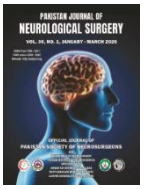

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Original Research

Revision Surgery For Degenerative Spine Disease in Resource-Limited Neurosurgical Settings of A Low – Income Country: A Growing Challenge

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ABSTRACT

Purpose: To determine the functional outcome and perioperative complications of degenerative spine disease revision surgery in a resource-constrained neurosurgical environment.

Materials & Methods: One hundred adults (>= 18 years) who had undergone degenerative cervical/ thoracic/ lumbar spine surgery before and were undergoing revision surgery were recruited. The demographic data, comorbidities, surgical history, hospitalisation, and perioperative complications (30 days) were captured. The Oswestry Disability Index (ODI) and the visual analogue scale (VAS) were used as a functional outcome measure during preoperative and 6 months postoperative. The response to be classified as a favorable outcome was a 30 percent or greater reduction in ODI and a 2-point or greater reduction in VAS with no new permanent neurological impairment.

Results: Mean ODI changed to an improved value of 37.10 ± 9.42 (as compared to 56.49 ± 9.42), and mean VAS to a worse value of 4.79 ± 1.33 (as compared to 7.50 ± 0.94). A positive result was attained in 58 percent of patients. The adverse effects included but were not limited to dural tear (7%), wound infection (6%), new neurological deficit (4%), implant-related problems (5%), and major medical events (3%). There was no significant baseline or surgical factor that had any association with outcome.

Conclusion: Degenerative spine disease after surgery may be effectively revised to generate significant functional outcomes with satisfactory complication rates in a resource-restricted environment.

Keywords: Spinal Diseases/surgery, Reoperation, Developing Countries, Neurosurgical Procedures, Treatment Outcome.

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INTRODUCTION

Degenerative spine disease has become one of the most prevalent causes of disability globally,[1] with low back pain in the world as a major cause of burden of years lived with disability in both the developed and developing countries,[2] as manual labour and the lack of preventive health care contribute to the progression of the degenerative spinal pathology.[3,4]

The world's predominance of spine surgery has been growing with the increasing degenerative disease burden, but most of the surgical services continue to be very concentrated in high-income environments.[5] In LICs, access to trained neurosurgeons, complex imaging, implants, and after-sale care is limited, which results in late onset of symptoms and unfavorable primary procedures.[6,7] Revision surgery is technically challenging, with longer operative time, higher complication rates, increased reliance on implants, and higher cost than primary procedures.[8,9]

In the resource-constrained neurosurgical setting, revision surgery further imposes extra burdens on already insufficient postoperative rehabilitation services, limited funds, and surgical capacity. Out-of-pocket spending disproportionately affects patients and leads to treatment abandonment and disastrous spending at home.[6,10]

The prevalence of degenerative spine disease has been well-known around the globe; however, the literature has lacked information about the problem of revision surgery of the spine in LICs, where the limited health systems of countries complicate both the choice of treatment and the maximisation of outcomes. These challenges should be understood to create some context-specific approaches to patient safety, sound resource utilization, and effective long-term functional results. To examine the increasing issue of revision surgery of degenerative spine disease in low-income nations and also emphasize impediments and situational approaches in resource-constrained neurosurgical settings.

MATERIALS & METHODS

Study Design and Setting

This is a retrospective observational study which was carried out in the Department of Neurosurgery, Maqsood Medical Complex (MMC) and General Hospital, Peshawar and data of patients between Feb 2024 and December 2025 were collected. The ethical standards were followed, and the study was carried out under the permission of the Institutional Review Board of the hospital with approval No. 21. Informed consent was recorded in writing before the enrolment of all the participants.

Study Population

One hundred adult patients (aged 18 and above) who had previously undergone a surgery on degenerative cervical, thoracic or lumbar spine disease and were to undergo revision surgery were included. Eligible patients who presented throughout the study period were enrolled through non-probability consecutive sampling.

Inclusion Criteria

The patients needed to have a history of previous degenerative disease spinal surgery that was done more than three months ago, and they needed revision surgery due to persistent or recurrent symptoms. Revision surgery indicators comprised recurrent/residual stenosis, pseudoarthrosis, implant failure or malposition, adjacent segment malady, progressive deformity, or fresh or aggravated neurological deficit.

