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INTRODUCTION

Cervical disc herniation (CDH) is a common clinical pathology in spine surgery, resulting from degenerative changes in the cervical intervertebral discs. Although the condition predominantly affects middle-aged and elderly individuals, recent studies have reported a progressive decrease in the age at diagnosis, with an increasing incidence among younger populations (1). CDH occurring in young adults may lead to significant impairment in occupational performance and quality of life, thereby rendering the early identification of appropriate treatment strategies

clinically more critical. Nevertheless, risk factors and predictive models aimed at identifying young adult patients with CDH who require surgical intervention have been insufficiently investigated in the existing literature (2).

The pathogenesis of CDH is considered to involve a complex interaction of genetic predisposition, biomechanical loading, and environmental factors. Biomechanical stressors such as repetitive microtrauma, prolonged maintenance of flexion or extension postures, and physically demanding workloads are known to accelerate disc degeneration (3). However, the relative

A predictive nomogram for surgical treatment requirement in young patients with cervical disc herniation

Abstract

Aim: Cervical disc herniation (CDH) has traditionally been considered a degenerative disorder of middle-aged and elderly populations; however, recent epidemiological data indicate an increasing incidence among younger individuals. Although many young adult patients respond favorably to conservative treatment, a subset ultimately requires surgical intervention. Clinically applicable and evidence-based predictive tools tailored to this age group remain limited. This study aimed to identify independent predictors of surgical treatment requirement in young adult patients with CDH and to develop a prognostic nomogram for individualized risk estimation.

Materials and Methods: This retrospective cohort study included 550 patients aged 18–40 years diagnosed with cervical disc herniation between January 2019 and December 2025. Clinical, demographic, lifestyle, and radiological variables were systematically collected. Variable importance was assessed using a Random Forest algorithm, and independent predictors were identified via multivariable logistic regression following multicollinearity evaluation using the variance inflation factor (VIF). A prognostic nomogram was constructed, and model performance was evaluated using receiver operating characteristic (ROC) analysis.

Results: Surgical intervention was performed in 234 patients (42.5%). Increasing age, male sex, neurological deficit, myelopathy, trauma history, positive family history, and low physical activity were identified as independent predictors of surgical requirement. Radiological instability and pain severity were significant in univariable and machine learning analyses but were excluded from the final model due to multicollinearity. The model demonstrated good discriminative ability (AUC $\approx$ 0.83). However, its generalizability is limited by the retrospective single-center design and the absence of external validation.

Conclusion: This study identifies independent determinants of surgical necessity in young adult patients with cervical disc herniation and proposes a prognostic nomogram for individualized risk stratification. The proposed model may support risk assessment and clinical decision-making in this population.

Keywords: Cervical disc herniation, young adult, surgical indication, nomogram, risk prediction

contribution of these factors and interindividual variability in the young population have not been adequately elucidated. Furthermore, a substantial proportion of patients under 40 years of age with CDH achieve clinical improvement with conservative treatment, and accurately identifying those who will ultimately require surgical intervention remains a significant challenge in clinical decision-making.

Although general risk factors associated with CDH have been described in previous studies, data regarding the distribution of these factors in terms of surgical necessity within the young age group remain limited (4). In recent years, nomograms have emerged as valuable clinical prediction tools that enable individualized risk estimation and support clinical decision-making processes (5). However, to date, no large-scale and clinically applicable nomogram model has been developed to predict the need for surgical treatment specifically in young adult patients with CDH.

In this single-center retrospective cohort study, comprehensive clinical and radiological data from young adult patients with CDH evaluated over an approximately six-year period at a tertiary care center were analyzed. Contemporary literature emphasizes the roles of genetic factors, individual biomechanical differences, and traumatic influences in the development of disc degeneration (6–8). The primary aim of this study was to identify clinical and demographic factors associated with surgically treated CDH in young individuals and to develop a reliable and user-friendly nomogram capable of predicting the need for surgical intervention in this patient population.

MATERIALS AND METHODS

This retrospective, single-center cohort study included patients with a confirmed diagnosis of cervical disc herniation at Ankara City Hospital between January 2019 and December 2025.

