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Original Article

Surgical Management of Cervical Disc Herniation in a Resource-Limited Setting: Outcomes and Challenges

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Abstract

Objectives: To evaluate clinical and functional outcomes and identify perioperative and health-system challenges among patients undergoing surgical treatment for symptomatic cervical disc herniation in a resource-limited tertiary-care hospital.

Methodology: This Retrospective Observational Study Was Conducted In The Department Of Neurosurgery, MMC/BKMC mardan, From January To December 2025. We included 100 consecutive adult patients with MRI-confirmed symptomatic cervical disc herniation who underwent surgical treatment. We retrospectively extracted demographic, clinical, radiological, operative, postoperative, and health-system data from medical records. We assessed pain and functional disability using the Visual Analog Scale (VAS) and Neck Disability Index (NDI), respectively, before surgery and at 6-month follow-up.

Results: Among 100 patients, 62% were male, and 38% were female, with a mean age of 47.8 ± 11.4 years. The most frequently affected level was C5–C6 (44%), followed by C6–C7 (31%). Radiculopathy was present in 71% of patients and myelopathy in 29%. We performed ACDF in 82% of patients, while 18% underwent discectomy without fusion. Mean VAS decreased from 7.6 ± 1.2 preoperatively to 2.3 ± 1.1 at 6 months, while mean NDI decreased from 34.5 ± 8.7 to 12.8 ± 5.4 (both $p < 0.001$). Postoperative complications occurred in 11% of patients. Documented health-system barriers included delayed MRI access (27%), implant shortages (19%), and operating-room scheduling delays (22%).

Conclusion: In this single-center retrospective cohort, surgical treatment of symptomatic cervical disc herniation was associated with substantial improvements in pain and functional disability at 6 months. Delays in MRI access, implant availability, and operating-room scheduling represented important health-system challenges.

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Introduction

Cervical disc herniation is a prevalent degenerative condition of the spine and a leading cause of neck pain, cervical radiculopathy, and myelopathy around the world. It results from protrusion of the nucleus pulposus through a damaged annulus fibrosus, which in turn compresses nearby nerve roots or the spinal cord. It commonly occurs in middle-aged adults (4th-6th decades) and may cause considerable disability in daily activities and productivity. While many patients benefit from conservative management with analgesics, cervical immobilization, and physiotherapy, many require surgical treatment for persistent symptoms, progressive neurological symptoms, or radiographic evidence of significant neural compression [1,2]. Over the past few decades, surgical treatment for cervical disc herniation has improved for appropriately selected patients, with the choice of procedure depending on disease level and extent, neurological findings, cervical alignment, and other patient- and surgeon-related factors. Alternative surgical approaches, including anterior cervical discectomy without fusion, cervical corpectomy, and posterior cervical decompression, are chosen depending on the pathology, location, and surgeon preference. Many reports from developed nations describe outstanding outcomes with cervical spine surgery, including pain reduction, neurological improvement, and improved quality of life. However, these results may not be directly applicable to low- and middle-income countries, where health-care infrastructure and resources are often scarce [3,4]. Limited-resource countries have several factors that could impact the treatment of cervical disc disease. These include delayed access to high-tech imaging (magnetic resonance imaging [MRI]), limited availability of spinal implants, limited operating room time, a shortage of spine surgeons, and financial barriers to accessing care. A delay in diagnosis and symptoms may lead to poorer neurological function at diagnosis and possibly an inferior outcome following surgery. Additionally, variable post-surgical follow-up and rehabilitation may impact long-term outcomes [5,6]. Despite these limitations, cervical spine surgery is growing in popularity in tertiary care neurosurgical hospitals in developing nations. Understanding outcomes in such settings is critical to determine whether satisfactory care can be delivered despite resource constraints. Furthermore, understanding region-specific obstacles can help hospital administrators and policymakers identify areas that need investment to ensure quality care for patients with spinal disorders [7]. Unfortunately, few studies from low-resource settings have been published on the surgical outcomes of cervical disc herniation and complications encountered during hospital care. Most of these data come from high-income healthcare systems and may not represent low-income settings. Thus, developing local data is critical for institutional benchmarking, developing clinical and hospital treatment protocols, and health-care planning [8]. This study was carried out to assess the results of surgical treatment for cervical disc herniation in a low-resource tertiary care neurosurgical department. It also sought to identify common perioperative and infrastructural complications during treatment. By evaluating pain relief, functional improvement, complications, and systemic challenges, this study aims to provide a holistic view of the feasibility

