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Abdominal Nerve Injuries Associated with Lumbotomies: A Retrospective Analysis and Literature Review

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Abstract

Background and Objectives: The lumbotomy approach is a well-established surgical technique for renal procedures, including nephron-sparing surgery, radical nephrectomy, and heminephrectomy. Although effective, this access is associated with the risk of abdominal wall nerve injuries, which may result in sensory deficits and the development of a so-called flank bulge. This study aimed to assess the incidence and predictors of abdominal nerve damage in patients who underwent lumbotomies. **Materials and Methods:** A retrospective review of 407 patients treated between 2018 and 2023 was conducted. Outcomes included the presence of abdominal wall protrusions, subjective burden, scar hypoesthesia, and extended sensory disturbance. Associations between variables were analyzed using multivariate regression models. **Results:** Flank bulges were observed in 21.6% of the patients, with more than half reporting it as bothersome. Scar hypoesthesia was noted in 14.0% of patients, while extended hypoesthesia occurred in 7.1%. The highest prevalence of bulging was observed in the nephron-sparing surgery group (27.0%). Regression models confirmed strong associations between bulging, perceived severity, and scar hypoesthesia. The demographic and biochemical parameters were not significant predictors. **Conclusions:** Abdominal nerve injuries following lumbotomy are relatively common and clinically relevant. These complications may affect both body contour and the patient's quality of life. Preventive measures and the use of minimally invasive techniques, whenever feasible, should be considered.

Keywords: lumbotomy; abdominal wall nerve injury; flank bulge; scar hypoesthesia

Introduction

Lumbotomy incisions provide direct access to the retroperitoneal space and continue to be regarded as a valuable operative option in urological surgery, particularly in complex scenarios or when minimally invasive techniques are not feasible [1]. At the same time, the flank incision necessitates transection of the abdominal wall muscle layers together with the intercostal branches and subcostal nerve, which predisposes the patient to injury of the sensorimotor fibers and subsequent denervation of the lateral musculature [2].

Clinically, such nerve injuries may manifest as sensory disturbances, chronic neuropathic pain, and the development of a so-called flank bulge, which is defined as asymmetry or a protrusion of the lateral abdominal wall. Recent studies have estimated that this complication occurs in approximately 25% of patients following a lumbar incision, and nearly half of the affected individuals report deterioration in quality of life associated with the deformity [3,4].

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The extent of this complication is influenced by several factors, including whether the approach is intercostal or subcostal, the degree of dissection and retraction, and patient-specific anatomical conditions. Prospective studies in kidney donors undergoing lumbotomies have demonstrated that the incidence of overt bulging may be reduced when the subcostal nerves are carefully preserved. In some cases, partial spontaneous improvement of the defect has been observed during mid-term follow-up [5]. At the same time, both surgical and urological literature emphasize that the so-called "pseudohernia," resulting from injury to the nerves of the lateral abdominal wall without fascial disruption, is not an uncommon finding after intercostal incisions. Similar complications have been documented in other surgical specialties, such as spinal procedures and thoracic surgery, supporting the concept of a shared pathophysiological mechanism driven by denervation [6,7].

Recently, there has been an increasing emphasis on standardizing the evaluation of abdominal wall complications. The proposed classifications, which incorporate computed tomography imaging together with patient-reported outcome measures (PROMs), make it possible to objectively assess both the severity of deformities and their functional impact. This framework facilitates the identification of patients who may benefit from targeted rehabilitation, neuromodulation strategies, or surgical abdominal wall reconstruction [3,4].

In addition, preventive strategies have been continuously refined. Anatomical and clinical research has highlighted the concept of the so-called "safe line," in which the incision is placed above the line connecting the apex of the 12th rib with the umbilicus, thereby reducing the risk of injury to the T11–T12 intercostal and subcostal nerves. Additional measures, such as limiting the duration and force of retraction, preserving muscular attachments, and exercising caution during partial resection of the 12th rib, further lowered the likelihood of abdominal wall denervation [8,9].