A total of 550 young adult patients aged 18–40 years without documented systemic comorbidities were identified and included in the analysis. Eligibility criteria required a clinically and radiologically confirmed diagnosis of cervical disc herniation and the availability of complete clinical and radiological datasets. Patients with a history of prior cervical spine surgery, the presence of chronic systemic conditions such as rheumatologic diseases or malignancies, or incomplete or insufficient medical records were excluded from the study. The inclusion of patients with varied demographic characteristics contributed to increased cohort heterogeneity, thereby enhancing the generalizability of the study findings. All study data were retrospectively extracted from electronic medical record systems following approval by the Institutional Ethics Committee of Ankara City Hospital (Approval No: TABED 1-25-1355, Date: 04.06.2025). The study was conducted in accordance with the Declaration of Helsinki, and the requirement for informed consent was waived due to its retrospective design.

Data Collection and Variables

Patient data were retrospectively collected from electronic medical record systems, preoperative clinical evaluations, radiological imaging studies, and follow-up records. Variables were predefined based on their clinical relevance to surgical decision-making and supported by previously published literature. The collected variables were categorized into demographic, clinical, lifestyle-related, medical history, and radiological domains. Demographic variables included age, sex, and body mass index (BMI).

Clinical variables comprised preoperative pain severity assessed using the Visual Analog Scale (VAS), the presence of radicular symptoms, neurological deficits, and myelopathy. These variables reflect the degree of neural compression and functional impairment and are regarded as key determinants in defining surgical necessity.

Lifestyle-related variables included smoking status, occupation, and physical activity level, as occupational workload and physical activity may influence symptom severity, functional limitation, and the decision-making process regarding surgical treatment.

Medical history variables consisted of family history and history of trauma, which may contribute to disease progression and symptom burden.

Radiological variables included the presence of radiological instability, a critical parameter guiding surgical indication due to its association with spinal imbalance and an increased risk of disease progression. Radiological instability was defined based on findings from dynamic flexion–extension lateral cervical radiographs, including increased segmental translation and/or angular motion, and was further supported by magnetic resonance imaging findings when available.

Outcome

The primary objective of this study was defined as the presence of cervical disc herniation requiring surgical intervention in young individuals. Accordingly, the main aim of the study was to systematically identify the clinical and demographic risk factors associated with the development of surgically indicated cervical disc herniation in a young adult patient population and to quantitatively evaluate the relative impact of these factors on surgical necessity using statistical methods. In addition, based on the obtained clinical and statistical findings, the study aimed to develop a reliable and individualized prognostic nomogram model to predict the need for surgical intervention in young adult patients with cervical disc herniation, which could be feasibly integrated into clinical decision-making processes.

Statistical Analysis

Descriptive statistics were used to summarize the study data, as appropriate. Continuous variables were presented as mean $\pm$ standard deviation for normally distributed data or as median with interquartile range (Q1–Q3) for non-normally distributed

variables. Categorical variables were expressed as frequencies (n) and percentages (%).

Comparisons between patients who underwent surgery and those managed nonoperatively were performed using the Wilcoxon rank-sum test for continuous variables, and the Pearson chi-square test or Fisher's exact test for categorical variables, as appropriate. A two-sided p value < 0.05 was considered statistically significant for all analyses.

No missing data were identified in the dataset; therefore, no data imputation or case deletion procedures were applied, and all available observations were included in the analyses.

To explore potential associations among continuous variables related to surgical decision-making, a correlation matrix was constructed. A strong positive correlation was observed between BMI and VAS pain score. Accordingly, multicollinearity among predictors was assessed using the Variance Inflation Factor (VIF). Due to high multicollinearity, BMI and VAS score were not included simultaneously in logistic regression and nomogram models. However, when entered individually, both variables demonstrated a strong and statistically significant association with surgical decision-making.

