

Functional outcome of conventional open discectomy versus minimally invasive surgery for lumbar disc prolapse: A non-randomised controlled study

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Abstract

Context: Lumbar prolapse of intervertebral disc (PIVD) is seen in over 1% of adults with the most incidence between the 3rd to 5th decades of life. It appears to be more prevalent in the male population and predominantly affects the L4-L5 and L5-S1 levels. Over the years several surgical techniques have been developed for its management but the best technique is still debatable.

Aims: This study aims to compare both immediate and long-term functional outcome following minimally invasive spine surgery (MISS) and open discectomies for Lumbar prolapse.

Settings and Design: It is a non-randomised controlled study.

Methods and Material: The patients, diagnosed with lumbar disc prolapse, were taken for the surgery of choice following an initial assessment. The outcome is assessed in the immediate post-operative period using VAS and ODI and long-term functional outcome using Modified macnab criteria between 12 and 18 months post-surgery.

Statistical analysis used: The IBM SPSS software was used to study the correlation. One-tailed ANOVA with CI of 95% was conducted for VAS score and ODI score while Mann-Whitney U test was done on the Modified Macnab Criteria.

Results: This study was conducted on 103 subjects with 56.3% undergoing open discectomies while 43.7% underwent minimally invasive discectomies. 73 subjects were operated on the L4-L5 level and 30 on the L5-S1 level. The study revealed that the operative duration of MISS is significantly more than that of open procedure. The VAS score for the MISS procedure had a mean change of 3.067 in the immediate postoperative period versus the mean reduction of 2.603 for open procedure. The ODI of MISS has decreased from 44.27 to 13.73 and that of Open procedure has decreased from 43.19 to 17.48. The long-term outcome at 12-18 months after surgery was excellent for 75.5% of MISS patients but only 25.9% open discectomy cases

Conclusions: The MISS procedure did not produce a strongly clinical outcome compared to open discectomies in the immediate after surgery but the functional outcome of MISS procedure on the long-term was greater than that of the conventional method

Keywords: Lumbar PIVD, Minimally invasive spine surgery, Open discectomy, functional outcome, Modified Macnab Criteria

Introduction

One of the earliest descriptions of lumbar discectomy was that reported by Mixter and Barr in 1932, in which an L2 to S1 exploratory laminectomy led to the removal of a “mass one

centimetre in diameter”^[1]. As an essential component of minimally invasive spine surgery, endoscopic spine surgery (ESS) has continuously evolved and has been accepted as a practical procedure by the worldwide spine community. Especially for lumbar disc herniation (LDH), the percutaneous endoscopic or full-endoscopic discectomy technique has been scientifically proven through randomized controlled trials and meta-analyses to be a good alternative to open discectomy^[2]. In this study, we aimed to determine the effectiveness of MISS discectomy in comparison to conventional open surgery for symptomatic lumbar disc herniation. Our primary objective was to evaluate potential differences in patient-reported leg pain, back pain, disability, function, and satisfaction at 12-months after surgery

Subjects and Methods

Patients with symptomatic lumbar disc herniation admitted to the Department of Neurosurgery at a single institute and operated on by the same surgeon, one of the authors, from November 2017 to January 2021, fulfilling the inclusion criteria were taken up for the study

Inclusion criteria

1. Unsuccessful conservative management of discogenic/radicular pain for over six weeks
2. Severe discogenic/radiating pain with radiological correlation
3. Radical pain with coexisting deficits like foot drop or urinary involvement.

Exclusion criteria

1. Patients not falling in the 18–60 years age group
2. Recurrent disc disease
3. Multiple level disc herniation
4. Spondylodiscitis

Procedure

Initial assessment: The patients presenting to the OPD are enquired in detail regarding their history and a thorough clinical evaluation is done. Depending on the clinical presentation, needy patients are subjected to an MRI of the lumbosacral spine and confirmed for intervertebral disc prolapse by radiological correlation. Depending on the symptomology, clinical findings and degree of nerve compression, patients are either conservatively managed or directly taken up for surgery. The latter is chosen in patients with unresolved complaints after conservative management or with deficits like foot drop or urinary involvement, or other motor deficits. Patients planned for surgery are assessed by their VAS score for back pain and their radicular pain. The surgical procedures offered are open discectomy and minimally invasive discectomy. The choice of the procedure is made by the patients after discussing in detail the available options, as MISS is expensive.