and success of cervical spine surgery in a resource-limited setting [9,10].

Materials and Methods

We conducted a retrospective observational study in the Department of Neurosurgery at a tertiary-care teaching hospital from January 2025 to December 2025. We retrospectively reviewed the records of 100 consecutive adult patients with symptomatic MRI-confirmed cervical disc herniation who underwent surgical treatment during the study period. We identified eligible cases from operative logs and hospital records. We extracted demographic characteristics, presenting symptoms, MRI findings, operative details, postoperative complications, and follow-up outcomes from medical and outpatient records.

Patient Sampling

We considered all consecutive eligible adult patients with MRI-confirmed symptomatic cervical disc herniation who underwent surgical treatment during the study period from January 1, 2025, to December 31, 2025. A total of 100 eligible patient records met the predefined inclusion and exclusion criteria and were included in the final analysis. We used consecutive sampling to minimize selection bias and include all eligible cases available during the predefined study period.

Inclusion Criteria

- Age ≥ 18 years.
- MRI-confirmed cervical disc herniation.
- Symptomatic cervical radiculopathy or myelopathy attributable to the cervical disc lesion.
- Failure of an adequate trial of conservative treatment
- Underwent cervical spine surgery during the study period.
- Documented clinical follow-up at 6 months after surgery.

Exclusion Criteria

- Cervical spinal trauma.
- Cervical spinal tumors or infections.
- Previous cervical spine surgery at the affected level.
- Multisystem trauma.
- Incomplete medical records preventing assessment of the study variables.
- No documented 6-month postoperative follow-up.

Diagnostic and Management Strategy

All patients underwent neurological examination and cervical MRI for confirmation of the diagnosis and assessment of the affected level and neural compression. The decision to operate was based on clinical presentation, neurological findings, MRI characteristics, symptom severity and persistence, and surgeon assessment. The surgical approach was selected according to the level and

characteristics of the disc pathology and the presence or absence of spinal cord or nerve-root compression. We provided standard perioperative antibiotic prophylaxis, postoperative analgesia, mobilization, and physiotherapy in line with institutional practice.

Outcome Assessment

The primary clinical outcomes were changes in pain intensity and functional disability from the preoperative assessment to the 6-month postoperative follow-up. We assessed pain intensity using a 0–10 Visual Analog Scale (VAS), with higher scores indicating greater pain intensity. We assessed functional disability using the Neck Disability Index (NDI), a 10-item patient-reported measure of neck-related disability. Each NDI item is scored from 0 to 5, yielding a total raw score of 0 to 50, with higher scores indicating greater disability. We obtained preoperative VAS and NDI scores from clinical records, and recorded postoperative scores at the 6-month follow-up visit using the same assessment method. We also documented postoperative complications during follow-up.

Assessment of Health-System Barriers

We assessed health-system barriers retrospectively by reviewing available hospital, radiology, operative, and perioperative records. We considered a health-system barrier present when a documented system-related factor contributed to delays or difficulties in providing planned diagnostic or surgical care. We defined delayed MRI access as a documented delay in obtaining a cervical MRI required for diagnostic confirmation or preoperative surgical planning because of limited imaging availability, scheduling constraints, or other institutional access-related factors. We defined operating-room scheduling delay as a documented postponement of the planned cervical spine procedure attributable to operating-room availability, scheduling constraints, or competing operative demands. We defined implant shortage as documented unavailability of the required spinal implant or instrumentation when needed for the planned surgical procedure, resulting in difficulty or delay in proceeding with surgery. We considered only barriers documented in available medical or hospital records. We did not classify patient-related delays, including failure to attend appointments or delays caused solely by patient preference, as health-system barriers unless a system-related factor was also documented. Because individual patients could experience more than one barrier, the categories were not mutually exclusive, and their percentages may therefore exceed the percentage of patients experiencing any single barrier.

