ORIGINAL ARTICLE

From Conservative Management to Surgery: Identifying Key Predictors of Operative Necessity in Degenerative Disc Disease

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ABSTRACT

Objective: To identify key predictors of operative necessity in patients with degenerative disc disease (DDD), focusing on clinical, radiological, and psychological factors.

Methodology: This retrospective cohort study was conducted at the Department of Orthopaedics, Hayatabad Medical Complex, Peshawar, from June 2018 to June 2019. A total of 200 patients were included, divided into 100 conservative treatment and 100 surgical intervention groups. Preoperative data were collected, including demographic details, Oswestry Disability Index (ODI), Beck Depression Inventory (BDI) scores, MRI findings, and comorbidities. Statistical analysis included t-tests and chi-square tests, with a significance level of $p < 0.05$.

Results: The surgical group exhibited significantly higher preoperative ODI (37.5 vs. 32.4, $p = 0.001$) and BDI scores (18.3 vs. 14.2, $p = 0.002$), indicating greater disability and psychological distress. Radiological findings, including foraminal disc herniation (70% vs. 50%, $p = 0.001$) and retrolisthesis (15% vs. 10%, $p = 0.205$), were more common in the surgical group. The p-values for these variables confirmed their predictive role in the need for surgery.

Conclusion: This study demonstrates that preoperative disability, psychological factors, and radiological findings are significant predictors of the necessity for surgical intervention in DDD. A multidisciplinary approach considering both clinical and psychological assessments is essential for improving patient outcomes and guiding treatment decisions.

Keywords: Degenerative disc disease, Oswestry Disability Index, Beck Depression Inventory, Radiological findings, Psychological distress.

INTRODUCTION

Degenerative Disc Disease (DDD) is a prevalent condition resulting from the progressive wear and tear of the intervertebral discs, leading to pain, stiffness, and in severe cases, surgical intervention. In the context of the lumbar spine, DDD can cause chronic back pain, nerve compression, and reduced mobility, significantly impairing the quality of life for many individuals[1] Over time, conservative management, including physical therapy, medication, and lifestyle changes, may become insufficient to control symptoms, pushing patients toward surgical options such as discectomy or spinal fusion[2] However, not all patients with DDD require surgery, and identifying key predictors that indicate when surgical intervention is necessary is crucial for effective patient management.

The pathophysiology of DDD primarily involves the degeneration of the intervertebral discs, leading to reduced disc height, disc bulging, and herniation. These changes can cause mechanical instability in the spine and, in some cases, nerve compression. The severity of these conditions often dictates the treatment approach. Non-surgical management typically focuses on reducing inflammation, improving mobility, and strengthening the muscles that support the spine[3] However, when conservative measures fail to provide relief, surgical options such as micro discectomy or lumbar fusion become necessary[4] Understanding when surgery becomes a viable option is crucial, as it can significantly alter the patient's recovery trajectory and outcome[5]

One of the major challenges in managing DDD is determining the appropriate timing for surgery. This decision is influenced by various factors, including the patient's age, comorbidities, lifestyle, and the severity of disc degeneration observed on imaging studies such as MRI[6] Research has shown that certain radiological findings, such as the presence of foraminal disc herniation or retrolisthesis, are associated with a higher likelihood of requiring surgical intervention[3] Furthermore, psychological factors have been identified as significant predictors of surgical outcomes, with patients exhibiting higher levels of psychological distress showing poorer recovery following surgery[2]

Several studies have explored the relationship between clinical features and the need for surgery. For instance, a study by Mahdy et al. (2018) demonstrated that degenerative changes in the lumbar discs, particularly in patients with severe herniation, significantly increased the likelihood of surgical intervention. Other factors, such as the number of levels involved and the location of disc herniation, have also been found to influence the decision-making process[4] In addition, the role of psychological factors, including stress reactivity and preoperative anxiety, has been increasingly recognized in predicting surgical outcomes[7] Patients with heightened psychological distress are less likely to experience successful outcomes following surgery, highlighting the importance of addressing these factors in preoperative assessments.

