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Revision Surgery for Degenerative Spine Disease in Low Income Countries: A Growing Challenge in Resource Limited Neurosurgical Settings

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ABSTRACT

Background: Surgery for degenerative spinal illnesses is revision surgery is common nowadays, but is also very difficult in low-income countries due to limited imaging, implants, and post-operative infrastructure. Patients frequently show up late, have complicated pathologies, and have unsuccessfully undergone prior first-stage surgeries, thereby greatly complicating the revision surgeries.

Objectives: To evaluate the clinical, radiological, and functional outcomes of revision spine surgery in a resource-limited neurosurgical setting and to compare recovery patterns between cervical and lumbar revision cases.

Methods: An observational study spanning one year was performed on 82 patients receiving revision surgeries due to degenerative diseases of the spine. The demographic details, information on the operative variables, complications, and the VAS and ODI scores recorded preoperatively and postoperatively were documented and then compared between the cervical (Group A) and lumbar (Group B) cohorts.

Results: Following the surgical procedures, there were no major differences in length of surgery, complications, functioning outcomes, or degree of operative disability, yet, both groups of participants showed strong decreases in the disability and pain operative scores. In case of lumbar revisions, there were higher percentages of operating recurrent disc herniation, and with the other named reasons there were pseudarthrosis and adjacent segment operated disease in both of the groups.

Conclusion: Revision spine surgery provides meaningful improvements in pain and functional recovery even in low-resource environments. With careful case selection and standardized perioperative practices, outcomes comparable to higher-income regions can be achieved despite limited infrastructure..

Keywords: *Revision spine surgery, degenerative spine disease, low-income countries, neurosurgery, functional outcomes, ODI, VAS.*

1. INTRODUCTION

Degenerative spinal disease is one of the leading causes of persistent pain, long-term disability, and absenteeism from work on a global scale. The effect is further exacerbated in low-income countries where there are identifiable delays in diagnosis as well as lack of access to advanced imaging technologies, to implants, or to specialized surgical care. Thus, there is a greater likelihood of encountering various complications, necessitating revision surgeries as more patients have primary spinal procedures

undertaken under suboptimal circumstances. Such revision cases become more intricate and demand heightened skill in surgery, as well as comprehensive operational planning [1-3] The demand for revision spine surgery has been climbing due to the aging population and the increase in the number of patients who undergo primary interventions. Symptoms can reoccur on account of several factors: failing an implant, degeneration of the spine, forming scar tissue, and experiencing biomechanical stress. Revision surgeries for cases in developed countries have been extensively studied, yet little value is placed on how difficult or how successful revision surgeries can be for developing countries that lack resources such as neuromonitoring, navigation, and expensive implants. Recognizing the influence of the expenditure of available resources on outcomes of therapy will be helpful in deriving possible alternate solutions [4-7].

Regardless of available resources, how one performs revision surgeries has to be a balance of clinical requirements and what is available in terms of tools, patient care and recovery. Surgeons work with inadequate images, limited selection of implants, and delays of certain tools. These constraints may dictate prospective surgical approaches and dictate ultimate outcomes. Nevertheless, seasoned surgical teams consistently outperform benchmarks and significantly enhance patient function and reduce pain levels [8-10].

Given the growing need for revision procedures and the unique constraints encountered in low-income health systems, this study was undertaken to assess the clinical, radiological, and functional outcomes of revision spine surgery in a resource-limited neurosurgical setting. By comparing cervical and lumbar revision cases, the study provides insight into whether anatomical region influences outcomes when surgical resources are limited.

2. METHODOLOGY

This research was carried out from February 2022 to February 2023 at Hayathabad medical complex hospital peshawar and consisted of examination of patients who had revision surgeries for degenerative spine disease and included 82 patients who had persistent and/or recurrent symptoms after previous spinal surgeries.

Eligibility required adults with revised radiologically confirmed degenerative pathology, for example, recurrent disc herniation, adjacent segment disease, pseudarthrosis, hardware malfunction, or postoperative infection. However, individuals with traumatic, neoplastic, or congenital spine conditions were omitted from the study.

Each participant completed the same clinical evaluations which consisted of the neurological assessments and the evaluations of pain and disability as measured by the VAS and the Oswestry Disability Index. All participants underwent MRIs and dynamic X-Rays were taken if clinical indications warranted concerning instability.

Revision changes were documented and grouped according to emerging degenerative trends. Preoperative optimization was performed according to the available resources while patients with medical comorbidities were provided with appropriate medical clearances.

