Original Article

Impact of Comorbidities on Outcome Following Revision of Recurrent Single-Level Lumbar Disc Prolapse between Revision Microdiscectomy and Posterior Lumbar Interbody Fusion: A Single-Institutional Analysis

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Abstract

Objectives: Reports exist in the literature on the relationship between comorbid conditions and recurrence of lumbar disc herniation. Meanwhile, documented evidence abound on microdiscectomy and posterior lumbar interbody fusion (PLIF) as techniques of managing recurrent disc prolapse. Some surgeons would choose to perform PLIF instead of microdiscectomy for a first time re-herniation, because of the possibility of higher chances of further recurrence as well as increased likelihood of spinal instability following treatment with microdiscectomy. In this study, the authors sought to determine whether PLIF is better than microdiscectomy for first-time recurrent single-level lumbar disc prolapse and to compare the impact of comorbidities on outcome following revision. **Patients and Methods:** This was retrospective review of surgical treatment of patients with recurrent single-level disc prolapse with either microdiscectomy or PLIF at a tertiary health institution in India. **Results:** A total of 26 patients were evaluated. There was no statistically significant correlation between the presence of comorbidity and outcome in terms of improvement of pain ($P > 0.05$ at 95% degree of confidence; Spearman's $\rho = 0.239$). Patients who had PLIF were neither more nor less likely to have a better outcome compared to those who had microdiscectomy, though this finding was not statistically significant (odds ratio = 0.263; $P = 0.284$). **Conclusion:** There was no significant relationship between the presence of comorbidity and outcome following revision. Microdiscectomy did not prove to be a better option than PLIF for surgical management of recurrent single-level disc prolapse. A quality randomized controlled study would help to validate these findings.

Keywords: *Posterior lumbar interbody fusion, recurrent single-level disc prolapse, revision microdiscectomy, revision surgery*

Introduction

Recurrent disc herniation has been defined as the presence of herniated disc material at the same level, ipsi-or contralateral, in a patient who has experienced a pain-free interval of at least 6 months since surgery for disc herniation.[1] Although an incidence of up to 5%–15% has been widely quoted in the literature, as much as 28% has also been mentioned.[1-3]

Different reasons for recurrence of symptoms after surgery for disc herniation have been suggested in the literature.[1,2,4] Male sex, old age, cigarette smoking, trauma, diabetes mellitus, high body mass index (BMI), occupational heavy weight lifting, and degenerative disc disease have all been identified as risk factors for recurrence.[4,5] In addition, studies have shown that the rates of re-herniation are in close relation with a defect on the posterior annulus.[6] Recurrence is also related to segmental instability and directly proportional to the integrity of defect in the posterior annulus.[6] It has been suggested by some that annular incision performed at primary discectomy may be a predisposing factor for recurrence,[4,5,7] whereas others have shown that it does not influence recurrence.[1] Among the common comorbid conditions, diabetes mellitus has been identified as a risk factor for recurrence and this is due to its association with increased tendency for less proteoglycan content in the intervertebral disc.[1,8] However, there are no studies yet in the literature to show if outcome following revision surgery after re-herniation is dependent on the presence of comorbid conditions or not.

On the other hand, studies comparing outcomes between different forms of minimally invasive techniques with

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techniques for lumbar spine fusion have been carried out using patients who have previously had surgical treatment for disc herniation.[9] Lumbar spine fusion options such as posterior lumbar interbody fusion (PLIF) have been tried with varying degrees of success.[3,10,11] Most surgeons would generally choose to perform revision microdiscectomy for a first time re-herniation and do PLIF instead when postoperative adhesions, intervertebral instability or any other additional pathology such as kyphosis is suspected in addition to the re-herniation, whereas a few others may prefer PLIF for revision as an option for first-time re-herniation even when these other problems are absent, with the idea that not fusing as part of revision after initial discectomy would allow more motion than normal at the involved segment, thereby predisposing to further re-herniation or other problems requiring more revisions (particularly varying degrees of spinal instability at the involved spinal segment). Is there any difference between revision microdiscectomy versus PLIF for recurrent lumbar disc herniations? Is it possible that comorbidities may differentially affect the outcome of revision with micro-discectomy or PLIF? This study was undertaken to find out.

