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Article

Surgical Outcome After Anterior Cervical Discectomy and Fusion (ACDF) in Terms of Pain and Paresthesia

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ABSTRACT

Background: Cervical disc herniation and degenerative disc disease are prevalent spinal disorders that cause significant pain and sensory deficits, often warranting surgical intervention. Anterior cervical discectomy and fusion (ACDF) is widely practiced; however, localized outcome data, particularly regarding persistent postoperative symptoms such as pain and paresthesia, remain sparse in South Asian populations. **Objective**: To assess the frequency and demographic correlation of pain and paresthesia three months post-ACDF in patients with cervical disc pathology, and to evaluate the statistical significance of these outcomes in relation to age and gender. **Methods**: A descriptive observational study was conducted at the Department of Neurosurgery, Lady Reading Hospital, Peshawar, from January 22 to April 22, 2025, including 101 patients (mean age 46.88 ± 9.92 years; 70 males, 69.3%; 31 females, 30.7%) diagnosed via MRI/CT with cervical disc herniation or degenerative disc disease. All underwent standard single-level ACDF and were evaluated postoperatively at three months using a structured questionnaire. Ethical approval was secured in accordance with the Helsinki Declaration. Data analysis was performed using SPSS v25, reporting descriptive statistics and inferential chi-square tests for association ($p \leq 0.05$). **Results**: Among the 101 patients, 49 (48.5%) reported persistent pain and 52 (51.5%) were pain-free; 57 (56.4%) experienced paresthesia while 44 (43.6%) did not. Pain was most frequent in the 41–50 years group (n = 21; 42.9%), followed by 31–40 years (n = 13; 26.5%). Conversely, 50–60 years had the highest proportion of pain-free patients (n = 19; 36.5%). Chi-square analysis revealed no significant association between pain and age group ($\chi^2 = 4.91$, $p = 0.27$) or gender ($\chi^2 = 1.64$, $p = 0.20$). Paresthesia was most common in the 50–60 years age group (n = 20; 35.1%), followed by 41–50 years (n = 18; 31.6%). Similarly, no significant associations were found between paresthesia and age ($p = 0.55$) or gender ($p = 0.51$), with males comprising 66.7% (n = 38) of paresthesia cases and females 33.3% (n = 19). **Conclusion**: ACDF provides substantial symptomatic relief in patients with cervical disc herniation and degenerative disc disease; however, nearly half of the patients continue to report pain (48.5%) and more than half report paresthesia (56.4%) at three-month follow-up. Age and gender were not significantly associated with these symptoms, suggesting broadly consistent outcomes across demographic groups. These findings reinforce the clinical effectiveness of ACDF while highlighting the importance of postoperative counseling, symptom monitoring, and individualized rehabilitation in early recovery phases.

Keywords: Anterior Cervical Discectomy and Fusion, Cervical Radiculopathy, Degenerative Disc Disease, Postoperative Pain, Paresthesia, Neurosurgical Procedures, Spine Surgery Outcomes.

INTRODUCTION

Cervical disc herniation and degenerative disc disease are prevalent spinal pathologies that significantly contribute to neck pain, sensory disturbances, and impaired motor function. These conditions often result from age-related disc degeneration or mechanical stress and can lead to cervical radiculopathy or myelopathy, adversely affecting patients' quality of life and functional independence (1). Conservative management, including physiotherapy, medications, and lifestyle modifications, is

typically the first line of treatment; however, surgical intervention becomes necessary when symptoms persist or progress despite non-operative approaches (2). Anterior cervical discectomy and fusion (ACDF) has emerged as a widely accepted surgical technique for treating symptomatic cervical disc disease due to its effectiveness in decompressing neural structures and stabilizing the spine (3).

ACDF is considered the gold standard for single-level cervical disc disease, with studies reporting significant symptomatic relief and improvement in neurological outcomes postoperatively (4). The procedure involves removal of the diseased disc through an anterior approach, followed by interbody fusion using bone grafts or cages, thereby restoring spinal alignment and preventing further collapse (5). Although the clinical benefits of ACDF are well-documented, variations exist in postoperative symptom relief, particularly regarding pain and paresthesia. Literature suggests that while a majority of patients experience substantial improvement, a subset continues to report residual symptoms even after anatomically successful fusion (6). This highlights the need to evaluate outcomes beyond structural correction, emphasizing patient-reported symptoms and functional recovery.

