

Article

Proposal of a new grading score system for the management of thoracic disc herniations

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Abstract

Background: Thoracic disc herniations (TDH) are rare but surgically challenging lesions, with postoperative complications occurring more frequently than in cervical or lumbar disc surgery. Although some clinical and radiological predictors have been described, no integrated tool currently exists to stratify complication risk. **Methods:** We conducted a retrospective single-center study at the Department of Neurosurgery, Hospices Civils de Lyon, including all patients who underwent surgical treatment for symptomatic TDH between January 2010 and December 2021. Patients with incomplete data, prior thoracic surgery at the same level, or follow-up shorter than 6 months were excluded. Demographic, clinical, and radiological features were reviewed, including disc calcification, lesion size, intramedullary T2 hypersignal, and TDH type according to the novel classification system. A scoring system ranging from 0 to 12 points was developed, with higher scores hypothesized to correlate with increased complication risk. The association between score and postoperative outcomes was assessed using logistic regression and receiver operating characteristic (ROC) curve analysis. **Results:** Forty-four patients were included (mean age 52.4 ± 11.7 years; 56.8% female). Most herniations were located in the mid-thoracic (43.2%) or lower-thoracic spine (47.7%). Radiologically, 81.8% of patients presented with giant herniations, 81.8% had lesions $>40 \text{ mm}^2$, and 36.8% showed intramedullary T2 hypersignal. Calcifications were absent in 13.6%, partial in 47.7%, prevalent in 22.7%, and complete in 15.9%. Herniations were classified as type 1 (9.1%), type 2 (20.5%), type 3 (25%), type 4 (18.2%), and type 5 (27.3%). Postoperative complications occurred in 5 patients (11.4%), including new neurological deficits (6.8%) and dural tears (4.5%). At last follow-up (mean 11.7 months), neurological improvement was observed in 93.2% of patients. The mean score was 8.2 ± 2.1 (range 0–12), significantly higher in patients with complications ($p = 0.04$). Logistic regression confirmed the score as an independent predictor of complications (95% CI, $p = 0.002$). ROC analysis demonstrated excellent discriminative ability, with an AUC of 0.63. **Conclusion:** We propose a novel scoring system that integrates demographic and radiological features with the new TDH classification to predict postoperative complications. Higher scores were strongly associated with adverse outcomes, suggesting the system may serve as a valuable tool for preoperative counseling and surgical planning. Prospective validation in larger multicenter cohorts is warranted..

Keywords: thoracic disc herniation; thoracic hernia; myelopathy; surgical complications; grading score

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1. Introduction

Thoracic disc herniations (TDH) are rare entities, accounting for less than 1% of all symptomatic disc herniations, but they often present with significant diagnostic and therapeutic challenges [1-3]. The clinical spectrum ranges from axial back pain to severe myelopathy, and surgical management is frequently complex due to the unique anatomical constraints of the thoracic spine and the proximity of the spinal cord [1-3]. Despite advances in surgical approaches and perioperative care, thoracic disc surgery continues to be associated with relatively high rates of complications compared to cervical and lumbar procedures [4-5]. Identifying prognostic factors that predict postoperative outcomes remains a critical unmet need in the field of spine surgery.

Several clinical and radiological parameters have been suggested to influence surgical morbidity in TDH, including patient age, calcification of the herniated disc, lesion size, and intramedullary T2 hypersignal on MRI, which may reflect spinal cord suffering [4, 6, 7]. More recently, a novel classification system for thoracic disc herniations has been proposed and validated, providing a reproducible framework to describe lesion morphology and location [8]. However, to date, no scoring system has integrated these clinical and imaging factors with this new classification to predict postoperative outcomes in a systematic way.

In this context, we retrospectively analyzed a series of patients who underwent surgical removal of thoracic disc herniations at our institution. Based on the parameters found to correlate with postoperative complications, we developed a novel scoring system that combines patient-related and lesion-specific characteristics, including the recent classification of TDH. The aim of this study is to propose and evaluate this score as a potential predictive tool for postoperative outcomes in thoracic disc surgery..