Patients and Methods

The study was reviewed and approved by the Institutional Ethics Review Board at the Amrita Institute of Medical Sciences and Research, Kochi, Kerala, India. Retrospective and follow-up review of clinical details of surgical treatment with either revision microdiscectomy or PLIF given to patients with repeat surgery after initial microdiscectomy for single-segment disc prolapse at the Department of Neurosurgery, Amrita Institute of Medical Sciences and Research, India over 13 years between January 2001 and March 2014. The inclusion criteria are summarized in Table 1. Patients' data on clinical information and surgical technique in each case was extracted from the hospital database. The extracted information of the patients were separated into two groups in tables for each of both treatment groups. Table 2 comprised those who had revision microdiscectomy, whereas Table 3 included all those who had PLIF as the revision surgery. Both procedures were performed in standard fashion by the same surgeon (SKM) and will not be discussed in detail in this paper. The indication for revision for every patient in each group was noted.

Table 1: Summary of selection criteria

Inclusion criteria	Exclusion criteria
First-time recurrence of lumbar intervertebral disc prolapse	Recurrence at a different level of the lumbar spine following initial discectomy
Recurrence at same level of the lumbar spine following initial discectomy	Presence of spinal deformities or other pathology of the spine
No demonstrable spinal instability	Presence of any evidence of spinal instability
Only single-segment recurrent lumbar disc prolapse	Surgical treatment with any other technique apart from microdiscectomy or PLIF
	More than one spinal segment involved

PLIF – Posterior lumbar interbody fusion

Clinical evaluation

Measurement of extent of relief of pain (or the presenting symptom) in each patient with recurrence following revision surgery was the primary outcome measure defined using an outcomes assessment scale graded on a scale of 1 (complete pain relief) to 5 (worsening of pain) which was developed and adopted for the evaluation as follows:

- Complete resolution of the symptom/pain = Grade 1
- Good pain relief but with occasional recurrence of symptom/pain = Grade 2
- Only slight relief of the symptom/pain = Grade 3
- Persistence of symptom/pain = Grade 4
- Worsening of pain = Grade 5.

To evaluate the effectiveness of both techniques for revision, the records of the selected patients were also scrutinized for evidence of any further revision or re-operation data after initial revision surgery.

Statistical analyses using SPSS software for Windows (SPSS Inc., Chicago, IL, USA) included bivariate analysis (Spearman's rho correlation and Mann–Whitney U rank test for nonparametric data) and multivariate analysis (Multivariate logistic regression, Wilcoxon signed-rank test). Only value of $P < 0.05$ was considered statistically significant.

Results

Among a total of 26 patients who met the inclusion criteria within the period under review, 15 patients had revision microdiscectomy as the revision surgery. These constituted Group A [Table 2]. A total of 11 patients had PLIF done as treatment for recurrence of single-segment lumbar disc prolapse over the same period, and constituted Group B [Table 3]. All 26 patients were operated by the same surgeon (SKM). The only indication for revision in each of all 26 patients was re-herniation evidenced by the recurrence of the same symptom(s) and with radiologic confirmation by spine magnetic resonance imaging scan. The average duration of follow-up following revision surgery was 4.9 months for the microdiscectomy group and was 10.3 months for the PLIF group. No serious surgical complication was noted for any patient in either of both groups.