Although the introduction of laparoscopic and robotic procedures has reduced the incidence of nerve-related complications, an open approach is still required in selected cases such as complex renal tumors, extensive scarring, or limited access to advanced technology. Contemporary reviews and analyses of open nephrectomy series emphasize that a flank bulge and sensory deficits remain clinically relevant sequelae, with the potential to negatively affect functional capacity and patient-reported satisfaction [10,11]. Persistent neuralgia, particularly involving the genitofemoral nerve, may arise when the nerve is entrapped by a surgical clip or stapler. In such cases, targeted surgical exploration with subsequent neurectomy has been shown to provide effective symptom relief [2,12].

Given the inconsistencies in the literature, including variations in surgical techniques, nonuniform definitions, and heterogeneous follow-up periods, there is a clear need for large-scale retrospective studies that apply standardized evaluation criteria. Such analyses should integrate anatomical outcomes and patient-reported perspectives. The present investigation, including more than 400 individuals, provides data on the prevalence, characteristics, and interrelationships of abdominal wall neurological complications after lumbotomies, while also highlighting the domains that require further standardization of clinical practice.

Materials and Methods

The study included a consecutive cohort of 407 patients (244 men and 163 women; median age, 64 years) who underwent kidney surgery via a lumbotomy approach between 2018 and 2023. These procedures included nephron-sparing surgery (NSS), radical nephrectomy, heminephrectomy, and nephroureterectomy. The exclusion criteria included a history of prior abdominal wall operations, neuromuscular disorders, or incomplete clinical documentation. Clinical data were obtained from medical records and follow-up visits at ≥6 months postoperatively. The primary endpoints assessed were the presence of a flank bulge, reported severity, scar hypoesthesia, and more extensive sensory disturbances. Statistical analysis was conducted using multivariate logistic regression models, with statistical significance defined as $p < 0.05$.

Data distribution was assessed using the Shapiro–Wilk test. Continuous variables with normal distribution are presented as mean ± standard error of the mean (SEM) and compared between groups using the student's *t*-test. Categorical variables were evaluated with the chi-squared test.

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Associations between paired variables were examined using Spearman's rank correlation. To assess the combined effects of predictors, multiple linear regression was applied with a stepwise forward elimination approach. Statistical significance was defined as a two-tailed $p < 0.05$. All analyses were performed in GraphPad Prism 8 (GraphPad Software, La Jolla, CA, USA).

Statistical Analysis

Data distribution was assessed using the Shapiro–Wilk test. Continuous variables with normal distribution are presented as mean ± standard error of the mean (SEM) and compared between groups using the Student's t-test. Categorical variables were evaluated with the chi-squared test. Associations between paired variables were examined using Spearman's rank correlation. To assess the combined effects of predictors, multiple linear regression was applied with a stepwise forward elimination approach. Statistical significance was defined as a two-tailed $p < 0.05$. All analyses were performed in GraphPad Prism 8 (GraphPad Software, La Jolla, CA, USA).

Results

A total of 407 patients who underwent kidney surgery via lumbotomy approaches were included in the analysis (men, 244; women, 163; median age, 64 years; interquartile range, 55–70 years). The most frequent postoperative abnormality was lateral abdominal wall protrusion (flank bulge), which was observed in 88 patients (21.6%). More than half of these patients (46/88, 52.3%) reported that the deformity interfered with their daily functioning or caused esthetic discomfort. Sensory disturbances restricted to the surgical scar were noted in 57 (14.0%) patients, whereas more extensive sensory deficits affecting the ipsilateral abdominal wall were observed in 29 (7.1%) patients.

When stratified according to the type of surgical procedure, distinct differences emerged in the incidence of postoperative complications.