To identify and rank variables associated with surgical intervention in an objective manner, a Random Forest classification algorithm was applied. Variable importance was evaluated using the mean decrease in Gini index, and the most influential predictors were identified. The dataset was randomly split into training (70%) and testing (30%) subsets to assess model performance. Internal validation using the Out-of-Bag (OOB) error estimate yielded an error rate below 1%, indicating high model stability and generalizability. To further illustrate the influence of key predictors on the outcome, partial dependence plots were generated.

Subsequently, multivariable logistic regression analysis was conducted to evaluate independent predictors of surgical intervention. BMI and VAS score were found to be significant predictors when included separately in the models ($p < 0.001$). Given the presence of multicollinearity and its adverse effect on model fit and statistical power, these variables were not incorporated simultaneously. Model selection was guided by the Akaike Information Criterion (AIC) and backward stepwise selection procedures.

Finally, a nomogram was developed based on the final logistic regression model to provide individualized risk estimation for surgical intervention. Model discrimination was assessed using receiver operating characteristic (ROC) curve analysis. The area under the ROC curve (AUC) was close to 0.83, demonstrating excellent discriminative performance of the model.

All statistical analyses were performed using R software (version 4.4.3). Random Forest analyses were conducted using the *randomForest* package, while nomogram construction and visualization were performed using the *rms* and *regplot* packages.

RESULTS

Patient Characteristics

A total of 550 young adult patients were included in the study; 234 (42.5%) underwent surgical treatment, while 316 (57.5%) were managed conservatively. Significant differences were observed between the groups in terms of age, sex distribution, and several clinical and radiological parameters.

The mean age of patients who underwent surgery was 38 years, compared with 29 years in the nonoperative group, with a statistically significant difference between the groups ($p < 0.001$). A significant difference in sex distribution was also noted: males constituted 65% and females 35% of the surgical group, whereas the nonoperative group comprised 47% males and 53% females ($p < 0.001$).

The median body mass index (BMI) was significantly higher in the surgical group [34.2 (33.3–35.3)] compared with the nonoperative group [24.8 (23.7–25.7)] ($p < 0.001$). Smoking prevalence was also significantly higher among surgically treated patients (61%) ($p < 0.001$). Analysis of occupational characteristics revealed that patients engaged in heavy physical labor had a higher rate of surgical intervention compared with those in less physically demanding occupations (74% vs 45%; $p < 0.001$). Similarly, patients with low levels of physical activity demonstrated a significantly higher rate of surgery (73%; $p < 0.001$).

The median visual analog scale (VAS) pain score was significantly higher in the surgical group [9.30 (9.10–9.40)] than in the nonoperative group [7.20 (6.50–7.95)] ($p < 0.001$). Radicular symptoms were more prevalent among surgically treated patients (77% vs 52%; $p < 0.001$). In addition, neurological deficits (89%) and myelopathy (76%) were significantly more common in the surgical group (both $p < 0.001$).

Regarding the affected disc levels, C5–C6 (47%) and C4–C5 (48%) were the most frequently involved segments in the surgical group, whereas C5–C6 (41%) and C6–C7 (31%) predominated in the nonoperative group. Multisegmental involvement was observed at low rates in both groups.

A positive family history was more frequently observed in the surgical group (49%) compared with the nonoperative group (27%) ($p < 0.001$). A history of trauma was also reported significantly more often among surgically treated patients (53% vs 14%; $p < 0.001$), indicating its potential influence on surgical decision-making.

Radiological instability was present in 85% of patients in the surgical group, compared with only 11% in the nonoperative group ($p < 0.001$). This finding underscores the critical role of spinal instability in the decision to pursue surgical intervention.

Baseline demographic and clinical characteristics of the study population are summarized in Table 1.

Correlation analysis was performed to evaluate the relationships among continuous variables and to identify potential multicollinearity prior to multivariable modeling. A strong positive correlation was observed between BMI and preoperative pain severity measured by the VAS. VIF analysis demonstrated

high collinearity between BMI and VAS score, indicating that the simultaneous inclusion of these variables in regression models could introduce bias and increase the risk of overfitting. Accordingly, these variables were not entered together into the multivariable logistic regression models.