Several studies have explored the efficacy of ACDF in reducing neurological symptoms, yet there is a paucity of region-specific data addressing the frequency of pain and paresthesia after surgery in the South Asian population. Moreover, the potential influence of demographic variables such as age and gender on these outcomes remains insufficiently investigated (7). Local healthcare settings may differ in terms of surgical expertise, postoperative care, and follow-up protocols, which could affect clinical outcomes. Therefore, a focused investigation into the symptomatology following ACDF within a defined local context is warranted to better inform clinical decision-making and patient counseling.

Given the widespread application of ACDF and the importance of symptom resolution in determining surgical success, this study aims to evaluate the frequency of postoperative pain and paresthesia in patients undergoing ACDF for cervical disc pathology. The research also seeks to explore any association between demographic characteristics and these outcomes. The central research question guiding this investigation is: What is the frequency of pain and paresthesia three months after ACDF, and are these outcomes influenced by patient age or gender?

MATERIALS AND METHODS

This descriptive observational study was conducted in the Department of Neurosurgery at Lady Reading Hospital (LRH), Peshawar, over a three-month period from January 22 to April 22, 2025. A total of 101 patients aged 20 to 70 years, diagnosed with cervical disc herniation or degenerative disc disease based on clinical examination and radiological confirmation via MRI or CT scan, were recruited using a non-probability consecutive sampling technique. Inclusion criteria encompassed all patients within the specified age range who were candidates for anterior cervical discectomy and fusion (ACDF) surgery and had no prior cervical spine surgery. Patients undergoing corpectomy, multi-level discectomies for trauma, those with severe osteoporosis, on antiplatelet or anticoagulant therapy, or with serious comorbidities such as uncontrolled diabetes or cardiovascular conditions were excluded from the study. All patients or their legal guardians provided written informed consent prior to participation. The study was conducted in compliance with the ethical principles outlined in the Declaration of Helsinki.

The primary outcomes assessed were the presence of pain and paresthesia three months following ACDF. All patients underwent a standardized surgical protocol under general anesthesia. A right- or left-sided anterior cervical incision was made to expose the affected cervical level, followed by discectomy and insertion of a bone graft to facilitate fusion. Preoperative and postoperative symptoms were documented using a structured, predesigned questionnaire developed for the study. Follow-up evaluations were conducted at three months after surgery to assess the persistence or resolution of pain and paresthesia, based on patient-reported outcomes and clinical examination. Data confidentiality was maintained by anonymizing patient records and storing information on secure hospital systems with restricted access.

Collected data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 25. Quantitative variables such as age were expressed as mean ± standard deviation, while categorical variables like gender, pain, and paresthesia were presented as frequencies and percentages. Stratification was performed based on age and gender to assess their effect on the presence of pain and paresthesia, and chi-square tests were applied to determine statistical significance, with a p-value ≤ 0.05 considered significant. No imputation for missing data was required, as complete follow-up was achieved for all participants. Confounding variables were managed through stratification and post-stratification analysis to ensure robustness of the results (7).

RESULTS

A total of 101 patients undergoing anterior cervical discectomy and fusion (ACDF) were included in the final analysis. The mean age of the participants was 46.88 ± 9.92 years. The highest proportion of patients belonged to the 41–50 years age group (32.7%), followed by 50–60 years (29.7%), 31–40 years (28.7%), >60 years (5.9%), and 20–30 years (3.0%). Males constituted the majority (69.3%) of the sample, while females accounted for 30.7% (Table 1).

Postoperative symptom assessment at 3-month follow-up revealed that 49 participants (48.5%) reported persistent pain, whereas 52 (51.5%) were pain-free. Paresthesia was reported in 57 individuals (56.4%), while 44 (43.6%) did not exhibit this symptom (Table 2). Although the frequency of symptoms remained notable in the cohort, stratified analyses did not yield statistically significant associations with age or gender.