- **NSS (n = 189):** Abdominal wall bulging was identified in 27.0% of patients (51/189), with 47.1% of those affected reporting the deformity as bothersome. Scar-associated hypoesthesia was present in 16.4% of patients, while more diffuse sensory deficits were documented in 7.9%.
- **Radical nephrectomy (n = 141):** Flank protrusion occurred in 16.3% (23/141) of the patients, of whom 65.2% described it as troublesome. Localized scar hypoesthesia was observed in 12.8% and extended sensory loss in 6.4%.
- **Heminephrectomy (n = 42):** Wall bulging was recorded in 19.0% (8/42) of patients, with 62.5% of cases considered disturbing by the patients. Hypoesthesia confined to the surgical scar occurred in 11.9% of patients, whereas broader sensory abnormalities were noted in 7.1% of patients.
- **Nephroureterectomy (n = 35):** Lateral wall bulge was observed in 17.1% (6/35) of the patients, and 33.3% of the affected patients rated it as bothersome. Scar hypoesthesia was reported in 8.6% of patients, while generalized sensory disturbances were identified in 5.7% of patients.

The highest proportion of abdominal wall bulging was observed after NSS, whereas the greatest proportion of patients described the symptoms as troublesome after radical nephrectomy and heminephrectomy.

In multivariate analyses, significant interrelationships were identified among the evaluated symptoms:

- Abdominal wall bulging showed a strong correlation with both reported severity (estimated 0.446; $p < 0.0001$) and the presence of scar site hypoesthesia (estimated 0.665; $p < 0.0001$).
- The perception of the symptom burden was primarily determined by the bulge itself (estimate, 0.436; $p < 0.0001$) and localized sensory loss at the scar (estimate, 0.141; $p = 0.022$).
- Scar-associated hypoesthesia was significantly associated with bulging (estimated 0.508, $p < 0.0001$) and extended sensory deficits (estimated 0.094, $p = 0.022$).
- Widespread hypoesthesia most frequently co-occurred with scar hypoesthesia (estimated at 0.504, $p < 0.0001$).

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Other variables, including age, body mass index (BMI), and biochemical measures (hematocrit and pre- and postoperative creatinine levels), showed no significant associations. These findings indicate that neurological complications following lumbotomies are frequent and heterogeneous, manifesting as alterations in the abdominal wall contour and sensory disturbances. Approximately one in five patients developed flank bulging, and nearly half of these individuals rated the condition as interfering with daily activities. The strong interconnections between bulging, its reported severity, and scar-related hypoesthesia suggest a shared pathophysiological mechanism, most likely linked to abdominal wall nerve injury during the surgical approach. An overview of the distribution of these complications across surgical procedures is summarized in Table A1.

Discussion

The present analysis demonstrates that neurological complications of the abdominal wall following lumbotomy are relatively frequent and have clinical significance. Contemporary literature shows that the reported incidence of flank bulges after lumbar incisions varies widely, from a few percentages to more than half of the cases, depending on the surgical technique (intercostal vs. subcostal), definitional criteria, and length of follow-up. In a prospective cohort of living kidney donors, the incidence of bulging was estimated to be approximately 5%, with sonographic evidence of gradual muscle recovery within 12 months. In contrast, other clinical series and systematic reviews, especially those incorporating imaging assessments and PROMs, have documented rates between 8% and 57%, often noting a substantial negative effect on quality of life in up to half of the affected individuals. The prevalence observed in our study (21.6%) falls within this spectrum and reflects the heterogeneity described in recent publications [4,5,13].

The underlying pathophysiological mechanism involves injury to the intercostal nerve branches (T10–T12) and the subcostal nerve, which lie between the internal oblique and transversus abdominis muscles. Damage to this level results in denervation and subsequent weakening or laxity of the corresponding abdominal wall segment [14]. Anatomical investigations and nerve-mapping studies have identified regions with lower fiber density, which formed the basis for the concept of the so-called “safe line.” This approach—placing the incision above the axis connecting the apex of the 12th rib to the umbilicus—has been proposed as a strategy to minimize the likelihood of neural injury. In our analysis, the concurrent presence of flank bulges, their reported burden, and scar-related hypoesthesia supported the hypothesis of a shared denervation-related mechanism [9].

