy	50.67	10.09	33
No Durotomy	49.91	9.99	367

The results show that increasing age does not significantly increase the risk of incidental durotomy in lumbar microdiscectomy procedures. Although older age has been suggested as a possible risk factor based on dural thinning and degenerative changes, our study suggests that the effect of these anatomical weaknesses may be counteracted by the advantage of skillful surgical technique and intraoperative decisions. Thus, age should not be considered a factor in the risk factor models for durotomy in this population of patients.

3.4. Multivariate Predictors of Incidental Durotomy: Logistic Regression Analysis

To more precisely delineate the independent predictors of incidental durotomy, a binary logistic regression analysis was performed including age, gender, and disc type as covariates (Table 4). The model demonstrated a statistically significant effect for recurrent disc herniation ($p = 0.018$), with an odds ratio of 2.38 (Exp(B) = 2.38), indicating that patients undergoing revision procedures were more than twice as likely to sustain a durotomy compared to those undergoing primary surgeries.

Table 4 Logistic Regression Analysis for Predicting Durotomy

Predictor	Coefficient (B)	Std. Error	Wald	p-value	Odds Ratio (Exp(B))
Intercept	-2.74	0.43	41.1	<0.001	—
Age	0.01	0.01	0.21	0.648	1.01
Gender (Female)	0.18	0.29	0.41	0.520	1.20
Recurrent Disc	0.87	0.37	5.57	0.018	2.38

Neither gender ($p = 0.520$) nor age ($p = 0.648$) emerged as significant predictors. These results lend statistical rigor to the qualitative inference derived from the univariate analysis and strengthen the argument for the inclusion of surgical history—particularly revision status—as a core component of intraoperative risk mitigation frameworks. Importantly, the non-significance of demographic variables such as age and gender underscores the centrality of procedural complexity rather than patient factors in dural tear risk.

3.5. Clinical Outcomes and Follow-Up

The postoperative outcomes were uniformly good for all the patients who underwent durotomy, regardless of the initial mode of treatment. All patients underwent a systematic follow-up at 1-month and 6-month periods after surgery. There were no cases of persistent cerebrospinal fluid leakage, wound infections, pseudomeningocele formation, or development of new neurological deficits reported either in the conservatively managed group or the patients who required reoperation. These results support the effectiveness of the perioperative protocol adopted in this study, emphasizing the role of both intraoperative repair measures and careful postoperative surveillance with timely interventions for achieving optimum recovery.

The absence of long-term complications also challenges the current argument that incidental durotomy necessarily has adverse consequences. This suggests that when a dural defect is promptly diagnosed and treated based on a systematic, evidence-based strategy, it does not necessarily compromise surgical outcomes or patient safety. This finding concurs with current literature highlighting the paramount importance of early intraoperative diagnosis as the most important prognostic factor in the treatment of durotomy.

4. Discussion

This study offers a comprehensive review of the incidence, related risk factors, and treatment outcomes of incidental durotomy in patients undergoing lumbar microdiscectomy, with specific emphasis on the differences between primary and revision surgical procedures. The findings of this study highlight the complex nature of revision spinal surgeries and demonstrate the effectiveness of carefully planned conservative measures in managing incidental durotomy.

The overall incidental durotomy rate in our study population was 8.25%, which aligns with current evidence in the literature [8]. Previous studies have reported a wide range of incidence, typically between 2.7% and 17.2%, depending on the complexity of the surgery and the patient selection criteria [9,10]. Notably, the significantly higher durotomy rate found in revision procedures (16%) compared to primary procedures (7.1%) supports findings from other recent studies. For example, Kögl et al. cited heightened intraoperative risks for reoperative settings due to the effects of adhesions and distorted anatomical structures [11]. Additionally, Albayar et al. recognized revision status and poor differentiation of tissue planes as key factors involved in durotomy during lumbar spine surgical procedures [12].