Exclusion Criteria: Patients who had primary surgery of the spinal column, or spinal infection, trauma, neoplastic, congenital or inflammatory pathology were left out. Patients who were not fit to undergo anaesthesia, those who refused

consent or were lost to follow-up were also excluded.

Preoperative Assessment

Every patient passed through a thorough preoperative clinical assessment, such as a neurology check-up and examination of appropriate radiological test images. Demographic data and comorbidities, especially hypertension and diabetes mellitus, were documented as baseline data. The definition of degenerative spine disease was made on clinical presentation that is in line with radiculopathy or neurogenic claudication, complemented by the radiological findings of degeneration of the disc, canal or foraminal stenosis, spondylolisthesis, or degenerative deformity.

Surgical Process and Data Retrieval

A revision surgery was considered as any further surgical work carried out at a previously operated level in the spinal column or at an adjoining area against degenerative pathology. The surgical data included was the part of the spinal area involved, a reason to revise, and the revision procedure type (decompression, decompression and fusion, or deformity correction/others).

The time taken to complete an operation, the estimated intraoperative blood loss, postoperative high-dependency or intensive care, and the length of stay at the hospital were recorded. The complications that happened during the perioperative time (30 days) were documented, such as dural tear, wound infection, new neurological deficit, implant-related complications, and thromboembolic or major medical events.

Revision procedures were carried out using previous surgical corridors where possible, and the scar tissue was carefully dissected to the least amount needed to provide satisfactory decompression. Direct visualisation in sharp dissection was used to reduce dural injury. The surgery loupes or the use of an operating microscope was used selectively in the event of magnification. When dural adhesion is thick, the microscopic principles of surgery are involved to track and preserve the dura during the surgery.

The choice of extension of levels of fusion was determined on preoperative radiological evidence of instability, pseudoarthrosis, adjacent segment disease or progressive deformity in combination with intraoperative evaluation of facet integrity and segmental motion. Sophisticated intraoperative navigation and neuromonitoring were not a routine aspect because of the scarcity of resources; thus, the choice of surgical procedure was based on reference to anatomical features, preoperative scans, and the experience of the surgeons.

Perioperative infection prevention measures were used as per the standard guidelines, such as use of prophylactic antibiotics, strict sterilization and postoperative wound care. The process of implant selection was informed by the availability, affordability, and comfort of the surgeon with choices of common pedicle screw-rod systems, which created a state of mechanical stability without compromising the cost-effectiveness in a resource-limited environment.

Outcome Measures

Oswestry Disability Index (ODI) measured functional outcome, and pain was measured using a 010 visual analogue scale (VAS). The scores were obtained at the preoperative stage and the 6-month follow-up. Favourable outcome was considered as a minimum of 30% improvement in ODI score and at least 2 points drop in VAS score without the emergence of any new permanent neurological deficit.

Statistical Analysis

Statistical Package of Social Sciences (SPSS), version 26.0, was used to analyse the data. Continuous variables were tested using the Shapiro-Wilk test to determine normality and

reported as mean, standard deviation, or median with the interquartile range, accordingly. The frequencies and percentages were used to state categorical variables.

Independent sample t-tests or Mann–Whitney U-tests were used to compare groups when the variable was continuous, and chi-square test or Fisher-exact test were used to compare groups when the variable was categorical. There were preoperative and postoperative ODI and VAS comparisons, which were done in pairs. The level of significance of a p-value to be statistically significant was 0.05 or less.