Pre-operative

Written informed consent is taken from all patients following a fitness checkup for anaesthesia.

Operative procedure

Conventional open discectomy: A vertical midline incision around one and half inches (0.04 m) in length was taken with the subperiosteal elevation of muscles, exposing the lamina
Minimally invasive discectomy: a paramedian incision about eighteen to 0.012m in length is taken a finger breadth away from the midline corresponding to the disc. After the fascia is incised, under c arm guidance, multiple sequential dilators are introduced with simultaneous dissection of muscles, landing on the inferior aspect of the lamina. Over the final dilator, the self-retaining retractor blades are introduced and fixed to a wall-mounted stand after confirming the position under the c arm. Medtronic self-retaining retractor system was used in the study.

The initial part of the procedure differs in both the techniques, till the lamina is reached. Once the lamina is accessed the procedure is common in both the techniques when the microscope is brought into the field. The inferior aspect of the lamina is excised and flavum is removed to identify the root and the dural tube. Root is retracted and the disc is accessed. Annulus is incised and the disc fragment is excised. After confirming hemostasis, the defect is covered with free fat graft harvested from subcutaneous fat or the epidural fat removed during surgery. In conventional discectomy muscle was also approximated with sutures through the interspinous ligament followed by fascial closure. In MISS Discectomy only fascia was closed.

In open discectomy if there were a csf leak attempt was made to close primarily with prolene 4-0 sutures if the defect was big. If it was small then crushed muscle tissue along with surgical were used to cover the defect. In MISS Discectomy cases csf leaks were addressed by covering the defect with crushed muscle along with surgical.

Post-operative

Following surgery, the patient was shifted to the surgical ICU and closely monitored for a minimum of two hours before being shifted to the ward. They were discharged within 3 to 5 days with instructions for post-operative care. The patients' condition following surgery was constantly reviewed. Depending on the patient's clinical condition and comfort levels after the surgery, discharge was planned on the third to fifth day. Patients' VAS score was assessed at the time of admission and at the time of discharge. Patients who were on regular follow-up were only included in the study. Patients were reassessed after 12 months, ranging from the one year to one and half years (18 months), depending on the regularity of their follow-up. During their visit, Modified Macnab criteria, as represented in Table 1, were applied to assess the patient's improvement. This included questions regarding three aspects: pain, restriction of mobility and ability to perform activities. On this basis, patients' recovery was categorized as excellent, good, fair and poor. On these criteria, both the procedures were assessed to have a final outcome analysis.

Table 1: Modified Macnab criteria for the assessment of clinical outcomes

Outcome	Characteristic
Excellent	No pain; no restriction of mobility; return to normal work and level of activity
Good	Occasional non-radicular pain; relief of presenting symptoms; able to return to modified work
Fair	Some improved functional capacity; still handicapped and/or unemployed
Poor	Continued objective symptoms of root involvement; additional operative intervention needed at index level irrespective of the length of postoperative follow-up

Source: Macnab I. "negative disc exploration: an analysis of the cause of nerve root involvement in sixty-eight patients." J Bone Joint Surg (Am) 1971;53:891-903

Statistics

The IBM SPSS software was used to study the correlation. One-tailed ANOVA with CI of 95% was conducted for VAS score and ODI score while Mann-Whitney U test was done on the Modified Macnab Criteria.

Results

Demographic data and Diagnosis

A total of 103 patients were included in the study with the mean age being 44.28 years (ranging between 26 and 60). The mean age for open procedure patients was 45.5 years and 42.4 years for MISS procedures. Female subjects constituted 43.7% (44 of 103) and male subjects constituted 57.2% (59 of 103) of the total subjects. Herniation of the L4-L5 intervertebral disc was seen in 73 subjects (70.8%) and that of L5-S1 was seen in 30 subjects

(29.2%). The demography and diagnosis is represented in Table 2.