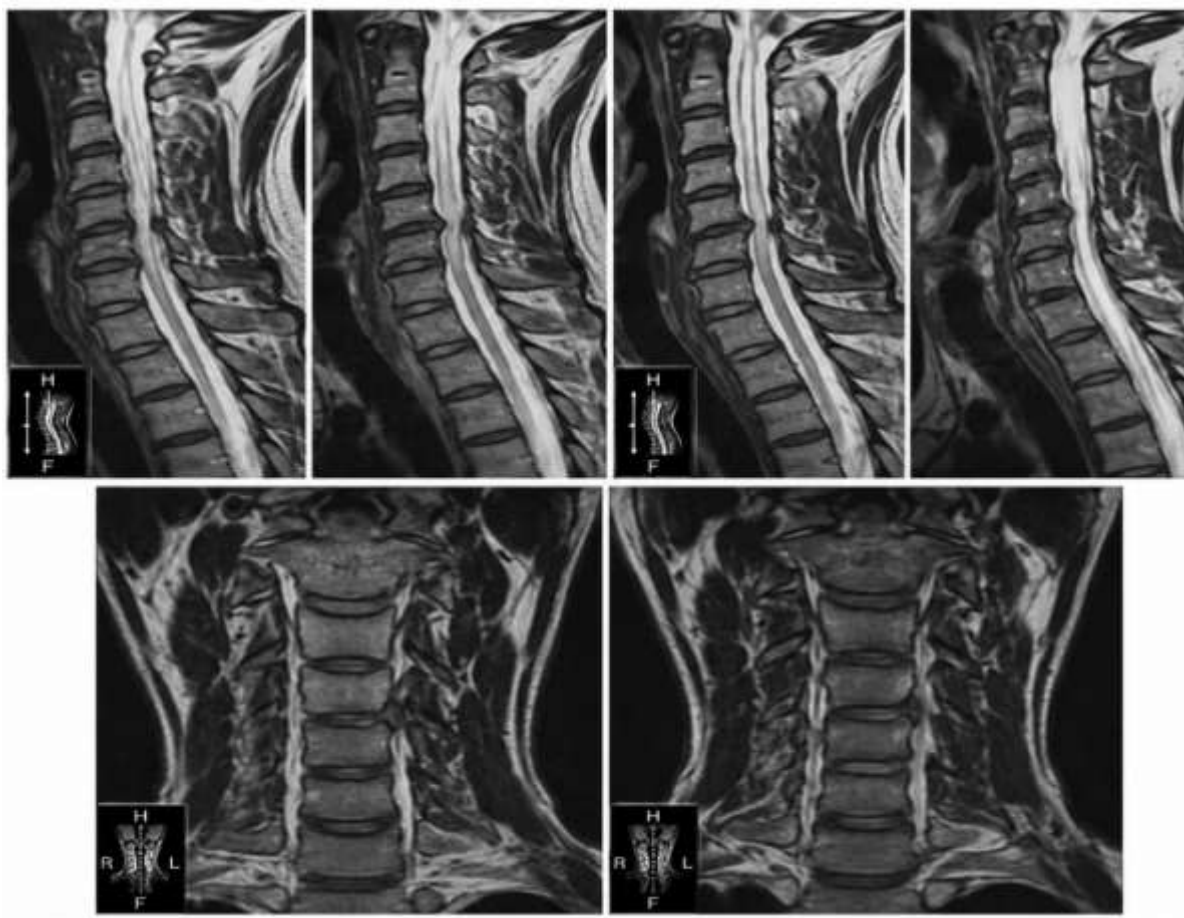
Statistical Analysis

We analyzed data using IBM SPSS Statistics version 26.0. We summarized continuous variables as mean $\pm$ standard deviation (SD), and presented categorical variables as frequencies and percentages. We assessed the distribution of continuous variables and the normality of paired differences before inferential analysis. We compared preoperative and postoperative VAS and NDI scores using paired-samples t-tests when the assumptions were met. We calculated mean changes from baseline to 6-month follow-up. For categorical variables, we reported frequencies and percentages and used appropriate statistical tests to compare subgroups. All statistical tests were two-sided, and we considered $p < 0.05$ statistically significant. We assessed missing data before analysis and included only patients with documented preoperative and 6-month postoperative outcome assessments in the paired analysis.

Results

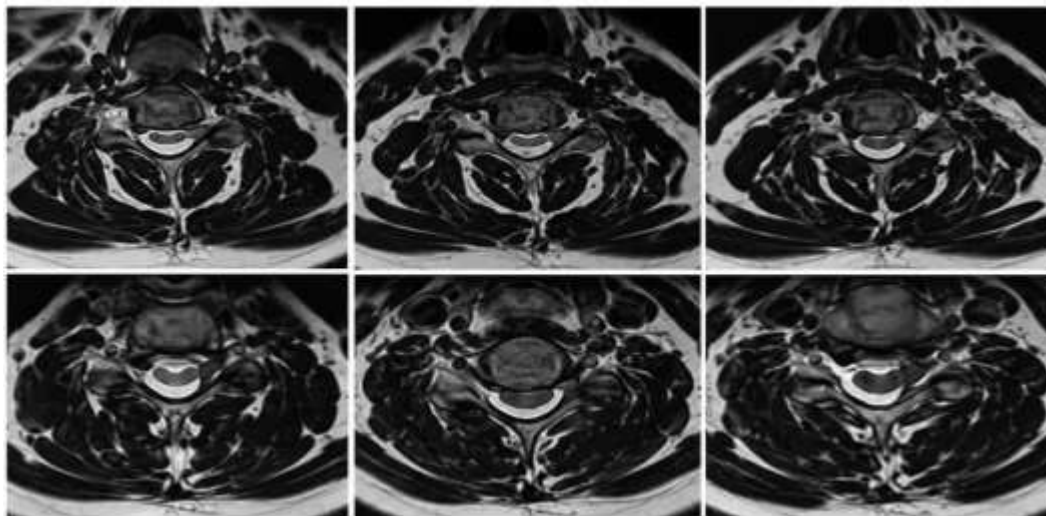
A total of 100 patients underwent surgical management for cervical disc herniation during the study period. The cohort included 62 males and 38 females, with a mean age of 47.8 ± 11.4 years. Radiculopathy was the predominant presentation, occurring in 