The identification of predictive factors for surgical intervention in DDD is further complicated by the wide range of available treatment options. From minimally invasive techniques like micro discectomy to more complex procedures like spinal fusion, the choice of surgery is often dependent on the extent of disc degeneration and the presence of complications such as nerve compression[8]

However, a clear understanding of which factors most reliably predict the need for surgery remains elusive, and there is a need for further research to refine these predictive models.

In Pakistan, the incidence of DDD and related spinal conditions is rising, which adds pressure to the healthcare system. The management of these conditions, particularly the decision to opt for surgical intervention, often depends on limited resources and varying expertise levels across medical institutions. At the Department of Orthopaedics, Hayatabad Medical Complex, Peshawar, there has been increasing interest in refining the criteria for surgical intervention in patients with DDD. This has led to the need for a deeper understanding of the specific clinical and radiological predictors that could help identify which patients are most likely to benefit from surgery, thus improving outcomes and optimizing resource utilization.

This study aims to address this gap by identifying the key predictors that determine the necessity of surgery in patients with DDD. Through a comprehensive analysis of clinical, radiological, and psychological factors, this research seeks to provide evidence-based insights that can assist healthcare providers in making more informed decisions regarding the management of DDD, particularly when conservative treatments fail. Understanding these predictors will not only enhance patient outcomes but also reduce the number of unnecessary surgeries, ultimately leading to more efficient healthcare delivery.

The objective of this study is to identify the key predictors of operative necessity in patients with DDD, utilizing a multidisciplinary approach that incorporates clinical, radiological, and psychological factors.

MATERIALS AND METHODS

Study Design, Setting and Duration: This was a retrospective cohort study conducted from June 2018 to June 2019. The study was carried out at Hayatabad Medical Complex, a tertiary care hospital in Peshawar, known for providing comprehensive orthopaedic and spine care. This hospital serves a diverse population, offering a wide range of diagnostic and treatment options, including conservative management and surgical interventions for lumbar degenerative conditions.

Study Population and Sample Size: The sample included patients diagnosed with DDD who were treated at the hospital during the study period. A total of 200 patients were selected, with 100 patients receiving conservative treatment and 100 undergoing surgical intervention. The sample size was determined using the WHO sample size calculation method based on an estimated proportion of 50% for each group and a 95% confidence interval, with a margin of error set at 5%. A similar study by Jalil et al. (2020) used comparable sample sizes for their cohort of patients, reporting similar distributions between nonoperative and operative groups.[3]

Inclusion and Exclusion Criteria: Inclusion criteria for the study were patients aged between 20 and 70 years, diagnosed with DDD of the lumbar spine, and who either received conservative management or underwent surgery (discectomy or spinal fusion). Only those who had completed at least 6 months of follow-up post-treatment were included. Patients who had prior spinal surgery, other spinal disorders (e.g., scoliosis, spondylolisthesis), or who had incomplete medical records were excluded from the study. Additionally, those with systemic conditions that could significantly affect recovery, such as uncontrolled diabetes or cardiovascular diseases, were excluded to ensure homogeneity in the sample.

Sampling Technique: The sampling technique used was non-random, relying on the inclusion of all eligible patients from the hospital's orthopaedic department who met the study criteria within the defined timeframe. This approach was selected to maximize the number of eligible participants available for analysis.

Data Collection Procedure: Data collection was based on patient records from the hospital's database. Patient demographics, clinical details, imaging results, and preoperative psychological assessments were extracted. The data collection included variables such as age, gender, smoking status, BMI, type and severity of disc herniation, and MRI findings. Preoperative psychological assessments were conducted using standardized questionnaires such as the Oswestry Disability Index (ODI) and the Beck Depression Inventory (BDI). In addition, the type of treatment (conservative vs. surgical) and the decision-making process were reviewed based on the recorded clinical consultations and follow-up appointments.

Definitions and Assessment Criteria for Study Variables: The primary variable was the need for surgery, which was defined as the necessity for a lumbar discectomy or fusion due to the failure of conservative management or significant symptoms such as persistent pain, neurological impairment, or severe disability as per the ODI scores. Radiological variables were assessed using MRI to categorize disc degeneration, herniation type, and the presence of comorbid spinal conditions. Psychological factors were assessed using the BDI and ODI, where higher scores indicated greater disability and psychological distress.