Table 2: Demography and Diagnosis (Original)

	Open discectomy	Minimally invasive discectomy	Overall
Patients-No (%)	58 (56.3%)	45 (43.7%)	103 (100%)
Sex			
Male-No (%)	35 (60.3%)	24 (53.3%)	59 (57.3%)
Female-No (%)	23 (39.7%)	21 (46.7%)	44 (43.7%)
Average duration since the start of symptoms in months	12.06	7.266	10.16
Diagnosis			
L4-L5 herniation-No (%)	39 (67.3%)	34 (75.6%)	73 (70.8%)
L5-S1 herniation-No (%)	19 (32.7%)	11 (24.4%)	30 (29.2%)

Comorbidities

31 patients (30.0%) were known cases of Diabetes mellitus, 20 patients (19.4%) were known cases of hypertension and 8 patients (7.7%) were known cases of Hypothyroidism.

Duration of symptoms

The average duration of symptoms for conventional discectomy was 12.08 months and that of minimally invasive procedure was 7.266 months.

Symptomatology

Back pain was the most common complaint seen in 79 of 103 subjects(76.6%), followed by lower limb pain in 46 subjects (44.6%), tingling sensation in 42 subjects (40.77%), inability to walk (neurogenic claudication) in 28 (27.1%) and Footdrop in 7 subjects(6.9%).

Procedure done

Macro discectomy was done on 58 subjects (56.3%) and a minimally invasive procedure was done on 45 (43.6%).

Duration of surgery

The mean duration of surgery for the Open procedure was 86.66 minutes and 103 minutes for the MISS procedure.

Outcome assessment

For outcome assessment VAS score, ODI score and Modified Macnab criteria were used. The mean VAS score with standard deviation before the surgery and in the immediate recovery period before discharge for both open procedure and MISS are represented in Table 3.

Table 3: VAS in preoperative period and immediate postoperative period (Original)

	Preoperative VAS mean+/-SD	Postoperative VAS mean+/-SD	Mean reduction in VAS+/-SD
Open discectomy	4.189 +/- 1.249	1.586+/-0.77	2.603+/- 1.09
Minimally invasive surgery	4.266 +/- 1.195	1.2+/-0.99	3.067+/- 1.19

The mean VAS score of MISS with standard deviation before surgery was 4.266 +/- 1.195. The mean VAS with standard deviation for back pain and leg pain after surgery were 1.22+/- 0.99 and 1.29+/-0.95 with a significant correlation ($p<0.0001$) between before and after data.

The mean VAS of open discectomy with standard deviation before surgery was 4.189 +/- 1.249. The mean VAS after surgery were 1.586 +/- 0.77 with a significant correlation ($p < 0.0001$) between before and after data. The outcome assessment of MISS and open procedures using ANOVA with CI of 95% showed a weakly significant correlation ($p = 0.043$) at $p < 0.05$.

The mean ODI score with standard deviation before the surgery and in the immediate recovery period before discharge for both open procedure and MISS are represented in Table 4.

Table 4: ODI in the preoperative period and immediate postoperative period (Original)

	Preoperative ODI	Postoperative ODI	Mean decrease
Minimally invasive	44.27 +/- 8.73	13.73 +/- 7.69	30.99
Open discectomy	43.19 +/- 7.79	17.48 +/- 7.69.	25.71

The mean ODI of MISS procedure with standard deviation before surgery was 44.27 +/- 8.73. The mean ODI with standard deviation after surgery was 13.73 +/- 7.69. The mean decrease was 30.99. The mean ODI of open procedure with standard deviation before surgery was 43.19 +/- 7.79. The mean ODI with standard deviation after surgery was 17.48 +/- 7.69. The mean decrease was 25.71. The correlation of ODI score for MISS and open procedures using Anova at 95% CI is significant ($p = 0.027$) at $p < 0.05$.

The long-term follow-up assessment using modified Macnab criteria between 12 to 18 months revealed the results as represented in Table 5.