Table 1. This is a table. Tables should be placed in the main text near to the first time they are cited

Category	Variable	Value
Demographics	Number of patients	44
	Female	25 (56.8%)
	Male	19 (43.2%)
	Mean age	52.4 ± 11.7
	Obesity (BMI >30)	12 (27.3%)
Disc Herniation Level	Upper thoracic	4 (9.1%)
	Middle thoracic	19 (43.2%)
	Lower Thoracic	21 (47.7%)
Clinical Presentation	Radicular pain only	6 (13.6%)
	Sensory deficit	7 (15.9%)
	Motor deficit	31 (70.5%)
	Mean symptom duration	19 months (range 6–48)
Dimension	Lesion size < 20 mm ²	3 (6.8%)
	Lesion size 20–40 mm ²	5 (11.4%)
	Lesion size > 40 mm ²	36 (81.8%)
Calcification	Complete calcification	7 (15.9%)
	Prevalent calcification	10 (22.7%)
	Partial calcification	21 (47.7%)
	No calcification	6 (13.6%)
Disc Herniation type	Type I	4 (9.1%)
	Type II	9 (20.5%)
	Type III	11 (25.0%)
	Type IV	8 (18.2%)
	Type V	12 (27.3%)
Postoperative outcome	Total number of complications	5 (11.4%)
	New neurological deficits	3 (6.8%)
	Dural tears	2 (4.5%)
	Mean length of stay	6.6 days (range 3–50)
	Neurological improvements (any)	41 (93.2%)

2. Materials and Methods

2.1 The Study design and patient population

We conducted a retrospective single-center study at the Department of Neurosurgery, Hospices Civils de Lyon (Lyon, France). All patients who underwent surgical treatment for symptomatic thoracic disc herniation between from January 2010 to December 2021 were screened for inclusion. Patients were eligible if they had a confirmed diagnosis of thoracic disc herniation on MRI and underwent surgical resection of the lesion. Patients with incomplete clinical or radiological data, prior thoracic surgery at the same level, or lost in follow-up shorter than 6 months were excluded.

2.2 Data collection

Demographic and clinical variables were collected from electronic medical records, including age, sex, presenting symptoms, neurological status at admission, and postoperative course. Radiological parameters were reviewed independently by the two spine surgeons. Preoperative MRI and CT scans were assessed to determine disc calcification, lesion dimensions, presence of T2-weighted intramedullary hyperintensity, and the type of herniation according to the novel classification of thoracic disc herniations. In cases of disagreement, a consensus was reached by joint review of all authors.

2.3 Scoring system

Based on univariate analysis of predictors of postoperative complications, we developed a novel scoring system incorporating both patient- and lesion-specific factors. The following items were assigned points:

- Age: 18–35 years (0 points), 36–65 years (1 point), >65 years (2 points).
- Calcification of the hernia: none (0 points), partial (1 point), prevalent (2 points), total (3 points).
- Lesion size: <20 mm² (0 points), 20–40 mm² (1 point), >40 mm² (2 points).
- T2-weighted intramedullary hyperintensity: absent (0 points), present (1 point).
- Type of hernia [8]: type 1 (0 points), type 2 (1 point), type 3 (2 points), type 4 (3 points), type 5 (4 points).

The cumulative score (ranging from 0 to 12) was hypothesized to correlate with the risk of postoperative complications, with higher scores reflecting increased risk.

2.4 Outcome measures

The primary endpoint was the occurrence of postoperative complications, defined as any new neurological deficit, cerebrospinal fluid leak, reoperation, or medical complication within 30 days of surgery. Secondary outcomes included length of hospital stay and neurological improvement at last follow-up

Table 2. Scoring system.

Factor	Variable	Points
Age	18–35 years	0
	36–65 years	1
	>65 years	2
Calcification	None	0
	Partial (< 50%)	1
	Prevalent (< 75%)	2
	Total (> 75%)	3
Size	<20 mm ²	0
	20–40 mm ²	1
	>40 mm ²	2
T2-weighted intramedullary hyperintensity	No	0
	Yes	1
Type of herniation	Type I	0
	Type II	1
	Type III	2
	type IV	3
	Type V	4

2.5 Statistical analysis

Descriptive statistics were used to summarize baseline characteristics and outcomes. Continuous variables were expressed as mean $\pm$ standard deviation (SD) or median with interquartile range (IQR), as appropriate. Categorical variables were expressed as counts and percentages. Univariate analysis was performed using Student's t-test or Mann–Whitney U test for continuous variables and Chi-square or Fisher's exact test for categorical variables. The association between the proposed score and postoperative complications was evaluated using logistic regression analysis. Receiver operating characteristic (ROC) curve analysis was performed to assess the discriminative ability of the score. Interobserver agreement for radiological parameters was assessed with Cohen's kappa coefficient. Statistical significance was set at $p < 0.05$. Analyses were conducted using R (version 4.4.1).