Table 1. Baseline demographic and clinical characteristics of the study population			
Characteristic	Patients with no operation N = 316 ¹	Patients with operation N = 234 ¹	p-value ²
Age	29.0 (26.0, 32.0)	38.0 (35.0, 40.0)	<0.001
Gender			<0.001
Female	168 (53%)	81 (35%)	
Male	148 (47%)	153 (65%)	
BMI	24.8 (23.7, 25.7)	34.2 (33.3, 35.3)	<0.001
Smoker			<0.001
Non Smoker	213 (67%)	92 (39%)	
Smoker	103 (33%)	142 (61%)	
Occupation_type			<0.001
Office	175 (55%)	62 (26%)	
Heavy	141 (45%)	172 (74%)	
VAS_score	7.20 (6.50, 7.95)	9.30 (9.10, 9.40)	<0.001
Radicular_symptoms	165 (52%)	181 (77%)	<0.001
Affected_level			<0.001
C3-C4	8 (2.5%)	3 (1.3%)	
C4-C5	68 (22%)	113 (48%)	
C5-C6	131 (41%)	111 (47%)	
C6-C7	99 (31%)	4 (1.7%)	
Multilevel	10 (3.2%)	3 (1.3%)	
Family_history	85 (27%)	115 (49%)	<0.001
Trauma_history	44 (14%)	124 (53%)	<0.001
Physical_activity_level			<0.001
Low	122 (39%)	170 (73%)	
High	194 (61%)	64 (27%)	
Radiologic_instability	34 (11%)	200 (85%)	<0.001
Neurological_deficit	16 (5.1%)	208 (89%)	<0.001
Myelopathy	13 (4.1%)	178 (76%)	<0.001

¹Median (Q1, Q3); n (%); ²Wilcoxon rank sum test; Pearson's Chi-squared test; Fisher's exact test

Random Forest Analysis and Variable Importance

Based on the variable importance analysis performed using the Random Forest algorithm, the variables contributing most to the decision regarding surgical intervention were identified as BMI, VAS score, neurological deficit, and radiological instability, in descending order of importance (Figure 1). These variables emerged as the primary determinants enhancing the classification

performance of the model. In particular, BMI and VAS score accounted for the largest proportion of the model's predictive power, as reflected by their high mean decrease in Gini values.

To further evaluate these findings, partial dependence plot (PDP) analyses were conducted to visualize the effects of these four variables on the target outcome, namely surgical intervention (Yes) (Figure 2).

For BMI, the PDP curve demonstrated a marked increase in the probability of surgical intervention starting at approximately a value of 28, indicating that patients approaching obesity or classified as obese were more likely to require surgical treatment.

Similarly, for VAS score, a sharp increase in the likelihood of surgical intervention was observed at pain levels of approximately 8 or higher. This finding suggests that pain severity represents a critical threshold influencing the surgical decision-making process.

For both neurological deficit and radiological instability, the presence of a “Yes” status was associated with an increased probability of surgical intervention. These findings support the clinical relevance of neurological impairment and radiological instability as important factors considered in surgical indications.

Overall, these graphical analyses corroborate the variable importance ranking derived from the Random Forest model and contribute to the identification of clinically meaningful threshold values influencing the decision for surgical intervention.