Table I: *Baseline characteristics of patients undergoing revision surgery for degenerative spine disease (n = 100).*

Variable	Value
Age (years)	54.77 ± 14.78
Operative time (minutes)	156.32 ± 48.12
Estimated blood loss (mL)	499.58 ± 230.49
Hospital stays (days)	6.94 ± 2.59
Gender	**n (%)**
Male	65 (65.0%)
Female	35 (35.0%)
Hypertension	**n (%)**
Yes	41 (41.0%)
No	59 (59.0%)
Diabetes mellitus	**n (%)**
Yes	67 (67.0%)
No	33 (33.0%)
Spine region	**n (%)**
Cervical	11 (11.0%)
Thoracic	9 (9.0%)
Lumbar	80 (80.0%)
Indication for revision	**n (%)**
Recurrent stenosis	37 (37.0%)
Pseudoarthrosis	17 (17.0%)
Implant failure	14 (14.0%)
Adjacent segment disease (ASD)	12 (12.0%)
Deformity	7 (7.0%)
New neurological deficit	13 (13.0%)
Type of revision procedure	**n (%)**
Decompression	42 (42.0%)
Decompression with fusion	53 (53.0%)
Deformity/other	5 (5.0%)
Perioperative complications	**n (%)**
Dural tear (yes)	7 (7.0%)
Wound infection (yes)	6 (6.0%)
New neurological deficit (yes)	4 (4.0%)
Implant problem (yes)	5 (5.0%)
Thromboembolism/major medical event (yes)	3 (3.0%)
Favourable outcome at 6 months	**n (%)**
Yes	58 (58.0%)
No	42 (42.0%)

RESULTS

Demographic and Baseline Characteristics

The analysis involved a group of 100 patients who were undergoing revision surgery because of degenerative spine disease. The average age of the target population was 54.77 years during the study, with a variance of 14.78. The majority of the patients were male (65%), and the lumbar spine was the most affected area (80%). Forty-one percent were found to have hypertension, and 67 percent were found to have diabetes mellitus. Fusion was the most commonly done revision procedure (53%). Table I is a summarisation of baseline demographic and clinical characteristics.

Functional Outcomes

The disability and pain were significantly improved statistically after revision surgery. The Oswestry Disability Index (ODI) score preoperative (56.49 ± 9.42) and postoperative (37.10 ± 9.42)

Table 2: *Comparison of disability and pain scores before and 6 months after revision surgery (n = 100).*

Variable	Pre-revision Mean ± SD	6-Month Mean ± SD	p-value
Oswestry Disability Index (ODI)	56.49 ± 9.42	37.10 ± 9.42	< 0.001*
Visual analogue scale (VAS) pain score	7.50 ± 0.94	4.79 ± 1.33	< 0.001*

*Statistically significant

was significantly low (p < 0.001). Likewise, the mean visual analogue scale (VAS) score of pain reduced between 7.50 ± 0.94 and 4.79 ± 1.33 at the same time (p < 0.001). Since the scores of ODI and VAS were not normally distributed, the comparison between the scores at preoperative and 6-month post-operative was done using the Mann-Whitney U test statistic, which proved both the ODI and the VAS scores were statistically significant (p < 0.001). Comprehensively, 58 patients (58%) had a positive result at 6 months, based on set ODI and VAS improvement criteria (Table 2).

Table 3: *Association of baseline and surgical variables with favourable outcome at 6 months (n = 100).*

Variable	Favorable Outcome		p-value
Gender	**Yes, n (%)**	**No, n (%)**	
Male	38 (58.5%)	27 (41.5%)	0.899
Female	20 (57.1%)	15 (42.9%)	
Hypertension	**Yes, n (%)**	**No, n (%)**	
Yes	22 (53.7%)	19 (46.3%)	0.463
No	36 (61.0%)	23 (39.0%)	
Diabetes mellitus	**Yes, n (%)**	**No, n (%)**	
Yes	41 (61.2%)	26 (38.8%)	0.356
No	17 (51.5%)	16 (48.5%)	
Spine region	**Yes, n (%)**	**No, n (%)**	
Cervical	6 (54.5%)	5 (45.5%)	0.954
Thoracic	5 (55.6%)	4 (44.4%)	
Lumbar	47 (58.8%)	33 (41.3%)	
Indication for revision	**Yes, n (%)**	**No, n (%)**	
Recurrent stenosis	21 (56.8%)	16 (43.2%)	
Pseudoarthrosis	10 (58.8%)	7 (41.2%)	
Implant failure	10 (71.4%)	4 (28.6%)	0.916
Adjacent segment disease	6 (50.0%)	6 (50.0%)	
Deformity	4 (57.1%)	3 (42.9%)	
New neurological deficit	7 (53.8%)	6 (46.2%)	
Type of revision procedure	**Yes, n (%)**	**No, n (%)**	
Decompression	24 (57.1%)	18 (42.9%)	0.592
Decompression with fusion	30 (56.6%)	23 (43.4%)	
Deformity/other	4 (80.0%)	1 (20.0%)	