Although laparoscopic and robotic procedures generally reduce the incidence of nerve-related complications, they do not completely prevent them. Reports from other lateral retroperitoneal approaches—such as extreme lateral interbody fusion (XLIF) in spine surgery—have described abdominal wall “pseudohernias” resulting from intercostal or subcostal neuropathies. These patients presented with a clinical picture resembling the flank bulge observed after lumbotomy, often with gradual improvement during follow-up. Rare, but well-documented instances of pseudohernias have also been observed after thoracotomy or intercostal incisions, reinforcing the concept of a shared injury mechanism associated with lateral surgical access [7,15].

In recent years, an increasing emphasis has been placed on standardizing the diagnosis and grading of abdominal wall deformities. The proposed strategies include imaging-based scales, such as computed tomography (CT)-based classifications, as well as PROMs, which enable the objective evaluation of severity and assessment of quality-of-life impact. This structured approach facilitates patient selection for targeted rehabilitation, pain neuromodulation, and, when indicated, reconstructive procedures. Simultaneously, intraoperative preventive strategies are being refined, including limiting the duration and intensity of retraction, avoiding unnecessary incision extension, preserving muscle attachments, and exercising caution during 12th-rib resections. Moreover, anatomical investigations published in 2024 highlighted the importance of preserving nerve branches when planning surgical exposure and fascial closure. Our findings, showing no significant role for demographic factors such as age or BMI but demonstrating strong correlations between specific

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symptoms, suggest that technical variables are critical and that standardized approaches to exposure and closure may reduce the risk of postoperative complications [3,4,9,16].

Conclusions

Based on the evaluation of 407 consecutive renal procedures performed using a lumbotomy approach, we found that abdominal wall nerve-related complications are both frequent and clinically meaningful. Approximately one in five patients developed a lateral abdominal wall bulge, and more than half of those affected reported significant functional limitations or cosmetic dissatisfaction. These observations align with recent literature showing that the incidence of a flank bulge after lumbar incisions may reach 25–50%, depending on the definition applied and the length of follow-up. Furthermore, the detrimental effect on quality of life has been consistently demonstrated in studies employing PROMs [4,17].

Practical Implications

Intraoperative prevention should emphasize careful incision planning within regions of lower neural fiber density (the so-called "safe line/zone"), preservation of muscular attachments, minimization of both the duration and force of retraction, and a cautious approach to resection of the 12th rib. This strategy is supported by both an anatomical rationale and clinical evidence [9,20].

Choice of surgical approach:

Whenever oncological safety and technical feasibility are required, minimally invasive strategies (laparoscopic or robotic) are preferred. Compared to open access surgery, these approaches are consistently associated with a lower incidence of nerve-related complications, although they do not completely eliminate this risk [18].

Standardization of assessment:

We recommend routine documentation of postoperative symptoms using validated PROMs. In ambiguous or clinically severe cases, imaging-based evaluation should be performed by applying the proposed CT-based grading systems that classify the degree of abdominal wall deformity. This structured approach facilitates patient selection for targeted rehabilitation, pain neuromodulation, and abdominal wall reconstruction [3,4].

Management pathway for neuralgia:

Persistent neuropathic pain requires early differential evaluation, including avoiding potential nerve entrapment using surgical clips or staplers. When such involvement is confirmed, surgical intervention should be considered as part of the therapeutic strategy [19].

Prospective multicenter studies are needed with harmonized definitions of endpoints that integrate PROMs with objective imaging-based criteria, extended follow-up periods, and meticulous documentation of intraoperative exposure factors such as incision length, 12th-rib resection, and the duration and type of retraction. In parallel, the development of predictive tools—such as combined clinical-radiologic models—may help identify patients at increased risk of clinically significant "morbid bulges," ultimately enabling more precise surgical planning and targeted preventive strategies [3].