Of the entire 26 patients evaluated from both groups, there were 19 (73%) males, whereas the remaining 7 (27%) were female with a mean age of 46.2 years (age range of 27 years

Table 2: Demographic and clinical data of the patients who had revision microdiscectomy as revision surgery

Age (years)/sex	Spinal level operated	Clinical outcome following revision (at postoperative evaluation)	Grade	Comorbidities
Male/35	L4/L5	Persistence of severe pain	4	Hypertension
Male/45	L4/L5	Occasional pain at operated site	2	None
Male/65	L4/L5	Persistence of pain, radicular in nature	4	Hypertension with coronary artery disease
Female/27	L4/L5	Initial relief; recurrence at 7 months postoperative	4	None
Female/65	L4/L5	Remarkable sustained improvement	1	Hypertension
Male/33	L4/L5	Occasional pain (after long trips)	2	None
Male/54	L4/L5	Complete resolution of pain	1	Hypertension and Diabetes mellitus
Male/39	L3/L4	Progressive sustained reduction of weakness and numbness	1	Diabetes mellitus
Male/51	L4/L5	Complete resolution of pain	1	HIV (retroviral) +ve
Male/51	L4/L5	Complete resolution of pain	1	Diabetes mellitus
Male/57	L2/L3	Complete resolution of numbness and weakness	1	None
Male/40	L5/S1	Complete resolution of numbness and weakness	1	None
Female/42	L5/S1	Complete resolution of pain	1	Diabetes mellitus
Male/45	L4/L5	Persistence of pain with significant paraspinal spasm	4	None
Male/38	L4/L5	Occasional S1 root (ankle joint) pain	2	Diabetes mellitus

Table 3: Demographic and clinical data of the patients who had posterior lumbar interbody fusion as revision surgery

Age (years)/sex	Spinal level operated	Clinical outcome following revision (at postoperative evaluation)	Grade	Co-morbidities
Male/62	L4/L5	Persisting low back pain, especially on the sides	4	None
Female/44	N/A	Only occasional numbness and tingling sensation on the left side	2	Hypertension and Diabetes mellitus
Female/34	L4/L5	Complete resolution of symptoms; no deficits	1	None
Male/37	L5/S1	Minimal dorsiflexion weakness	2	None
Female/58	L4/L5	Complete resolution of pain; no deficits	1	Hypertension
Male/43	L4/L5	Complete resolution of symptoms	1	Hypertemsion
Female/53	L4/L5	Occasional upper back pain only	2	Diabetes mellitus and Hyperlipidemia
Male/50	L4/L5	Complete resolution of pain and symptoms	1	Hypertension
Male/43	L5/S1	Complete resolution of pain and symptoms	1	None
Male/41	L4/L5	Complete resolution of pain and symptom	1	None
Male/50	L4/L5	Persisting minimal numbness; otherwise ok with no deficits or pain	2	Diabetes mellitus

N/A – Not available

to 65 years) [Figure 1]. There was a male-to-female ratio of 2.7: 1. Among the 15 patients in Group A, the most common disc involved was L4/L5 disc (73.3%), with diabetes mellitus as the most common comorbidity (33.3%) in that group, whereas L4/L5 was also the most common level among the 11 patients in Group B (72.7%), but with hypertension as the most common comorbidity (36.5%). Altogether, the comorbidities included in this analysis are hypertension (n = 8), diabetes mellitus (n = 8), HIV (n = 1), and hyperlipidemia (n = 1), but none had smoking or high BMI. None of the patients in both groups required a second surgery for further revision. Hence, the re-operation rate after revision microdiscectomy and PLIF in this cohort was zero for both groups.

The age distribution in the entire cohort of 26 patients did not differ significantly from the expected normal distribution (P = 0.711; Shapiro–Wilk test), as shown in Figure 2. Furthermore, the baseline demographic data did not differ significantly [Table 4] for both groups of patients in terms of both gender and age (P = 0.407; Fischer's exact test and P = 0.804; Independent samples t-test, respectively). There was no statistically significant