71% of patients, while 29% presented with cervical myelopathy. The mean symptom duration before surgery was 8.4 ± 3.2 months. Common comorbidities included hypertension (28%), current smoking (26%), and diabetes mellitus (21%) (Table 1). The C5–C6 level was the most frequently affected disc level (44%), followed by C6–C7 (31%), C4–C5 (15%), and multilevel disease (10%). ACDF was performed in 82% of patients, while 18% underwent anterior cervical discectomy without fusion. The mean operative duration was 102 ± 18 minutes, and the mean hospital stay was 4.2 ± 1.3 days (Table 2). Representative MRI findings are shown in Figures 1 and 2. At 6 months, the mean VAS score decreased from 7.6 ± 1.2 preoperatively to 2.3 ± 1.1 , representing a mean reduction of 5.3 points ($p < 0.001$). The mean NDI score decreased from 34.5 ± 8.7 to 12.8 ± 5.4 , representing a mean reduction of 21.7 points ($p < 0.001$) (Table 3). Postoperative complications occurred in 11% of patients, including transient dysphagia (5%), superficial wound infection (3%), and recurrent symptoms (3%). Documented health-system barriers included delayed MRI access (27%), operating-room scheduling delays (22%), and implant shortages (19%). These barriers were not mutually exclusive (Table 4).