Random Forest – Variance Importance

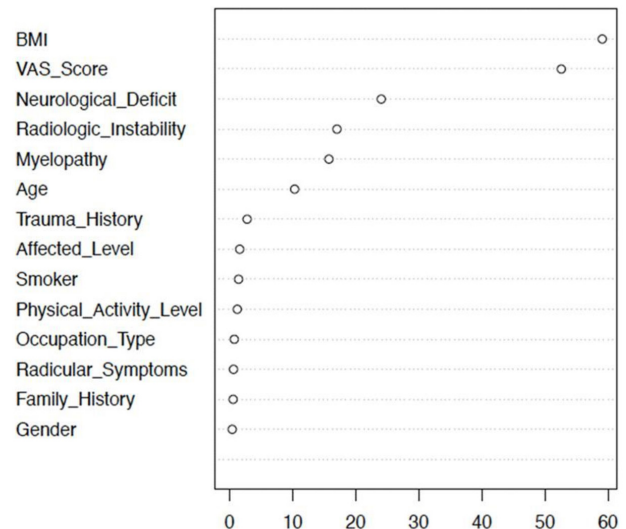


Figure 1. Variable importance ranking derived from the Random Forest analysis

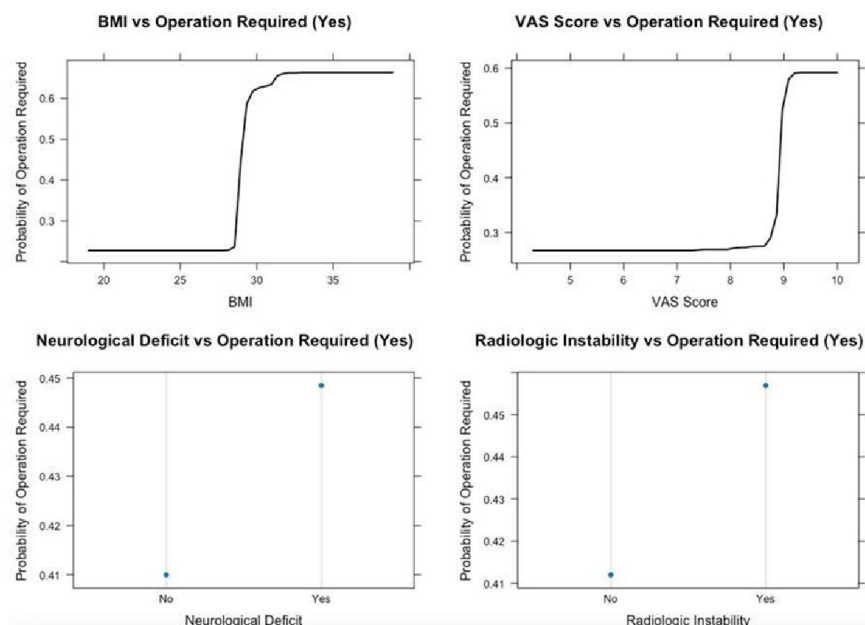


Figure 2. Partial dependence plot illustrating the effects of the four most important variables identified in the Random Forest analysis—body mass index (BMI), Visual Analog Scale (VAS) score, neurological deficit, and radiological instability—on the requirement for surgical intervention

Logistic Regression Analysis

Multivariable logistic regression analysis was performed to identify independent predictors of surgical treatment requirement. Due to multicollinearity concerns, BMI and VAS score were excluded from the final regression models. Among the evaluated models, Model 2 (Table 2) demonstrated the best overall fit.

In Model 2 (Table 2), age, myelopathy, neurological deficit, physical activity level, family history, radicular symptoms, and

trauma history were included as predictors. Increasing age was significantly associated with a higher likelihood of surgical treatment. The presence of myelopathy and neurological deficit were the strongest predictors of surgical requirement. Higher physical activity levels were associated with a reduced likelihood of surgery. Family history and trauma history were also associated with increased surgical risk, while radicular symptoms showed a borderline association. Overall, Model 2 (Table 2) demonstrated strong explanatory performance with an AIC value of 64.6.

Table 2. Logistic regression model predicting surgical treatment requirement

Variable	Coefficient (β)	p value	Comment
Age	0.33	1.98e-10 ***	The likelihood of requiring surgical intervention increases with advancing age.
Male	1.63	0.0047**	Male patients have a higher likelihood of requiring surgical intervention.
Myelopathy	4.25	1.16e-11 ***	The presence of myelopathy is associated with an increased risk of surgical intervention.
Neurological deficit	6.04	<2e-16***	The presence of neurological deficit is associated with a markedly increased risk of surgical intervention.