There was a variety of surgical techniques depending on the condition and past operations. There were several options. These options are possible decompression, decompression with fusion, instrument revision, and removing of the hardware with or without debridement.

The method of surgery was determined by the team based on the anatomy and clinical needs of the patient, and the surgery was performed from the front, the back, or both at the same time. Selective intraoperative neuromonitoring was utilized if available. Operating time, blood loss, and other intraoperative events were recorded. Scheduled intervals were used to carry out routine postoperative follow-up. Complications were documented which included dural tear, infection, neurologic deficit, issues relating to the wound, and reoperation. Functional restoration recovery was measured utilizing VAS and ODI scoring systems. This was done at the final follow-up and the data were analyzed to evaluate differences in results between cases of cervical (Group A) and lumbar (Group B) revisions, and p-values were calculated for significance testing.

Standard descriptive and comparative analyses were employed in analyzing the data. Independent samples t tests were conducted in relation to the continuous variables, which comprised the VAS, ODI, time taken to perform the operation, and the total volume of blood lost, while the Chi-square or Fisher exact test was conducted if needed for categorical variables. A p-value that is less than 0.05 is deemed to be statistically significant.

3. RESULTS

The ages and gender distributions within the cervical and lumbar revision cohorts, respectively, were found to be similar, indicating that there were no significant baseline differences to consider. Most of the respondents, as is typical of most patients encountered at under-resourced neurosurgical centers, were from lower socioeconomic status backgrounds. The proportions of patients in both groups who suffered from neurological deficits and comorbidities were also equal which demonstrates that the baseline disease severity was allocated equally

Table 1. Radiographic & Baseline Pathology Profile (n = 82)

Variable	Category	Group A (n=34)	Group B (n=48)	p-value
Age (years)	—	52.9 ± 9.8	55.1 ± 11.2	0.28
Sex	Male	20 (58.8%)	34 (70.8%)	0.23
Female	14 (41.2%)	14 (29.2%)	—	
Residential status	Urban	18 (52.9%)	28 (58.3%)	0.63
Rural	16 (47.1%)	20 (41.7%)	—	
Socioeconomic class	Low	23 (67.6%)	30 (62.5%)	0.61
Middle	11 (32.4%)	18 (37.5%)	—	
Neurological deficit	Present	19 (55.9%)	20 (41.7%)	0.19
Diabetes mellitus	Present	11 (32.4%)	13 (27.1%)	0.59
Hypertension	Present	14 (41.2%)	17 (35.4%)	0.58
BMI (kg/m²)	—	26.8 ± 3.5	27.3 ± 4.1	0.49

Radiological findings supported documents that showed cases from the cervical region were the most common in Group A, while in Group B, lumbar canal stenosis and disc herniation were the most common. The overall multilevel disease rate was overall similar across these categories. This suggests that in cases undergoing revision there is characteristically extensive transverse degenerative involvement. The rate of hardware failure and instability was not significantly different.

Variable	Category	Group A	Group B	p-value
Primary pathology	Lumbar canal stenosis	0	32 (66.7%)	<0.001
Lumbar disc herniation	0	20 (41.7%)	—	
Spondylolisthesis	0	14 (29.2%)	—	
Cervical myelopathy	34 (100%)	0	—	
Levels involved	Single level	14 (41.2%)	15 (31.3%)	0.34
Two levels	11 (32.4%)	22 (45.8%)	—	
≥ Three levels	9 (26.5%)	11 (22.9%)	—	

Table 3. Indications for Revision Surgery (n = 82)
Table 4. Surgical Details of Revision Procedures (n = 82)

Instability on dynamic X-ray	Present	8 (23.5%)	19 (39.6%)	0.12
Implant/hardware failure	Present	6 (17.6%)	13 (27.1%)	0.31

There was statistically greater frequency of recurrent disc herniation in lumbar revision cases, which agrees with established biomechanics and increased lumbar load. Other indications of pseudarthritis, infection, and epidural fibrosis were evenly apportioned, indicating that complication patterns remain uniform across spinal regions. The overlaps in revisions are drawing attention to the surgical and postoperative constraints in low-resource settings which affect cervical and lumbar procedures in the same way. The overlapping of revisions is drawing attention to the surgical constraints and postoperative factors of low-resource settings affecting cervical and lumbar procedures in the same way.