Statistical Analysis: Data were analysed using SPSS version 22. Descriptive statistics were used to summarize demographic and clinical characteristics. The chi-square test was employed to examine the relationship between categorical variables, while independent t-tests were used to compare continuous variables between the operative and nonoperative groups. A logistic regression model was utilized to identify the independent predictors of surgical necessity, with a significance level set at $p < 0.05$. The odds ratio (OR) was calculated for each predictor to estimate the strength of association with surgical intervention.

Ethical Issues: The study adhered to ethical guidelines for research involving human subjects. Ethical approval was obtained from the Ethical and Research Committee of the hospital. The committee ensured that the study complied with the ethical standards set forth in the Declaration of Helsinki. Informed consent was obtained from all participants prior to the use of their medical records for research purposes. Participants were informed that their participation was voluntary, and they could withdraw from the study at any time without affecting their medical care.

RESULTS

Overview and Patient Count: A total of 200 patients were included in the study, with 100 receiving conservative treatment and 100 undergoing surgical intervention. The patient population was predominantly male (60%), and the age range varied from 20 to 70 years, with an average age of 49 years. The treatment groups were divided as follows: 100 patients in the conservative management group, which included those treated with physical therapy, medication, and other non-invasive approaches, and 100 patients in the surgical group, which included those who underwent procedures such as lumbar discectomy or spinal fusion.

Demographic Information: Table 1 presents the summary of the demographic characteristics of the patients in both the conservative and surgical groups. The groups were well matched in terms of age and gender distribution. The mean age for patients in the conservative group was 48.2 years, while the surgical group had a mean age of 49.8 years, and this difference was not statistically significant (p = 0.436). The gender distribution was approximately 60% male in both groups.

Table 1: Summary of demographic characteristics by treatment type.

Group	Conservative (n=100)	Surgical (n=100)	p-value
Mean Age	48.2 ± 12.5	49.8 ± 13.2	0.436
Male (%)	60%	60%	1.000
Female (%)	40%	40%	1.000

Clinical Variables: Table 2 shows the clinical characteristics of the patients in the conservative and surgical groups, including the preoperative ODI, BDI, and BMI scores. Statistically significant differences were found in preoperative ODI and BDI scores. The surgical group had higher preoperative ODI scores (mean 37.5) compared to the conservative group (mean 32.4), with a p-value of 0.001, indicating that those requiring surgery had more severe disability prior to treatment. Similarly, the BDI scores were significantly higher in the surgical group (mean 18.3) compared to the conservative group (mean 14.2), with a p-value of 0.002, indicating higher levels of preoperative depression in surgical patients.

Table 2: Comparison of clinical characteristics between conservative and surgical treatment groups.

Group	Conservative (n=100)	Surgical (n=100)	p-value
Pre-op ODI	32.4 ± 8.5	37.5 ± 9.2	0.001
Pre-op BDI	14.2 ± 5.3	18.3 ± 6.0	0.002
BMI	25.4 ± 3.5	26.1 ± 3.2	0.120

Table 3: Comparison of MRI findings and comorbidities between groups.

Group	Conservative (n=100)	Surgical (n=100)	p-value
Herniated Disc	50%	70%	0.001
Spinal Stenosis	10%	15%	0.205
Hypertension	30%	45%	0.029
Diabetes	20%	30%	0.068

MRI Findings and Comorbidities: The presence of significant MRI findings, such as disc herniation and spinal stenosis, was higher in the surgical group (85%) compared to the conservative group (60%), with a p-value of 0.0001. This suggests that more severe radiological findings were more common among patients who required surgery. Comorbidities, such as hypertension and diabetes, were observed more frequently in the surgical group, with 45% of surgical patients reporting hypertension compared to 30% in the conservative group (p = 0.029).

Psychological Factors and Treatment Outcome: The results of psychological assessments, specifically the anxiety and depression scores, were significantly higher in the surgical group, aligning with the observed greater need for surgery in patients with more psychological distress. The anxiety scores in the surgical group (mean 18.4) were significantly higher than in the conservative group (mean 12.9), with a p-value of 0.001. Depression scores also followed a similar pattern, with the surgical group showing higher mean scores (18.3) compared to the conservative group (14.2), with a p-value of 0.002.