	β	OR (Odds Ratio) (exp(β))	
Age	0.443	1.56	The likelihood of requiring surgical intervention increases by 56% with increasing age.
Male	1.44	4.21	Male patients have a 4.2-fold higher likelihood of requiring surgical intervention; however, this association did not reach statistical significance (p = 0.11).
Myelopathy	6.52	679.84	The presence of myelopathy is associated with an approximately 680-fold increase in the likelihood of surgical intervention.
Neurological deficit	8.00	2984.49	The presence of neurological deficit is associated with an approximately 3000-fold increase in the likelihood of surgical intervention.
Physical activity level	-3.48	0.03	Higher levels of physical activity are associated with a 97% reduction in the likelihood of requiring surgical intervention.
Family history	2.06	7.83	Patients with a positive family history have an approximately 8-fold increased risk of requiring surgical intervention.
Radicular symptoms	1.68	5.39	The presence of radicular symptoms is associated with an approximately 5.4-fold increased risk of surgical intervention, showing borderline statistical significance (p ≈ 0.098).
Trauma history	3.01	20.37	A history of trauma is associated with an approximately 20-fold increased risk of requiring surgical intervention.

Nomogram Development and Performance

Based on the final multivariable logistic regression model, a prognostic nomogram was constructed incorporating age, sex, myelopathy, neurological deficit, physical activity level, family

history, trauma history, and radicular symptoms (Figure 3). Each variable was assigned a weighted score proportional to its regression coefficient, and the total score corresponded to an estimated probability of requiring surgical treatment.

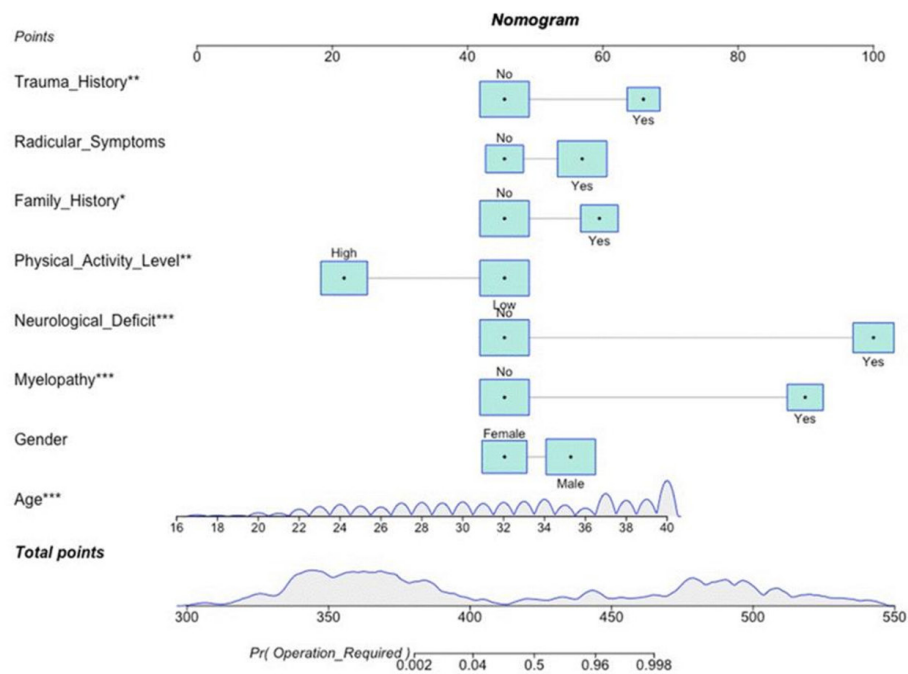


Figure 3. Nomogram predicting the probability of surgical treatment requirement in young patients with cervical disc herniation

ROC analysis of the nomogram demonstrated good discriminative performance, with an AUC of approximately 0.83, indicating a high level of accuracy in distinguishing patients who required surgical intervention from those who did not (Figure 4).