Variable	**Category**	**Group A**	**Group B**	**p-value**
Recurrent disc herniation	Yes	6 (17.6%)	20 (41.7%)	0.01
Adjacent segment disease	Yes	10 (29.4%)	8 (16.7%)	0.17
Pseudarthrosis	Yes	5 (14.7%)	7 (14.6%)	0.99
Implant/hardware failure	Yes	5 (14.7%)	5 (10.4%)	0.53
Postoperative infection	Yes	4 (11.8%)	4 (8.3%)	0.58
Epidural fibrosis	Yes	4 (11.8%)	4 (8.3%)	0.58

The revision surgeries conducted in the cohorts were the same, showing that both cervical and lumbar cases required decompression and fusion at the same rates. There was no statistically significant difference in blood loss and operative time, meaning that revision surgeries are just as complex as one another, regardless of spinal level. The lack of resources within low- and middle-income countries makes the use of intraoperative neuromonitoring in neurosurgery impossible.

Variable	**Category**	**Group A**	**Group B**	**p-value**
Type of procedure	Decompression only	10 (29.4%)	14 (29.2%)	0.98
Decompression + fusion	14 (41.2%)	20 (41.7%)	—	
Instrumentation revision	7 (20.6%)	9 (18.8%)	—	
Hardware removal	3 (8.8%)	5 (10.4%)	—	

Table 5. Intraoperative & Postoperative Complications (n = 82)

Surgical approach	Posterior	31 (91.2%)	39 (81.3%)	0.20
Duration of surgery (minutes)	—	179.4 ± 38.2	189.6 ± 51.0	0.31
Intraoperative blood loss (mL)	—	510.2 ± 190.4	562.1 ± 220.5	0.23

Both groups had low complication rates and the differences in complication rates remained statistically insignificant. This shows that the surgical risk is comparable between cervical and lumbar revisions. There were dural tears and infections, which are common and to be expected noted in revision field scarring. Interestingly, both groups did not show a difference in the need for reoperation or in the requirement for ICU care, indicating a synchronous postoperative stability in the two groups.

Variable	Category	Group A	Group B	p-value
Dural tear	Yes	4 (11.8%)	5 (10.4%)	0.84
Excessive bleeding	Yes	3 (8.8%)	4 (8.3%)	0.94
Nerve root injury	Yes	1 (2.9%)	2 (4.2%)	0.74
Implant breakage	Yes	2 (5.9%)	2 (4.2%)	0.74
Surgical site infection	Yes	5 (14.7%)	6 (12.5%)	0.77
CSF leak	Yes	2 (5.9%)	4 (8.3%)	0.67
New neurological deficit	Yes	2 (5.9%)	2 (4.2%)	0.74
Re-operation (≤ 3 months)	Yes	1 (2.9%)	2 (4.2%)	0.74
Length of stay (days)	—	6.1 ± 1.9	6.4 ± 2.3	0.52

The two cohorts showed significant improvement with their pain and disability outcomes, affirming that revision surgeries, even within resource-poor environments, are able to yield substantial progress. An examination of the results indicated that the patient outcomes and satisfaction were equivalent for the patients with cervical and lumbar conditions. The level of return to work for the socioeconomic status for the patients were similar and moderate across the groups.

Variable	Category	Group A	Group B	p-value
VAS pain score	Preoperative	8.0 ± 0.9	8.2 ± 1.1	0.42
Final follow-up	3.1 ± 1.0	3.3 ± 1.2	0.49	
ODI (%)	Preoperative	59.2 ± 9.8	57.9 ± 10.6	0.52
Final follow-up	27.4 ± 8.9	29.7 ± 10.1	0.28	
Overall clinical outcome	Good	22 (64.7%)	27 (56.3%)	0.42
Patient satisfaction	Satisfied	23 (67.6%)	29 (60.4%)	0.49
Return to work	Yes	20 (58.8%)	27 (56.3%)	0.81