Our findings suggested that neither sex nor chronological age were determinants of incidental durotomy. This is in keeping with the assertion by Lenschow et al., who suggested that the major determinant of dural injury is the technical difficulty of the procedure, and not demographic factors [13]. While previous research [8] suggested that thinning of

the dura in older patients would be a risk factor, more recent research—especially from randomized series—has turned the focus to technical and anatomical determinants [10,13].

In clinical management, our findings are consistent with the growing accepted perspective that incidental durotomy can be treated conservatively, both safely and effectively in most cases. In the 33 cases of durotomy under review, an impressive 84.8% were successfully managed without requiring reoperation. The findings are consistent with the work of Gomes et al., who, using a systematic review and meta-analysis, identified no significant difference in complication rates between early mobilization and prolonged bed rest following durotomy [14]. Further confirmation was given by Farshad et al., who stated that early ambulation did not lead to a higher rate of complications and indicated that conservative management might be superior if intraoperative closure was carried out tightly [10].

In our series, two patients required further surgical intervention due to persistent cerebrospinal fluid (CSF) leakage. These cases highlight that, while conservative management is optimal for most, early surgical reintervention is still important for certain patients. Najjar et al. noted that complication rates are significantly reduced when reoperation is performed early in patients who do not show improvement [15]. Shahmohammadi et al. also highlighted the effectiveness of primary direct closure for anterior lumbar tears when conservative measures do not provide satisfactory outcomes [16].

In addition, the use of multilayer repair techniques during surgery—such as direct suturing, fibrin glue, and fat grafting—coincides with the evolving standards for dural closure. Zhu et al. demonstrated the impressive efficacy of hydrogel sutureless sealants, which can be considered for inclusion in future clinical guidelines to enhance outcomes in cases where suturing is not possible [17]. Jeon et al. reported results that support watertight closure without the need for lumbar drainage, thus optimizing our approach to eliminate unnecessary procedures when appropriate [18].

The postoperative assessment in our study demonstrated the lack of long-term complications such as chronic cerebrospinal fluid leaks, pseudomeningoceles, or neurological deficits, thus validating the effectiveness of our multimodal management strategy. These findings are consistent with the institutional practices at our institution, where intraoperative dural repairs are augmented with careful conservative postoperative monitoring.

However, limitations should be acknowledged. This was a single-center retrospective study with a relatively small number of reoperations, limiting the power to perform extensive subgroup analyses. Moreover, variables such as BMI, steroid use, and comorbidities were not included in our logistic model. Future prospective multicenter studies are necessary to confirm our findings and optimize durotomy risk stratification and treatment protocols.

5. Conclusion

This retrospective cohort study emphasizes the continued significance of incidental durotomy as a significant, albeit manageable, complication after lumbar microdiscectomy. The study suggests that revision procedures are associated with a significantly increased risk of dural tears, perhaps due to alterations in anatomical landmarks and the presence of epidural fibrosis. Despite this increased risk, the findings of the study show that a standardized approach to intraoperative repair, combined with adequate postoperative management, can result in excellent clinical outcomes, with a significant number of patients being able to achieve resolution without the need for reoperation or experiencing prolonged sequelae.

The results of our research suggest that demographic variables, namely age and gender, are not predictive of durotomy. This highlights the intricacy of the procedure and the impact of the operating room environment. Our study also adds to the growing body of literature that suggests forced mobilization after early mobilization is harmful to recovery, and thus prolonged bed rest is not justified.

The use of multilayered closure techniques—direct suturing of the dura mater, biological glue, and autologous tissue grafts—was effective in reducing cerebrospinal fluid leaks and their associated complications. The results highlight the importance of prompt recognition and management of dural injuries intraoperatively and the importance of vigilant postoperative monitoring protocols.

Given the low rate of reoperations and absence of long-term neurological complications in our series, we endorse a protocol-based, risk-adjusted approach to the management of incidental durotomy that is characterized by technical precision, conservative management, and individualized patient care. Moreover, prospective multicenter studies are needed to improve risk assessment models and promote the development of standardized treatment protocols in various institutions.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

Statement of Ethical Approval

This study was conducted in accordance with institutional guidelines and was approved by the Ethics Committee at King Hussein Medical Center

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