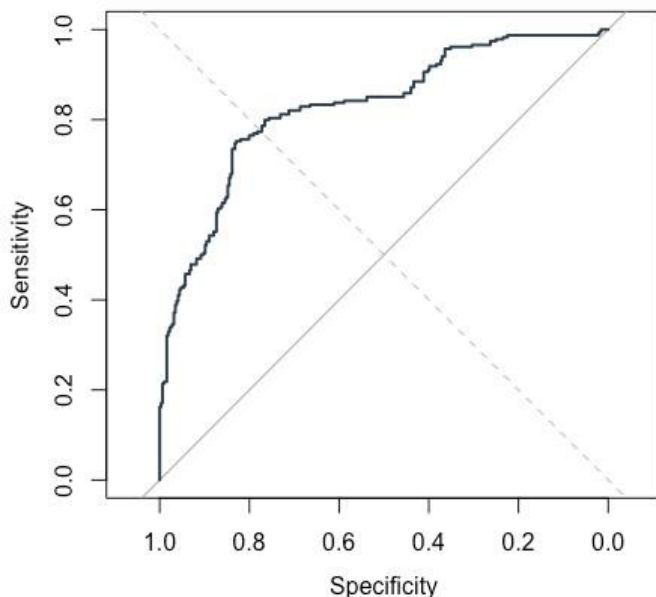


Figure 4. ROC curve of the model (AUC $\approx$ 0.83)

DISCUSSION

This study represents one of the first large-scale investigations aiming to evaluate the clinical and demographic characteristics of young individuals who develop a need for surgical treatment due to CDH and to develop a predictive nomogram accordingly. By comparing patients under 40 years of age who required surgical intervention with those who achieved clinical improvement through conservative management, our study identified key determinants predictive of surgical treatment necessity. When interpreted in light of the current literature, these findings contribute to a better understanding of the age-specific risk profile of CDH in young individuals through a multidisciplinary perspective.

In our cohort, the mean age of patients requiring surgical treatment was significantly higher than that of patients managed conservatively (38.0 vs. 29.0 years; $p < 0.001$). This finding is consistent with previous studies demonstrating that increasing age is associated with disc degeneration and the subsequent development of surgical necessity (9). However, analyses focusing specifically on young adult populations (under 40 years of age) remain extremely limited in the literature. In this regard, the present study is noteworthy in demonstrating that age plays a significant role in CDH progression not only in elderly populations but also among young individuals. The higher mean age observed in the surgical group may reflect not only biological aging but also cumulative mechanical stress and prolonged occupational exposure. Individuals in their late 30s may have experienced repetitive cervical loading over time,

which could accelerate disc degeneration and contribute to disease progression requiring surgical intervention.

With respect to sex distribution, the proportion of males was significantly higher in the surgical group (65%; $p < 0.001$). Greater exposure of male individuals to physical activity, higher biomechanical loading, and increased susceptibility to trauma may account for this difference (10). In addition, genetic and hormonal protective factors may confer relative resistance against disc degeneration in female individuals (11).

In our study, BMI was significantly higher in the surgical group compared with the conservatively treated group (34.2 vs. 24.8; $p < 0.001$). This finding is consistent with previous evidence indicating that obesity accelerates degenerative processes by increasing the mechanical load applied to the spinal disc. Particularly in young obese individuals, sustained loading of the cervical spine has been shown to compromise disc structural integrity and increase the risk of herniation (12). Furthermore, the proinflammatory effects of adipokines may contribute to the progression of disc degeneration at the molecular level (13).

Smoking is a well-established factor exerting detrimental effects on cervical disc pathology at both vascular and cellular levels. In the present study, smoking was significantly associated with a higher likelihood of surgical requirement ($p < 0.001$). The cytotoxic effects of nicotine on disc cells and its microvascular impact impairing annulus fibrosus nutrition represent key mechanisms underlying this association (14). Moreover, the suppressive effects of smoking on anti-inflammatory responses may facilitate the progression of disc herniation to a symptomatic state.

A substantial majority of patients requiring surgical treatment (74%) were employed in physically demanding occupations ($p < 0.001$). This finding suggests that repetitive microtrauma resulting from continuous exposure to flexion, extension, and rotational movements accelerates degenerative processes in the cervical spine. Previous studies have similarly reported an increased risk of cervical degeneration across specific occupational groups (15). Data regarding physical activity levels further support this observation, as patients with lower physical activity levels demonstrated significantly higher surgical rates ($p < 0.001$).