The present analysis demonstrates that although the lumbotomy approach has substantial clinical and oncological value, it is associated with a considerable incidence of abdominal wall neurological complications [5,9]. In more than 20% of patients, lateral abdominal wall protrusion (flank bulge) was identified, and in approximately half of these cases, the deformity was associated with a self-reported decline in quality of life [4,5]. The resulting abdominal wall protrusion substantially compromises the ability to perform professional duties within uniform services. Simultaneously, sensory disturbances localized to the surgical scar or involving the abdominal wall have been observed in a considerable proportion of patients[4]. The concordance of our findings with international reports confirms that this issue represents a systemic complication and should not be regarded as an uncommon cosmetic outcome [4,5].

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There is a clear need for prospective multicenter studies with extended follow-up that incorporate both the patient's perspective and objective imaging-based evaluation [3–5]. The development of predictive models capable of identifying patients at an increased risk of complications may allow for greater individualization of the surgical approach. In addition, ongoing research on nerve-sparing strategies and abdominal wall reconstruction has the potential to enhance the quality of life of patients undergoing retroperitoneal surgery for kidney disease [9,19].

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The original contributions presented in this study are included in the article. Further inquiries can be directed to the corresponding authors.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

PROM	Patient-reported outcome measure
NSS	Nephron-sparing surgery
BMI	Body mass index
H-A	Heminephrectomy
NU	Nephroureterectomy
XLIF	Extreme lateral interbody fusion
CT	Computed tomography

Appendix A

Table A1. Incidence of abdominal wall complications following lumbotomy stratified by surgical procedure type.

References

1. Nanidis, T.; Antcliffe, D.; Kokkinos, C.; Borysiewicz, C.A.; Darzi, A.W.; Tekkis, P.P.; Papalois, V.E. Laparoscopic vs open donor nephrectomy: meta-analysis. *Ann Surg* **2008,** *247*, 58–70.
2. Colalillo, G.; Ippoliti, S.; Altieri, V.M.; Saldutto, P.; Galli, R.; Asimakopoulos, A.D. Nerve at Risk: A Narrative Review of Surgical Nerve Injuries in Urological Practice. *Surgeries* **2025**, *6*, 58.
3. Inkiläinen, A.; Ljungberg, B.; Blomqvist, L.; Strigård, K. Addressing the need for predictive tools in postoperative abdominal wall complications after nephrectomy—Evaluation of a novel abdominal bulge grading system using computed tomography. *Acta Radiol Open* **2025**, *14*, 20584601251367336.
4. Inkiläinen, A.; Blomqvist, L.; Ljungberg, B.; Strigård, K. Patient-reported outcome measures of abdominal wall morbidity after flank incision for open partial nephrectomy. *BJU Int* **2021**, *128*, 497–503.