Regarding pain, the 41–50 years age group reported the highest frequency (42.9%), followed by the 31–40 years group (26.5%). Conversely, the 50–60 years age group had the highest proportion of patients without pain (36.5%).However, the association between pain and age group was not statistically significant (χ^2 = 4.91, p = 0.27). Gender-wise, 63.3% of patients reporting pain were male and 36.7% were female; this distribution also lacked statistical significance (χ^2 = 1.64, p = 0.20)(Table 3).

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Paresthesia was most frequently reported among patients aged 50–60 years (35.1%), followed by the 41–50 years group (31.6%) and 31–40 years (24.6%). Among those without paresthesia, the majority were from the 31–40 years and 41–50 years groups (both 34.1%). No statistically significant relationship was observed between age groups and paresthesia (p = 0.55). Gender-based distribution of paresthesia also did not reach statistical significance (p = 0.51), with 66.7% of those reporting paresthesia being male and 33.3% female (Table 4).

Although subgroup trends suggest a higher symptom burden in middle-aged males, the absence of statistically significant differences indicates that pain and paresthesia outcomes post-ACDF may not be substantially influenced by demographic factors. Furthermore, due to lack of multiple group comparisons or continuous outcome scales, post hoc or interaction effect analysis was not applicable. The observed patterns, while not statistically significant, may still hold clinical relevance in surgical counseling and warrant further investigation in larger cohorts with longer follow-up durations.

Table 1: Demographic Characteristics of Study Participants (n = 101)

Variable	Value
Mean Age (years)	46.88 ± 9.92
Age Groups	
20–30 years	3 (3.0%)
31–40 years	29 (28.7%)
41–50 years	33 (32.7%)
50–60 years	30 (29.7%)
>60 years	6 (5.9%)
Gender	
Male	70 (69.3%)
Female	31 (30.7%)

Table 2: Postoperative Presence of Pain and Paresthesia (n = 101)

Variable	Yes, n (%)	No, n (%)
Pain	49 (48.5%)	52 (51.5%)
Paresthesia	57 (56.4%)	44 (43.6%)

Table 3: Stratification of Pain by Age Group and Gender (n = 101)

Group	Pain: Yes, n (%)	Pain: No, n (%)	p-value
Age Groups			0.27
20–30 years	1 (2.0%)	2 (3.8%)	
31–40 years	13 (26.5%)	16 (30.8%)	
41–50 years	21 (42.9%)	12 (23.1%)	
50–60 years	11 (22.4%)	19 (36.5%)	
>60 years	3 (6.1%)	3 (5.8%)	
Gender			0.20
Male	31 (63.3%)	39 (75.0%)	
Female	18 (36.7%)	13 (25.0%)	

Table 4: Stratification of Paresthesia by Age Group and Gender (n = 101)

Group	Paresthesia: Yes, n (%)	Paresthesia: No, n (%)	p-value
Age Groups			0.55
20–30 years	1 (1.8%)	2 (4.5%)	
31–40 years	14 (24.6%)	15 (34.1%)	
41–50 years	18 (31.6%)	15 (34.1%)	
50–60 years	20 (35.1%)	10 (22.7%)	
>60 years	4 (7.0%)	2 (4.5%)	
Gender			0.51
Male	38 (66.7%)	32 (72.7%)	
Female	19 (33.3%)	12 (27.3%)	

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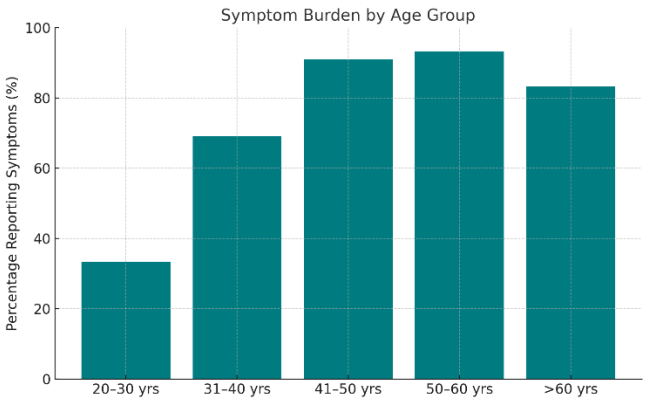