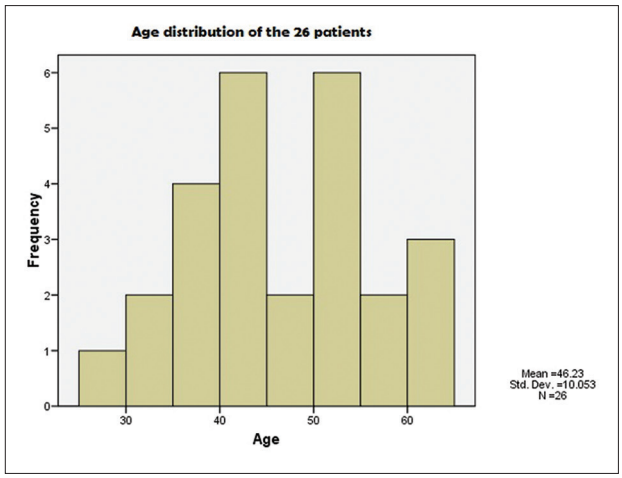

Figure 1: Age distribution of the patients

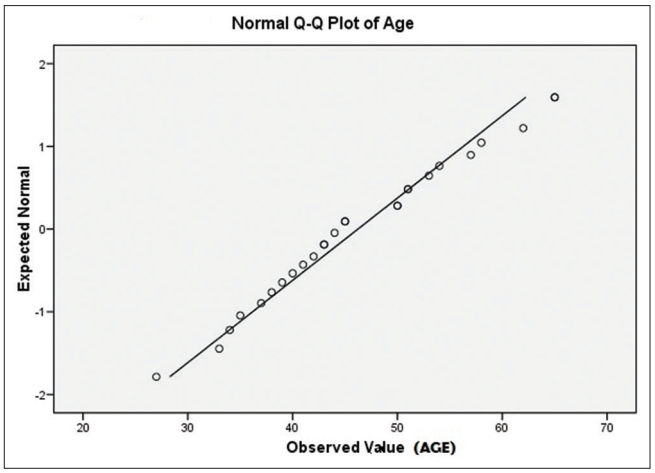

Figure 2: Age distribution in the cohort

Table 4: Distribution of baseline demographic data

	Revision microdiscectomy (*n*=15)	PLIF (*n*=11)	*P*
Sex distribution (male:female)	12:3	7:4	0.407*
Age (years), mean±SD	45.80±11.26	46.82±8.64	0.804$^{\phi}$

*Fischer's exact test; $^{\phi}$Independent sample's *t*-test. SD – Standard deviation; PLIF – Posterior lumbar interbody fusion

relationship of outcome in terms of postoperative grade with age and gender ($P > 0.05$ at 95% degree of confidence; Spearman's rho correlation = −0.120 and 0.058, respectively). Similarly, there was no statistically significant correlation between the presence of comorbidity and outcome in terms of postoperative grade ($P > 0.05$ at 95% degree of confidence; Spearman's $\rho = 0.239$), suggesting that outcomes following revision were not dependent on the presence of other comorbid conditions, age, or gender. There was also no statistically significant difference in the time interval between the time of revision and time of postoperative evaluation for both groups ($P = 0.084$; Mann–Whitney U-test rank test).

To assess for any significant impact of age, gender, the presence of comorbidity and the choice of procedure done on outcome following revision, multivariate logistic regression revealed none of these factors to be a significant predictor of improvement in symptoms for these patients [Table 5]. Controlling for age, gender, and extent of surgery, patients who had revision microdiscectomy were neither more nor less likely to have any better outcome compared to those who had PLIF, though this finding was not statistically significant (odds ratio = 0.263; $P = 0.284$) as shown in Table 5.

Discussion

From this review, findings show that both revision microdiscectomy and PLIF as options of revision surgery for the first-time recurrence of single-level lumbar disc herniation with no other added problems have no clear superiority over each other. In addition, the outcome of revision was not dependent on the presence of other comorbid conditions, age or gender.