Perioperative Complications

The frequency of perioperative complications within 30 days was rare. Dural tear was seen in 7%, wound infection in 6, new neurological deficit in 4, implant-related in 5 and thromboembolic or major medical event in 3. No perioperative mortality was observed (Table 1).

In incidental durotomy repair, it was repaired in the first instance, where possible, using sutures and fat graft or sealant was used as an adjuvant where necessary. Proper positioning and close observation of cerebrospinal fluid leakage were considered as some of the postoperative measures. No patient had a persistent cerebrospinal fluid fistula or had to be reoperated due to durotomy-related complications.

Correlation between Baseline and Surgical Items and Outcome

Non-normally distributed continuous variables were compared between favourable and non-favourable outcome groups of the study using the Mann-Whitney U test, whereas categorical variables were compared using the chi-square test or Fisher's Exact test. There was no statistically significant relationship between a favourable outcome and patient gender on subgroup analysis (p = 0.899). In the same way, hypertension or diabetes mellitus did not play a

significant role in the 6-month outcome ($p = 0.463$ and $p = 0.356$, respectively).

Clinical and surgical factors, such as the area of the spine affected, the reason to perform the revision operation, and the kind of revision operation done, were also not significantly linked with favourable outcome. The distribution of outcome was similar in cervical and thoracic and lumbar revisions, in the different revision indications, and in the decompression and decomposition with fusion, and deformity or other surgeries (all $p > 0.05$; Table 3).

DISCUSSION

The current investigation shows that in a low-income, publicly funded neurosurgical case, degenerative spine disease can be successfully treated with revision surgery, which can result in a clinically important reduction in pain and disability in a significant proportion of patients, with only slightly more than half achieving a pre-determined favourable outcome at six months and comparatively low concentrations of significant adverse perioperative events.[11,12] The results are interesting since revision operations are typically deemed more technologically and resource-intensive than index operations, and yet may provide significant functional benefits to the patients when it comes to selecting the right patient.[11,12]

The findings must be discussed in the context of an increasing global epidemiology of degenerative spine disease, which is becoming more and more focused on low- and middle-income societies where specialist spinal services have limited access.[13,14] The fact that a significant change in the Oswestry Disability Index (ODI) and visual analogue scale (VAS) scores occurred in the majority of patients confirms that revision surgery is justifiable even in resource-constrained settings, as long as there are indicators and perioperative pathways are optimised.[14,15]

Various studies in higher-income environments have documented that patients receiving revision lumbar decompression or fusion surgery obtain smaller and less predictable improvements than those receiving primary surgery, and nonetheless may obtain really minor clinically significant changes in disability and pain.[15,16] The change in ODI and VAS between the current cohort and the two series would seem similar, indicating that resource limitation is not always the limit to directing functional improvements that would be in line with international standards as long as fundamental surgical principles are followed.[15,16] This promotes the essence of developing and sustaining fundamental neurosurgical capacity despite the absence of sophisticated technologies like navigation, neuromonitoring, or sophisticated implants.[17]

The perioperative complication profile of low dural tear, wound infection, new neurological deficit, and thromboembolic or major medical events is in line with the lower range of perioperative complication profiles reported for revision degenerative spine procedures.[17,18] One of the most prevalent intraoperative complications of lumbar decompression and especially of revision is recognised as incidental durotomy that has been linked to high risks of infection, cerebrospinal fluid leakage and prolonged hospitalisation.[18] The comparatively low rate of such incidents herein indicates that the revision procedures were usually done with reasonable technical safety despite the lack of regular, costly adjuncts.[17,19]