5. van Uitert, A.; Chaman-Baz, H.A.; van der Wal, S.E.I.; Zhu, X.; Wijntjes, J.; Timmers, H.J.L.M.; Witjes. J.A.; van Alfen, N.; Langenhuijsen, J.F. A prospective case series to evaluate subcostal nerve injury with high-resolution ultrasound in posterior retroperitoneoscopic adrenalectomy. *Surg Endosc* **2024**, *38*, 3145–3155.
6. Choi, J.H.; Jang, J.S.; Jang, I.T. Abdominal Flank Bulging after Lateral Retroperitoneal Approach: A Case Report. *NMC Case Rep J* **2016**, *4*, 23–26.
7. Shen, S.; He, Z.; Li, G.; Jia, X.; Lu, Z.; Shi, Y.; Pu, J.; Huang, H. Abdominal wall pseudohernia following video-assisted thoracoscopic surgery: a case report and literature review. *Video-Assisted Thoracic Surgery* **2024**, 9. [access: https://vats.amegroups.org/article/view/9371/html; 09.09.2025]
8. Ozel, L.; Marur, T.; Unal, E.; Kara, M.; Erdoğdu, E.; Demir, T.; Berber, I.; Gurkan, A.; Kiliçoğlu, G.; Bakal, N.; Titiz, M.I. Avoiding abdominal flank bulge after lumbotomy incision: cadaveric study and ultrasonographic investigation. *Transplant Proc* **2012**, *44*, 1618–1622.
9. van der Graaf, T.;, Verhagen, P.; Kerver, A.L.; Kleinrensink, G.J. Surgical anatomy of the 10th and 11th intercostal, and subcostal nerves: prevention of damage during lumbotomy. *J Urol* **2011,** *186*, 579–583.
10. O'Connor, E.; Timm, B.; Lawrentschuk, N.; Ischia, J. Open partial nephrectomy: current review. *Transl Androl Urol* **2020**, *9*, 3149–3159.
11. Kalapara, A.A.; Frydenberg, M. The role of open radical nephrectomy in contemporary management of renal cell carcinoma. *Transl Androl Urol* **2020**, *9*, 3123–3139.
12. Ramdhani, K.; Malessy, M.J.A.; Simon, M.J.G.; Huurman, V.A.L. Nerve Surgery to Treat Intractable Genitofemoral Neuropathic Pain following Laparoscopic Live Kidney Donation. *Case Rep Transplant* **2018**, 9326975.
13. Abdi, A.; Imani, B.; Mousavibahar, S.H.; Khazaei, S.; Jalal, S.B. Comparing the effects of intercostal and subcostal flank incision on post-operative pain and incisional hernia or bulge in patients undergoing open kidney surgery: A randomized clinical trial. *Int J Abd Wall Hernia Surg* **2024**, *7*, 165–170.
14. Kesikburun, B.; Ekşioğlu, E.; Akyüz, E.Ü.; Demirel, F.; Çakcı, A. Femoral neuropathy after donor nephrectomy: A case report. *J Back Musculoskelet Rehabil* **2015**, *28*, 873–875.
15. Yasukawa, T.; Ohya, J.; Kawamura, N.; Onishi, Y.; Yoshida, Y.; Kobayashi, M.; Kudo, Y.; Shirahata, T.; Kunogi, J. Abdominal Pseudohernia after Extreme Lateral Interbody Fusion Procedure: A Case Report. *Spine Surg Relat Res* **2020**, *5*, 218–220.
16. Alblowi, A.; Settembre, N.; Alsadery, H.; Nabokov, V.; Perez, M.; Malikov, S. Anatomical Study of Abdominal Wall Muscle Innervation to Optimize Retroperitoneal Vascular Approach. *Ann Vasc Surg* **2025**, *110*, 66–74.
17. Chatterjee, S.; Nam, R.; Fleshner, N.; Klotz, L. Permanent flank bulge is a consequence of flank incision for radical nephrectomy in one half of patients. *Urol Oncol* **2004**, *22*, 36–39.
18. Cui, L.; Zhu, Y.; Liu, S.; Zhang, L.; Zhu, Q.; Wang, Y.; Ma, D. Effect of Low Thoracic Paravertebral Block via the Arcuate Ligament Under Direct Visualization on the Quality of Postoperative Recovery After Laparoscopic Donor Nephrectomy for Living-Donor Kidney Transplantation: Study Protocol for a Prospective, Blinded, Randomized Controlled Clinical Trial. *J Pain Res* **2025**, *18*, 2409–2416.
19. Alonso, F.; Graham, R.; Rustagi, T.; Drazin, D.; Loukas, M.; Oskouian, R.J.; Chapman, J.R.; Tubbs, R.S. The Subcostal Nerve During Lateral Approaches to the Lumbar Spine: An Anatomical Study with Relevance for Injury Avoidance and Postoperative Complications Such as Abdominal Wall Hernia. *World Neurosurg* **2017**, *104*, 669–673.