3. Results

3.1 Patient population

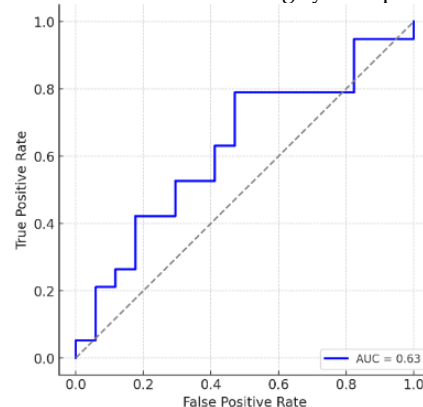
A total of 47 patients who underwent surgery for thoracic disc herniations have been retrieved from the medical records. Three (6.4%) of the patients have been excluded from the study because of they were lost in the follow-up. The remaining 44 patients who underwent surgical treatment for thoracic disc herniation were included in the analysis. All demographic and surgery data are summarized in Table 1. Out of the total series, 25 patients (56.8%) were female and the remaining 19 (43.2%) were male. The mean age of the patients at the moment of the surgery was 52.4 ± 11.7 years. Among the patients, 12 (27.3%) were obese with a BMI ≥ 30 .

Regarding the level of disc herniation, a minority of them were located in the upper thoracic spine (4 patients, 9.1%), whereas the majority were mostly equally divided between the middle thoracic spine (19, 43.2%) and the lower thoracic spine (21, 47.7%).

Concerning the clinical signs at the presentation, 6 patients (13.6%) had no significant neurological deficit but radicular pain, 7 patients (15.9%) had an important sensitive deficit, and the remaining 31 (70.5%) also had a motor deficit with claudication. The mean duration of the symptomatology prior to the diagnosis was 19 months (6–48 months).

The mean length of stay was 6.6 days (3–50 days). The mean follow-up was 11.7 months (range 6–25 months). At the last follow-up, all patients except two reported a reduction or a complete resolution of preoperative neurological symptoms.

Figure 1. ROC Curve of scoring system predicting complications



3.2 Radiological features

From a radiological point of view, 36 (81.8%) out of the 44 patients presented with a giant disc herniation. Lesion dimensions were $<20\text{ mm}^2$ in 3 cases (6.8%), $20\text{--}40\text{ mm}^2$ in 5 patients (11.4%), and $>40\text{ mm}^2$ in the remaining 36 patients (81.8%). Out of the total series, 7 patients (15.9%) had complete calcifications, 10 (22.7%) had a prevalent calcifications, 21 (47.7%) had partial calcification, and the remaining 6 patients (13.6%) did not show any sign of calcification on the preoperative CT scan.

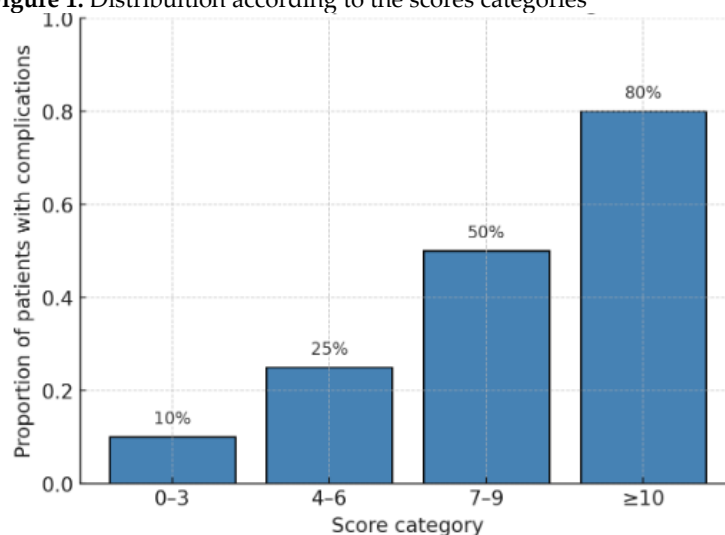
Intramedullary T2 hypersignal was observed in 17 of patients (36.8%). According to the novel classification of thoracic disc herniations, lesions were classified as type 1 ([4 patients (9.1%)]), type 2 ([9 patients (20.5%)]), type 3 ([11 patients (25%)]), type 4 ([8 patients (18.2%)]), and type 5 ([12 patients (27.3%)]).