The length of stay following the operation was also moderate regarding a revision cohort. Age, comorbidities, occurrence of complications and institutional discharge practices influence hospital stay after spine surgery and serve as a crucial determinant of direct inpatient costs.[19,20] In low-income systems with low bed capacity and a high demand for neurosurgical services, it is important to establish a balance between safe

after-operation control and prompt discharge to ensure throughput and prevent cancellations.[19,20] This series of improvements in terms of clinically meaningful improvement, manageable complication rates, and moderate length of stay has a positive implication on patient outcomes and service efficiency in such a setting.[20]

The non-significance of the relations between favourable outcome and the prevalent baseline or surgical variables, including sex, hypertension, diabetes, spinal area, reason to revise, or kind of revision surgery, should be viewed cautiously. Although these findings might indicate that these variables were not the defining determinants of six-month functional status in this cohort, other-setting studies have indicated that age, comorbidity burden, psychosocial factors, and socioeconomic status could determine the postoperative spine surgery recovery.[21,22] This lack of important predictors can probably be associated with small sample sizes, comparatively short follow-up, and broad categorical groupings that could have concealed finer risk gradients.[21,22] Further studies that include finer frailty, mental health, work demands, and health literacy may give a better understanding of which patients are most likely to benefit from revision procedures in resource-constrained settings.[22]

Another strength of the current study is the regular application of patient-reported outcome measures, namely, ODI and VAS, which are validated, to measure the change in disability and pain. The patient-reported outcomes are becoming a valuable measure of the success of spine procedures, especially where it is hard to maintain long-term imaging follow-ups or advanced functional tests.[23] The use of straightforward, validated instruments in everyday practice in low-income contexts can help internal audit, compare with external standards, and do more informed counselling of the patients about the outcomes and risks to expect.[23]

There are a few constraints that should be considered. This was a single-centre study, so its generalisability to other institutions, particularly to the private setting or centres with a different case-mix and resource mix, is limited.[24] There was a small sample size, and the follow-up was limited to six months, which does not allow for making solid conclusions about the effectiveness of benefits, late developments, recurrence rates, or long-term fusion and alignment rates.[24,25] Radiological outcomes were not quantified systematically beyond clinical judgement, and no cost data or a comprehensive evaluation of financial toxicity were gathered, although this is particularly pertinent in the context of low-income patients, where out-of-pocket costs of surgery and implantation can be devastating. The relatively brief follow-up does not allow for measuring long-term fusion status, long-term deformity correction, and mechanical stability. The radiological outcomes were not quantified systematically, but this should be improved in the future by longer follow-ups and standardization of the imaging protocols.

These shortcomings notwithstanding, the study adds localized data to a meagre body of literature on the concept of revision degenerative spine surgery in low-income and resource-restricted neurosurgical entities. It states that in these limitations, revision surgery may provide acceptable safety and clinically significant benefits to most patients, and it also highlights the importance of preventing inertial improvements in primary spine care, improving indications to revision surgery and incorporating outcome measurement into practice.[13,25] Simultaneously, on the system level, the strategies to enhance the quality of index operations, increase workforce and perioperative capacity and create sustainable financing mechanisms will play a vital role in reducing preventable revisions and making sure that the scarce neurosurgical resources are utilized to the maximum.[20,25]

CONCLUSION

In a neurosurgical environment with limited resources, revision surgery of degenerative spine disease showed a high percentage of pain and disability improvement in most patients, with an acceptable overall profile of perioperative complications and moderate hospitalization. In this group, no definite association of six-month functional outcome was seen with common baseline comorbidities and routine surgical factors. These results imply that in the presence of proper patient selection and adherence to general principles of operative practice, even at low-income high-demand public hospitals, revision degenerative spine surgery can be a feasible and effective alternative to saving scarce neurosurgical resources by optimizing primary spine treatment and perioperative pathways.

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Additional Information

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AUTHORS CONTRIBUTIONS

Sr.#	Author's Full Name	Intellectual Contribution to the Paper in Terms of
1	**Muhammad Abbas Khan**	Study concept and methodology design.
2	**Zia ur Rehman**	Data Analysis, statistical analysis, and result interpretation.
3	**Kashif Jamal**	Critical reading and Revision. Data collection and referencing.