As previously highlighted, much of the available information in the literature is simply on the relationship between comorbid conditions and recurrence of lumbar disc herniation, but none on the effect of co-morbidities on the outcome of treatment for recurrence. Some of these include studies of recurrent disc herniation in 28 patients by Suk; *et al*., and 75 patients by Meredith; *et al*., in which smoking and some other factors were not significantly associated with recurrence of disc herniation.[12,13] Similarly, a meta-analysis of 17 publications by Huang; *et al*., revealed that BMI in addition to a few other factors did not correlate with recurrent disc herniation.[14] In a retrospective subgroup analysis of patients from the intervertebral disc herniation arm of the Spine Patient Outcomes Research Trial randomized and observational cohorts by Leven; *et al*., diabetes mellitus in addition to smoking and a few other factors were not associated with a greater risk of reoperation following initial surgery for intervertebral disc herniation.[15]

However, a few studies, on the other hand, clearly highlight a link between recurrence of disc herniation of the lumbar spine following the initial disc surgery and comorbid conditions[8] [Table 6]. In the review by Mobbs; *et al*., as much as 28% of diabetic patients had a recurrence of disc herniation at the same level compared with only 3.5% of a control group of nondiabetic patients.[8,16,17] Diabetes mellitus results in both macrovascular and microvascular disease and also reduces the bone mineral and crystal formation.[18] In addition, there are fewer proteoglycans in the intervertebral discs of diabetics, which may increase the tendency of disc prolapse in patients with diabetes.[1] Studies have also shown that the intervertebral discs in patients with diabetes mellitus have proteoglycans with lower

Table 5: Multivariate logistic regression model of comparing patients with and without improvement of symptoms after undergoing revision microdiscectomy versus posterior lumbar interbody fusion as revision for recurrent lumbar disc herniation (*n*=26)

Parameter	Degree of freedom (df)	β co-efficient	SE of the mean	Wald	*P*	OR	95% CI for the OR	
							Lower	Upper
Age	1	−0.015	0.051	0.089	0.766	0.985	0.892	1.088
Sex	1	−0.071	1.302	0.003	0.957	0.932	0.073	11.955
Co-morbidity	1	−0.184	0.278	0.437	0.508	0.832	0.483	1.434
MILD versus PLIF	1	−1.336	1.247	1.147	0.284	0.263	0.023	3.029
Constant	1	3.878	3.097	1.568	0.210	48.323	-	-

*P<0.05, significant factors relating to clinical status following revision for recurrent lumbar disc herniation; Between 7.1% and 11.3% of the variability in the dependent variable is explained by this model. PLIF – Posterior lumbar interbody fusion; CI – Confidence interval; OR – Odds ratio; SE – Standard error

Table 6: Previous publications/studies relating comorbidities with recurrence of single-level lumbar disc herniation

Authors and year	Comorbid condition studied	Number of patients evaluated	Findings
Shimia; *et al*., 2013	Diabetes mellitus hypertension	40 patients	DM and HTN not significantly related to LDH recurrence (P=0.2 and 0.53, respectively)
Mobbs; *et al*., 2001	Diabetes mellitus	25 patients	Higher rate of recurrent disc herniation in diabetics compared to control group (28% vs. 3.5%)
Huang; *et al*., 2016	Diabetes mellitus	7687 patients from 17 studies (meta-analysis)	Apart from smoking and disc protrusion, diabetes proven to be a predictor for recurrence (P=0.002; pooled OR=1.19)
Simpson; *et al*., 2001	Diabetes mellitus	62 patients	Higher rates of postoperative infection and prolonged hospitalization in diabetics compared to control group?
Meredith; *et al*., 2010	Obesity Smoking	75 patients	Obese patients 12 times more likely to have recurrence than nonobese patients (OR=12.46; 95% CI=2.25–69.90). Smoking not significantly associated with recurrent
Leven; *et al*., 2015 (IDH arm of SPORT study)	Diabetes mellitus Hypertension Osteoporosis Heart problem Stomach problem Intestinal problem Joint problem Depression Others	Approximately 74 patients	No comorbidity significantly associated with reoperation following initial discectomy
Moliterno *et al*., 2010	Diabetes mellitus Obesity Smoking/tobacco use Steroid use	14 patients	Greater risk for recurrence in non-obese patients with lower body mass index (P=0.005); Nil recurrence in obese patients
Miwa;*et al*., 2015	Smoking Alchoholism	32 patients	Smoking was an independent risk factor for recurrence (P=0.003)
Omidi-Kashani; *et al*., 2016	Smoking	32 patients	Smoking was an independent risk factor for recurrence (P<0.001)