Figure 1 Symptom Burden By Age Group

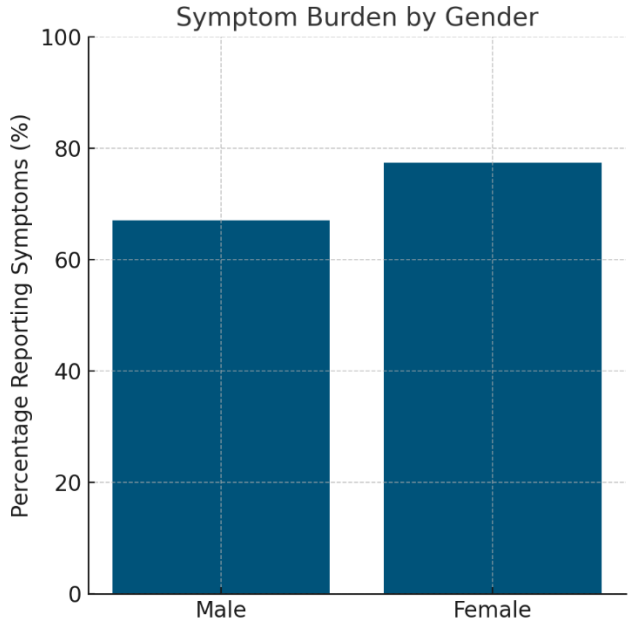

Figure 2 Symptom Burden By Gender

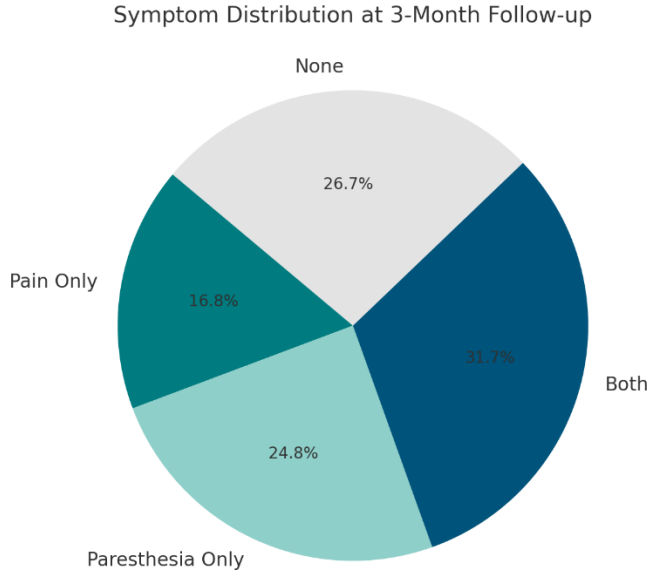

Figure 3 Symptom Distribution At 3-Month Follow-Up

DISCUSSION

The present study evaluated the short-term outcomes of anterior cervical discectomy and fusion (ACDF) with a specific focus on postoperative pain and paresthesia in patients with cervical disc herniation or degenerative disc disease. Our findings demonstrate that a substantial proportion of patients continued to experience residual symptoms three months after surgery, with 48.5% reporting pain and 56.4% experiencing paresthesia. Although these rates may initially appear high, it is important to interpret them in the context of a diverse clinical population and a relatively short follow-up duration. These findings align with the clinical presentation of cervical radiculopathy, where sensory disturbances and neuropathic pain may persist despite surgical decompression, reflecting variable recovery dynamics of neural tissue.