The significantly higher mean VAS score observed in the surgical group (9.30 vs. 7.20; $p < 0.001$) indicates that pain severity constitutes an important marker in determining surgical necessity. Numerous studies have reported an association between elevated pain scores, poor response to conservative treatment, and transition to surgical intervention (16). Additionally, the markedly higher prevalence of radiological instability (85%), neurological deficit (89%), and myelopathy (76%) in the surgical group underscores that surgical indications were established through an integrated clinical and radiological assessment. The high prevalence of neurological deficits and myelopathy in the surgical group suggests that surgical decision-making was largely guided by integrated clinical and radiological findings,

in line with current clinical practice. Previous studies have similarly emphasized the critical role of neurological impairment and myelopathy in determining surgical indications. However, this finding may also indicate that a considerable proportion of patients presented at a more advanced stage of the disease, which could introduce a degree of selection bias. Therefore, this aspect should be considered when interpreting the results.

A positive family history was present in 49% of patients in the surgical group, compared with only 27% in the conservatively treated group ($p < 0.001$), supporting the notion that genetic predisposition may accelerate disc degeneration at a young age. Mutations in collagen-related genes, such as *COL9A3* and *COL11A2*, have been shown to compromise disc integrity and contribute to early degenerative changes (17). Consistent with these findings, genetic analyses have identified multiple risk loci associated with disc pathologies (18).

A history of trauma was also significantly more frequent among patients requiring surgical treatment ($p < 0.001$). In young individuals, trauma may initiate the herniation process by causing microtears in the outer layers of the disc. Repetitive low-energy trauma can render cervical disc loading chronic, thereby promoting degenerative changes. Trauma-related acute cervical disc herniations have also been documented in the literature (19). Our findings suggest that trauma contributes not only to acute disc disruption but also to subclinical degenerative processes leading to surgical necessity.

One of the main strengths of this study is that it represents one of the first analyses to focus specifically on a young population and to include a relatively large patient cohort. In addition, the detailed and systematic evaluation of patients who were indicated for surgical treatment due to cervical disc herniation enhances the clinical validity and predictive reliability of the developed nomogram model.

Nevertheless, several methodological limitations should be acknowledged. First, the single-center study design may partially limit the generalizability of the findings to other demographic and clinical populations. Second, because genetic analyses were not incorporated into the study, the influence of genetic predisposition could only be indirectly assessed through family history. Furthermore, the assessment of certain variables, such as history of trauma and occupational exposure, relied on patient self-reporting, which may have introduced a potential risk of information bias.

The nomogram developed in the present study provides a practical tool for predicting the likelihood of surgical requirement in young adult patients with cervical disc herniation. The inclusion of readily available clinical and radiological variables—such as age, body mass index, occupational type, Visual Analog Scale score, smoking status, family history, and radiological findings—enhances the feasibility and applicability of the model in routine clinical practice. The model demonstrated a high area under the receiver operating characteristic curve, confirming

its strong discriminative performance in distinguishing patients who required surgical intervention from those managed conservatively.

Individualized predictive tools of this nature are increasingly being integrated into personalized medicine approaches, facilitating risk stratification and supporting tailored treatment strategies (8).

CONCLUSION

By identifying clinical markers predictive of the need for surgical treatment in young adult patients with cervical disc herniation, this study represents an important step toward early diagnosis and individualized treatment planning. The developed nomogram may serve not only as a clinical decision-support tool but also as a guide for the development of preventive strategies.

In the future, the model may be further strengthened and generalized through prospective, multicenter studies incorporating genetic and biomarker-based data. In this context, the present study provides an original contribution to the literature by improving the understanding of the dynamic pathophysiological characteristics of cervical disc herniation in young individuals and by advancing effective predictive tools.

Conflict of Interests

The authors declare that there is no conflict of interest in the study.

Financial Disclosure

The authors declare that there is no financial support.

Ethical Approval

Ethical approval was obtained from Institutional Ethics Committee of Ankara City Hospital (Approval No: TABED 1-25-1355, Date: 04.06.2025).

Patient Consent

The study was conducted in accordance with the Declaration of Helsinki, and the requirement for informed consent was waived due to its retrospective design.

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