Figure 1. Multiplanar MRI findings of left C5–C6 cervical disc herniation.



Representative sagittal and coronal T2-weighted magnetic resonance images demonstrating a left-sided C5–C6 disc herniation with associated spinal canal narrowing and neural foraminal compromise. The findings demonstrate compression of the corresponding neural structures and were used for preoperative assessment and surgical planning.

Figure 2. Axial MRI demonstrating left C5–C6 nerve-root compression.



Representative axial T2-weighted magnetic resonance images demonstrating a left-sided C5–C6 disc herniation with narrowing of the left neural foramen and compression of the exiting cervical nerve root. Mild associated spinal canal narrowing is also demonstrated.

Table 1. Baseline Demographic and Clinical Characteristics of Study Participants (n=100)

Variable	Frequency (%) / Mean ± SD
Age (years)	47.8 ± 11.4
Male	62 (62%)
Female	38 (38%)
Radiculopathy	71 (71%)
Myelopathy	29 (29%)
Symptom Duration (months)	8.4 ± 3.2
Diabetes Mellitus	21 (21%)
Hypertension	28 (28%)
Current smokers, n (%)	26 (26%)

Values are presented as mean ± SD or n (%), as appropriate.

Table 2. Radiological and Operative Characteristics

Variable	Frequency (%)
Affected Disc Level	
C4–C5	15 (15%)
C5–C6	44 (44%)
C6–C7	31 (31%)
Multilevel Disease	10 (10%)
Surgical Procedure	
ACDF	82 (82%)
Discectomy Alone	18 (18%)
Mean Operative Time (minutes)	102 ± 18
Mean Hospital Stay (days)	4.2 ± 1.3

Multilevel disease was defined as cervical disc herniation involving two or more cervical disc levels.

Table 3. Preoperative and 6-Month Postoperative Clinical Outcomes

Outcome measure	Preoperative Mean ± SD	6-Month Postoperative Mean ± SD	Mean Change*	p-value
VAS score (0–10)	7.6 ± 1.2	2.3 ± 1.1	5.3	<0.001
NDI score (0–50)	34.5 ± 8.7	12.8 ± 5.4	21.7	<0.001

Mean change was calculated as preoperative score minus 6-month postoperative score; a positive value indicates clinical improvement.

Table 4. Postoperative Complications and Health-System Barriers

Variable	Frequency (%)
Postoperative Complications	
Transient dysphagia	5 (5%)
Superficial wound infection	3 (3%)
Recurrent symptoms	3 (3%)
Any postoperative complication	11 (11%)
Health-System Barriers	

Delayed MRI access	27 (27%)
Operating-room scheduling delay	22 (22%)
Implant shortage	19 (19%)

Health-system barriers were not mutually exclusive; therefore, individual Patients could have experienced More than one barrier.