N/A – Not available; IDH – Intervertebral disc herniation; SPORT – Spine patient outcomes research trial; DM – Diabetes mellitus; HTN – Hypertension; LDH – Lumbar disc herniation; OR – Odds ratio; CI – Confidence interval

buoyant density and undersulfated glycosaminoglycan as well as both a lowered glycosylation rate and a lower number of sugar side chains per core protein to explain the tendency for recurrence in people with diabetes.[19] A meta-analysis of 17 publications by Huang; *et al*., revealed smoking and diabetes to be predictors for recurrent lumbar

disc herniation.[14] They suggested that the healing of the annulus fibrosus in diabetic patients might require a longer period and hence not heal as well as in nondiabetics.[14]

A weight of 25 pounds or more with knees straight and back bent has also been associated with increased risk of recurrent herniation of the lumbar disc.[17] In their retrospective study of 75 patients, Meredith; *et al*., demonstrated significant increase in risk for recurrent herniation of nucleus pulposus after lumbar microdiscectomy in obese patients and suggested that counseling on weight loss should be incorporated by surgeons into their preoperative discussions with patients.[12] However, while this and some other studies show that higher BMI and obesity are associated with recurrence of lumbar disc herniation, a few others do not find any significant link between obesity and recurrence of lumbar disc herniation.[5] On the other hand, another study by Moliterno *et al*., interestingly, revealed that patients with lower BMI tend to be at greater risk for recurrence compared to those with higher BMI.[16]

Other factors identified in connection with recurrence of lumbar disc herniation from previous studies include young age, male sex, smoking, and a history of trauma.[9,20,21] Smoking has been known to cause capillary vessels to contract, affects cellular multiplication and cellular metabolism and also reduces the rate of wound healing.[21]

Limitations

We have attempted to provide some useful outcomes data for patients with recurrent lumbar disc herniation. There was a rather small sample size of only 26 patients for this assessment, and selection criteria at the time of the surgeries were simply based on surgeon preference. Due to the retrospective nature of the study, there was considerable difficulty with reaching some of the patients during the follow-up period, leading to the lack of uniformity in the duration of follow-up as well as reduction in follow-up rate to just 54%. Furthermore, the postoperative evaluation of pain was simply clinician-based using the nonvalidated outcomes assessment as presented, graded on a scale of 1 (complete pain relief) to 5 (worsening of pain) and not a comprehensive measure of the quality of life.

Despite these drawbacks and concerns with the possibility of some difficulty with statistical detection of differences where they probably existed, we still believe this review to form a strong basis for further evaluations on a much larger scale to further confirm the findings.

Conclusion

In this study, we hypothesized that the presence of a comorbidity might differentially affect the outcome of revision for first-time single-level lumbar disc re-herniation with either micro-discectomy or PLIF. However, we found no relationship between the presence of co-morbidities and outcome following revision. Second, some proponents of revision surgery believe that fusion of the previously operated symptomatic spinal segment as one of the available options is related to a better outcome. From our experience; however, this retrospective evaluation of both techniques for recurrent single-level disc herniation in the absence of any other disc or spine pathology clearly demonstrates none of both to be a more effective technique of revision after initial surgical excision of recurrent disc prolapse. Since there was no difference in comorbidity and outcome between revision discectomy with or without fusion, we suggest microdiscectomy to probably be a more appropriate option for a patient with a first-time recurrent disc herniation in the absence of any other added problems, in view of extra cost of implants for fusion, higher risks of surgical site infection, and longer operating time which are commonly associated with PLIF. A prospective well randomized controlled study on a much larger scale will, however, be required to confirm and validate these findings.

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Conflicts of interest

There are no conflicts of interest.

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