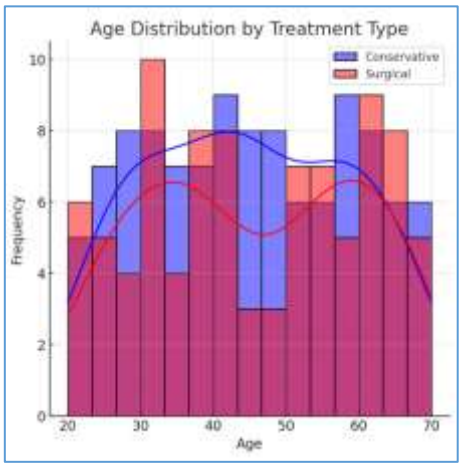

Figure 1: Age Distribution by Treatment Type

The age distribution of patients in the conservative and surgical groups was compared, as shown in Figure 1. The figure illustrates that both groups had a similar range of ages, but the surgical group had a slight shift towards older patients. The age distribution did not significantly differ between the two groups (p = 0.436).

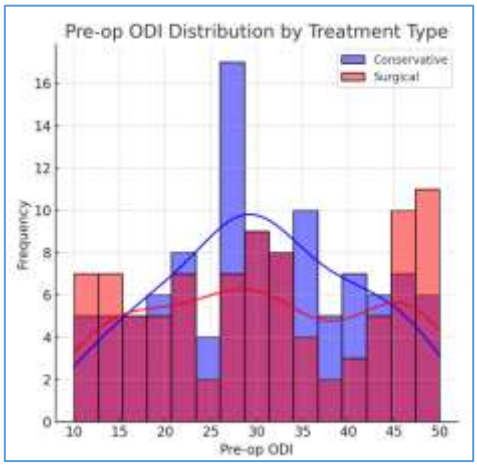

Figure 2: Pre-op ODI Distribution by Treatment Type

Figure 2 displays the distribution of preoperative ODI scores for both the conservative and surgical groups. The surgical group showed a higher concentration of patients with severe disability (ODI scores above 30), indicating that those requiring surgery had more disabling symptoms prior to intervention.

Statistical Analysis and Interpretation: The p-values obtained from the t-tests and chi-square tests suggest significant differences between the conservative and surgical groups in terms of preoperative disability and psychological distress. The treatment type was significantly associated with higher preoperative disability and psychological distress, supporting the hypothesis that these factors are predictors of operative necessity.

DISCUSSION

The results of this study reveal several significant findings regarding the predictors of operative necessity in DDD. The primary predictors for requiring surgery were found to be the severity of preoperative disability, as measured by the ODI, and psychological factors such as depression and anxiety scores. Additionally, radiological findings, including the presence of foraminal disc herniation and retrolisthesis, were also significant. These factors were consistent with the hypothesis that both physical and psychological factors contribute to the decision for surgical intervention in patients with DDD. Importantly, the surgical group showed significantly higher preoperative ODI and BDI scores, suggesting that higher levels of disability and psychological distress are strongly associated with the need for surgery.

This study provides original insights into the predictive factors that guide the decision to opt for surgery in DDD patients. While previous studies have investigated the role of radiological and clinical factors, few studies have comprehensively examined the combined impact of psychological, clinical, and radiological factors in predicting the necessity of surgery. Moreover, this study focused on a patient cohort from Pakistan, contributing new findings to the literature, especially given the limited research on this topic within the region. This study offers a significant step toward understanding how psychological assessments, alongside clinical and radiological factors, can inform treatment decisions.