Discussion

Cervical disc herniation is an important cause of cervical radiculopathy and myelopathy and can result in significant pain, neurological symptoms, and functional impairment. In this study, 100 patients with symptomatic, MRI-confirmed cervical disc herniation underwent surgical treatment. The majority were male (62%), and the mean age of the cohort was 47.8 ± 11.4 years. Radiculopathy was the predominant clinical presentation, occurring in 71% of patients, while myelopathy was present in 29%. These findings are consistent with the clinical spectrum of cervical disc disease, in which nerve-root compression commonly produces arm pain and neurological symptoms. In contrast, more advanced or central compression may result in myelopathic features. Recent evidence supports surgical treatment in appropriately selected patients with persistent cervical radiculopathy or neurological compromise. A network meta-analysis of randomized trials found that several surgical strategies provide satisfactory clinical outcomes, with treatment selection influenced by disease and patient characteristics [11,12].In our cohort, C5–C6 was the most frequently affected level (44%), followed by C6–C7 (31%). The predominance of these levels may reflect their substantial contribution to cervical motion and mechanical loading. MRI played an important role in confirming the diagnosis, identifying the affected level and degree of neural compression, and guiding surgical planning. The high proportion of patients presenting with radiculopathy was also consistent with the observed distribution of foraminal and nerve-root compression. These findings emphasize that surgical decision-making should integrate clinical symptoms, neurological findings, and imaging abnormalities rather than relying on radiological findings alone.ACDF was the most commonly performed procedure, accounting for 82% of operations, while 18% of patients underwent discectomy without fusion. Significant improvement was observed following surgery in the present cohort. Mean VAS scores decreased from 7.6 ± 1.2 preoperatively to 2.3 ± 1.1 at 6 months, while mean NDI scores decreased from 34.5 ± 8.7 to 12.8 ± 5.4. Both changes were statistically significant (p<0.001). These findings are consistent with evidence demonstrating improvement in pain and disability following surgical treatment of cervical radiculopathy. In a randomized trial, surgical treatment was associated with greater improvement in NDI at 12 months than nonsurgical treatment among patients with cervical radiculopathy related to disc herniation [12]. Similarly, a large nationwide study of patients undergoing surgery for degenerative cervical radiculopathy reported significant improvements in patient-reported disability and pain [13].The overall postoperative complication rate in our study was 11%. This finding is comparable with recently published evidence. A systematic review and meta-analysis involving more than 50,000 patients undergoing ACDF reported an overall complication rate of approximately 16%, with dysphagia among the most frequently reported complications [14]. Another systematic review identified dysphagia as a common adverse outcome following ACDF and reported that complication rates may increase with a greater number of operated levels [15]. In our cohort, transient dysphagia occurred in 5% of patients, superficial wound infection in 3%, and recurrent symptoms in 3%. The relatively low complication rate should nevertheless be interpreted cautiously because

complication rates may vary according to patient selection, number of operated levels, definitions used for complications, duration of follow-up, and reporting methods. Alternative surgical options are increasingly considered for selected patients with cervical radiculopathy. Minimally invasive posterior cervical foraminotomy and cervical disc arthroplasty may provide clinically meaningful outcomes in appropriately selected patients while offering alternatives to conventional anterior fusion. A comparative study published in 2024 reported clinically relevant outcomes following anterior cervical disc replacement and minimally invasive posterior cervical foraminotomy, with differences in complication and revision rates [16]. A systematic review and meta-analysis similarly found broadly comparable clinical outcomes between minimally invasive posterior cervical foraminotomy and anterior procedures, though it observed differences in complication and reoperation rates [17]. Furthermore, an updated meta-analysis comparing cervical disc arthroplasty with ACDF for two-level cervical degenerative disc disease found higher overall surgical success and lower secondary surgery rates with cervical disc arthroplasty. However, patient selection and implant requirements remain important considerations [18]. Another systematic review and meta-analysis reported favorable outcomes for cervical disc arthroplasty compared with ACDF in selected patients with cervical spondylotic myelopathy [19]. However, these procedures may require specialized implants, instrumentation, technical expertise, and appropriate patient selection. In resource-limited settings, ACDF may therefore remain an important and practical surgical option when specialized technologies are not readily available. A notable finding of this study was the frequency of health-system barriers affecting access to cervical spine care. Delayed MRI access was documented in 27% of patients, operating-room scheduling delays in 22%, and implant shortages in 19%. These barriers were identified as descriptive health-system challenges and were not demonstrated to be independent determinants of postoperative outcomes. Therefore, the present study cannot conclude that these delays caused poorer clinical outcomes. Evidence from low- and middle-income countries similarly demonstrates substantial health-system challenges affecting neurosurgical care. A systematic review of neurosurgical service delivery in LMICs identified delays in neuroimaging and surgical scheduling, inadequate facilities, and limited availability of advanced diagnostic and surgical resources as key challenges [20]. Another systematic review identified infrastructure-related limitations involving operating rooms, imaging capacity, specialized centers, referral pathways, and ward capacity [21]. Governance-related problems, including budget constraints, limited institutional support, and weak national planning, have also been reported as barriers to neurosurgical care in LMICs [22]. These findings provide contextual support for the system-level challenges observed in our cohort; however, the cited literature does not specifically evaluate cervical disc surgery and therefore should not be interpreted as demonstrating causation in the present study. The operating-room delays identified in our study are also consistent with findings from Pakistan. A prospective audit of elective neurosurgical theatre utilization in a public tertiary-care hospital in Pakistan identified delays related to patient transfer, anesthesia procedures, preparation, and operating-theatre processes [23]. These findings suggest that organizational and logistical factors can affect surgical service efficiency even when appropriately trained staff are available. Financial and imaging-related barriers have also been identified as important obstacles to neurosurgical care in LMICs [24]. In resource-limited environments, improving surgical care may therefore require not only technical expertise but also strengthening diagnostic workflows, operating-room efficiency, equipment availability, and health-system financing. Despite these challenges, the present study demonstrated significant improvements in pain and functional disability at 6 months after surgery. These