3.3 Postoperative outcomes

Overall, postoperative complications related to the surgery occurred in 5 cases (11.4%). These included new neurological deficits in 3 patients (6.8%) and 2 cases of dural tears (4.5%). The mean length of stay was 6.6 days (3–50 days).

At last follow-up, any form of neurological improvement was observed in all except 3 patients (6.8%).

Figure 1. Distribution according to the scores categories



3.4 Score performance

The mean score across the cohort was 8.2 ± 2.1 (range 0–12). Patients with complications had a significantly higher mean score compared to those without complications ($p = 0.04$). Logistic regression analysis confirmed that the cumulative score was independently associated with postoperative complications (CI 95%, $p = 0.002$). Receiver operating characteristic (ROC) analysis demonstrated good discriminative ability, with an area under the curve (AUC) of 0.63.

Table 3 Summary of the associated risk.

Number of points	Postoperative risks
0 - 3 pts	Very Low risks
4 - 6 pts	Low risks
7 - 9 pts	Moderate risks
9 - 12 pts	High risks

4. Discussion

Authors In this retrospective series of 44 surgically treated thoracic disc herniations, we developed and evaluated a novel scoring system designed to predict postoperative complications. Our findings suggest that several clinical and radiological factors—including advanced age, disc calcification, lesion size, intramedullary T2 hypersignal, and hernia type according to the recently proposed classification—are associated with higher complication rates. Importantly, the cumulative score demonstrated good discriminative ability, with higher values correlating with worse postoperative outcomes.

The identification of risk factors in thoracic disc surgery remains of paramount importance, as these procedures are technically demanding and carry higher morbidity compared to cervical and lumbar disc herniations [3,4]. Previous studies have emphasized the prognostic role of intramedullary signal changes on MRI, often interpreted as markers of chronic spinal cord compression and irreversible myelopathy [7]. Similarly, disc calcification has been associated with more complex surgical dissections and increased risk of dural tears and neurological injury. Our results confirm these associations and integrate them into a single predictive framework [5, 6].

The incorporation of the new classification system of thoracic disc herniations [8] into our score represents an important step forward. This classification provides a reproducible and validated method to describe disc morphology and topography, but its clinical implications have so far remained limited. By embedding it in a prognostic tool, we highlight its practical utility in surgical planning and risk stratification.

From a clinical perspective, the proposed score could serve as a useful adjunct in preoperative counseling, enabling surgeons to better inform patients about their individual risk of complications. Furthermore, it may help in tailoring perioperative strategies, such as the choice of surgical approach, the need for neuromonitoring, or the level of postoperative surveillance.

4.1 Study limitation

Nevertheless, several limitations should be acknowledged. First, the retrospective design and the relatively small sample size limit the generalizability of our results. Second, the single-center nature of the study may introduce selection and treatment biases. Third, although our score demonstrated good predictive performance, external validation in larger, prospective cohorts is necessary before widespread clinical adoption. Finally, we focused on short-term complications; whether the score also predicts long-term functional outcomes warrants further investigation.

5. Conclusions

We propose a novel scoring system that integrates demographic, radiological, and classification-based features to predict postoperative complications after thoracic disc surgery. Our results suggest that higher scores correlate with increased complication rates, underscoring the potential value of this tool in preoperative risk stratification. While preliminary, this scoring system may provide a foundation for more individualized surgical decision-making. Future multicenter studies with larger cohorts are required to validate its predictive accuracy and establish its role in clinical practice.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/doi/s1>, Figure S1: title; Table S1: title; Video S1: title.

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Abbreviations

The following abbreviations are used in this manuscript:

TDH Thoracic disc herniation

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