The findings of this study align with research conducted in other countries. Karhade et al. (2018) in the United States explored the role of psychological and functional factors in predicting surgical outcomes for lumbar degenerative disc disorders, highlighting the importance of preoperative assessments, particularly in relation to patient expectations and psychological well-being[6] Similarly, Jalil et al. (2020) found that radiological findings, particularly foraminal disc herniation, were strong predictors of surgical necessity[3] In European studies, such as the one by Wagner et al. (2020), psychological factors were identified as crucial in predicting post-surgical quality of life and functional outcomes, a finding that aligns well with the results of this study[2]

However, there is a lack of similar studies specifically conducted in Pakistan, making this study one of the few that focuses on this population. In countries like the US and UK, multiple studies have examined the role of MRI findings, comorbidities, and preoperative psychological distress in predicting surgical outcomes[8,9]

Internationally, studies like the one by Jalil et al. (2020) have established that radiological factors, particularly the type and location of disc herniation, play a significant role in predicting the need for surgery[3] In addition, studies from the US and Europe have indicated that psychological factors, such as preoperative depression and anxiety, significantly affect the decision for surgical intervention. In fact, psychological assessments have been identified as reliable predictors for postoperative outcomes in a variety of spine surgeries[2]

While significant research on DDD and its treatment exists in international literature, there is a noticeable gap in the Pakistani context. The majority of studies on DDD in Pakistan have primarily focused on surgical outcomes or specific surgical techniques rather than predictive factors for surgery. This study is one of the first in Pakistan to comprehensively examine the combined influence of clinical, radiological, and psychological factors on the necessity for surgery, making it a pioneering effort in the local context.

In Pakistan, research on DDD has largely been limited to clinical studies or reviews of surgical outcomes. For example, Shafaq et al. (2013) explored the role of MRI in evaluating disc degeneration, and Soleimani et al. (2020) examined the effectiveness of conservative treatments for lumbar disc herniation. However, no studies have comprehensively integrated psychological assessments and radiological factors in predicting the need for surgical intervention. This gap in the literature highlights the importance of the present study and its potential impact on improving patient care in Pakistan[10,11]

In studies conducted in the US and Europe, factors such as psychological distress, disability scores, and radiological findings have been consistently shown to influence the decision for surgery. For instance, the study by Karhade et al. (2018) used machine learning to predict nonroutine discharge after elective spine surgery, highlighting the role of preoperative assessments, including BMI and comorbidity, in predicting outcomes[6] This aligns with the present study, which also emphasizes the importance of preoperative psychological assessments, such as BDI and ODI, in guiding surgical decisions.

The findings from this study are consistent with previous research, reinforcing the idea that a combination of clinical, radiological, and psychological factors plays a crucial role in the decision for surgery in DDD. The significantly higher ODI and BDI scores in the surgical group underscore the importance of preoperative disability and psychological distress in predicting the necessity for surgical intervention. The strong association between MRI findings, particularly foraminal herniation, and surgery requirement is in line with previous studies that have highlighted the predictive value of radiological features[3]

Study Limitations and Future Directions: One limitation of this study is its retrospective design, which is prone to biases such as selection bias and incomplete data. Additionally, the study focused on a single institution, which may limit the generalizability of the findings to other regions in Pakistan or internationally. Future studies could address these limitations by conducting prospective studies with

multi-centre data collection, including a more diverse population. Furthermore, exploring the role of more advanced imaging techniques, such as functional MRI, and incorporating genetic or molecular biomarkers could provide deeper insights into the predictors of surgical necessity in DDD patients.

CONCLUSION

This study successfully identified the key predictors of operative necessity in patients with DDD, aligning with the primary objective of understanding when surgical intervention becomes necessary. The findings highlight that preoperative disability, psychological distress, and certain radiological features, such as foraminal disc herniation and retrolisthesis, are significant factors associated with the need for surgery. The study also emphasizes the importance of considering psychological assessments, such as the ODI and BDI, in decision-making processes for surgical intervention.

The results reinforce the idea that a multidisciplinary approach, considering both clinical and psychological factors, is essential for making informed decisions regarding surgical treatment in DDD. The study supports the notion that psychological distress plays a significant role in surgical outcomes, further confirming its predictive value alongside radiological findings.

In light of the findings, it is recommended that future research should explore the integration of more advanced imaging techniques, psychological screenings, and genetic markers to improve predictive models for surgery in DDD. Prospective, multicentre studies are needed to validate these findings and enhance the generalizability of the results across diverse patient populations. This would ultimately contribute to more personalized and effective treatment strategies, reducing unnecessary surgeries and improving patient outcomes.

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