findings suggest that surgical treatment may provide meaningful short-term benefits for appropriately selected patients with symptomatic cervical disc herniation in resource-limited settings. However, interpret the results in light of the study's limitations. The retrospective single-center design limits generalizability and may introduce selection and information bias. The sample size was relatively small, follow-up was limited to 6 months, and the study included no nonsurgical comparison group. In addition, the authors described health-system barriers rather than analyzing them as independent predictors of surgical delay, complications, or functional outcomes. Multicenter prospective studies using standardized definitions and longer follow-up are needed to evaluate these factors more rigorously. The overall postoperative complication rate was 11%, while delayed MRI access, operating-room scheduling, and implant availability represented important health-system challenges. Addressing these logistical and infrastructural limitations may help facilitate timely and efficient cervical spine surgical care in resource-limited environments. This study has several limitations. Its retrospective single-center design may introduce selection and information bias and limits the generalizability of the findings. The sample size was relatively small, and follow-up was limited to 6 months, preventing assessment of longer-term outcomes. The absence of a control or comparison group limits the ability to attribute the observed improvements solely to surgical treatment. The authors identified health-system barriers retrospectively from available records and did not assess them using a standardized, validated instrument. In addition, the study was not designed to determine whether individual delays independently influenced postoperative outcomes. Multicenter prospective studies with standardized assessment of health-system barriers and longer follow-up are needed.

Conclusion

In this single-center retrospective cohort, surgical treatment of symptomatic cervical disc herniation was associated with substantial improvements in pain and functional disability at 6 months. Postoperative complications occurred in 11% of patients, while delays in MRI access, implant availability, and operating-room scheduling represented important health-system challenges. Improving diagnostic imaging capacity, ensuring availability of essential surgical implants, and optimizing operative scheduling may facilitate more timely cervical spine care in resource-limited settings.

Data Availability Statement

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Disclaimer: Nil

Conflict of Interest: Nil

Funding Disclosure: Nil

Authors' Contributions

Rizwan Ali: Study conception and design, supervision, critical revision of the manuscript, and overall responsibility for the integrity of the work.

Syed Nasir Shah: Data collection, data entry, preliminary data analysis, manuscript drafting, and correspondence with the journal.

Naeem ul Haq: Clinical case review, quality assurance, interpretation of surgical methodology, and critical review of the manuscript.

Muhammad Ishaq, Altaf Ahmad: Data collection, literature review, manuscript editing, and critical review of the final manuscript.

All authors reviewed and approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

Ethical approval

Ethical approval for this retrospective record-review study was obtained from the Institutional Review Board of **Bacha Khan Medical College/Mardan Medical Complex, Mardan, Pakistan, on 22 April 2024 (Approval No. 940/Neuro/BKMC/22/4/2024).**

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