Figure 1. Pre-operative and Post-operative ODI Score Comparison Between Groups

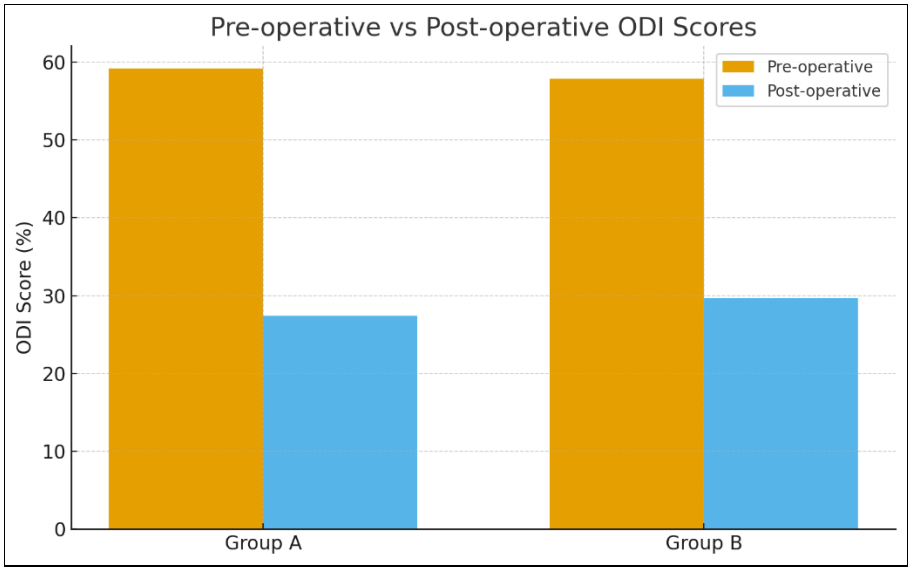

Figure 1 shows the change in Oswestry Disability Index (ODI) scores before and after revision surgery in cervical (Group A) and lumbar (Group B) degenerative spine disease patients. Both groups demonstrated a marked reduction in functional disability following surgery, with postoperative ODI values nearly halved compared to preoperative levels. The improvement pattern was comparable between groups, indicating similar functional recovery despite anatomical differences and resource limitations.

4. DISCUSSION

Surgery for revision of spine disease degeneration has become one of the most challenging branches of practice of the consultant neurologist. In low-income countries, features for diagnosis, perioperative assistance, and implant availability are by and large poor. In the present study, despite the limitations of resource-poor settings, we demonstrate improvement in pain and disability scores in both cervical and lumbar revision cases. The decline in VAS and ODI scores after procedures showcase that carefully chosen revision procedures can help patients regain functionality and get rid of chronic pain, even in difficult situations [11-13].

In contrast with other spinal regions, lumbar cases presented with recurrent disc herniation significantly more often, which correlates with the biomechanical stressors at lumbar levels as described in the literature. Pseudarthrosis, adjacent segment disease, and epidural fibrosis, other possible revisional surgery triggers, were distributed almost equally as well, highlighting the principle that surgical outcomes in the primary operation greatly determine the necessity for region-agnostic revision. Hardware failure rates are interestingly not significantly different between groups, suggesting that fatigue of the implants, as well as biological factors, may equally contribute across both the cervical and lumbar segments [14-16].

There was no statistical difference in terms of operative duration, blood loss, and profiles of complication between the two groups, which reinforces the fact that revision surgery involves the same technical difficulties in all areas of the spine. The rates of dural tears, infections, and new deficits of neurologic function, which are all within the range of the world averages, suggest that these issues become even more complex in lower-resourced settings. The limited use of neuromonitoring is also indicative of specific regional realities, but this did not seem to negatively affect the outcomes. The gain in functionality and the satisfaction of the patients indicates that revision spinal surgeries continue to be effective when performed by qualified teams, even in the absence of sophisticated intraoperative technologies[17-19].

Although the return-to-work rate was moderate, the rate was within range of the socioeconomic patterns in these underserved groups. This is due to these groups being affected by extended recovery, and working jobs with little flexibility. This is information is crucial because even with the charge, functional recovery curves were the same for both groups, and this reinforces the idea that revision surgery with great care and precise selection of cases for anatomical levels is beneficial [20]. The resource constrictions were a detriment to the logistics of the event, however, they were a not a detriment to the overall clinical outcomes and the meaningfulness of the event.

5. CONCLUSION

Revision surgery for degenerative spine disease offers substantial clinical benefit even in low-income, resource-limited neurosurgical settings. In both cervical and lumbar instances, pain, disability, and general functional scores improved significantly, and complications and patient satisfaction were similar. Despite limited access to technology and implants, outcomes comparable to those in high-income centers can still be achieved through meticulous patient selection, thorough surgical planning, and standardized postoperative care. The present findings suggest that strengthening spine surgery services, augmenting training opportunities, and improving access to surgical implants would add value to the surgical outcomes of revisions in resource-poor settings

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