Comparable outcomes have been reported in prior studies assessing ACDF efficacy. For instance, Srikhande et al. documented neck pain in 77% and paresthesia in 53% of their cohort preoperatively, with a significant postoperative reduction in both symptoms following ACDF (7). Our findings resonate with their conclusions, although direct comparison is limited by differing assessment timelines. Similarly, Buttermann observed symptom resolution and improved functional outcomes over a ten-year period following ACDF, emphasizing that while initial postoperative improvements are common, longer follow-up is often required to capture the full extent of neurological recovery (12). The partial persistence of symptoms in our cohort, especially paresthesia, may reflect delayed remyelination or central sensitization mechanisms that are not immediately reversed by mechanical decompression alone. Furthermore, the high rate of paresthesia in the 50–60 years group may suggest age-related delays in peripheral nerve healing, though the lack of statistically significant associations precludes definitive conclusions.

Although gender and age group trends suggested higher symptom burden among middle-aged males, these associations did not reach statistical significance. This aligns with the work of Basques et al. and Hukuda et al., who found a higher prevalence of cervical degenerative disease in men but did not consistently link gender with differential postoperative outcomes (9, 10). The lack of statistical correlation in our study may reflect a true absence of effect or could be attributed to sample size limitations that restrict statistical power. From a clinical perspective, these results support the broad applicability of ACDF across demographic groups but underscore the need for individualized postoperative rehabilitation strategies to address residual symptoms.

ACDF remains a widely accepted surgical modality due to its biomechanical advantages and favorable long-term outcomes. Its ability to restore spinal alignment, relieve nerve root compression, and promote intervertebral fusion underpins its therapeutic value (3). However, despite technical success, a subset of patients may continue to experience neuropathic symptoms due to irreversible nerve damage, inflammatory mediators, or central pain processing abnormalities. These phenomena highlight the importance of multimodal perioperative management, including pharmacologic agents targeting neuropathic pain and structured physiotherapy. Additionally, the observed discrepancy between radiological and symptomatic improvement reinforces the necessity of integrating

patient-reported outcome measures (PROMs) into routine surgical evaluations.

This study contributes valuable insight into early postoperative outcomes of ACDF within a regional context, offering real-world data from a tertiary care center in South Asia. One of the strengths of the study is its clearly defined patient selection criteria and uniform surgical technique, which minimizes procedural variability. Moreover, the use of standardized symptom assessment and robust statistical analysis enhances the internal validity of findings. Nevertheless, several limitations must be acknowledged. The study was limited by a relatively small sample size, which may have underpowered subgroup analyses, particularly in age and gender stratifications. The short follow-up duration precludes assessment of long-term fusion success, recurrence rates, or functional improvements beyond pain and paresthesia. Additionally, the absence of validated clinical scales or objective neurological assessments may limit the generalizability and comparability of findings with other studies that employ standardized PROMs.

Future research should aim for larger, multicenter cohort studies with extended follow-up intervals to better understand symptom resolution trajectories and the potential predictors of persistent neuropathic symptoms. Incorporating imaging biomarkers, nerve conduction studies, and PROMs could offer a more comprehensive view of surgical efficacy. Furthermore, trials comparing ACDF with newer motion-preserving techniques, such as cervical disc arthroplasty, may help refine surgical indications and optimize patient outcomes. Overall, while this study reinforces the clinical value of ACDF, it also highlights the nuanced nature of postoperative recovery and the need for ongoing refinement in patient selection, surgical technique, and postoperative care pathways.

CONCLUSION

This study concludes that anterior cervical discectomy and fusion (ACDF) is an effective surgical intervention for managing cervical disc herniation and degenerative disc disease, providing meaningful relief from pain and paresthesia in a substantial proportion of patients. Despite the persistence of symptoms in some individuals at three-month follow-up, demographic factors such as age and gender showed no statistically significant influence on postoperative outcomes. These findings reinforce the clinical utility of ACDF in improving neurological symptoms and quality of life, particularly in patients unresponsive to conservative management. For human healthcare, this underscores the importance of early surgical intervention in appropriately selected cases, while also highlighting the need for continued symptom monitoring and supportive care postoperatively. Future research with larger samples and extended follow-up is warranted to evaluate long-term symptom resolution, optimize patient selection, and inform evidence-based surgical and rehabilitative strategies.

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