Table 5: Modified Macnab criteria for assessment of outcome (Original)

	Open discectomy	Minimally invasive
Excellent	15 (25.86%)	34(75.56%)
Good	31(53.4%)	9(20%)
Fair	11(20.68%)	2(4.4%)

The correlation between the procedures done and the outcome grade using Mann-Whitney U test was found to be very significant ($p < 0.00001$).

The correlation between age and outcome was found to be insignificant at $p < 0.05$. The average period of recovery for minimally invasive surgery was 3.18 months and 3.27 months for open discectomy.

Complications

CSF leak was seen in 2(4.4%) of the 45 MISS procedures as seen in Table 6. Recurrence of LDP in 2 cases post MISS Procedure and in 1 case post open procedure.

Table 6: Postoperative complications (Original)

	Open	MISS
CSF leak	0 (0%)	2 (4.4%)
Recurrence of LDP	1 (1.7%)	2 (4.4%)

Discussion

Lumbar PIVD is a very common spine problem seen in the neurosurgery outpatient department, sometimes presenting in an emergency with an acute picture. There have been multiple changes in the approaches to the lumbar disc over time^[3]. The concept of minimally invasive techniques in the lumbar spine has been in existence for a few decades now^[4]. The initial enthusiasm was met with setbacks with long-term studies and comparative analyses showing an overall inclination towards conventional techniques^[5]. As technology advances, newer trends come more to the forefront with new adaptations to overcome the flaws^[6]. This study is aimed at understanding and comparing the conventional microdiscectomy with

minimally invasive tubular discectomy with a subjective analysis of the patient outcome with a follow-up of 1 year to understand where each technique stands. The surgeries were attempted by a single surgeon over a period of 4 years.

Lumbar disc pathology was seen more commonly in men than women, Similar to the prevalence found in previous studies ^[7]. Most of the patients were in the fifth decade, with patients opting for MISS procedures being a bit younger than the conventional procedure. The prevalence of lumbar disc herniation is highest in the 30-50 years age group ^[8]. The disc herniation is at higher levels with progress in age ^[9].

As highlighted in previous studies, disc pathology was seen most commonly at the L4-L5 level followed by the L5-S1 level, both in MISS and open cases ^[8].

Conventional surgery was opted for by 56.3% while MISS surgery was opted by 46.3% of the patients. There was no randomization attempted in the study. As MISS was a costly procedure as compared to conventional surgery, the option was given to the patients. Depending on their affordability and educational status, after understanding both the procedures, the chance was given for informed decision-making. To reduce selection bias due to this, the inclusion criteria were strongly adhered to.

The mean duration of surgery was longer in MISS cases than in conventional procedures (86.6 vs 103 minutes). Most of the studies analysing MISS techniques have highlighted the same ^[10]. The appropriate docking of the retractor system at the area of interest determines the subsequent ease of surgery and duration of surgery to a certain extent, because improper docking would cause muscle intrusion into the field of interest and subsequent and subsequent muscle injury to manage the same. This would not only increase bleeding during surgery but also be a contributor for postoperative pain ^[11]. The different factors affecting this could be the size of the facet joint (hypertrophied facets could pose difficulty), the size of the patient, the size of the retractor blades chosen and the size of the inferior lamina.

The mean reduction in vas score was greater for MISS procedure than the conventional open procedure. In a study by Hui Peng and team, it was observed that the mean reduction in vas score was better with MISS approach than with conventional surgery ^[12]. According to a study by Dustin. H. Massel *et al.*, the vas score improvement was better for radicular pain than the low back ache in minimally invasive procedures ^[13] in long-term follow-up, though in our study the follow-up was assessed by modified Macnab criteria without specifically focusing on individual components of back pain and radicular pain. Modified Macnab scoring was used to assess the functional outcome of both procedures. The p-value was weakly significantly in favour of MISS procedures than conventional procedures. Two cases of CSF leak were noted in MISS cases and 2 cases had a recurrence of the symptoms among MISS cases and 1 case had a recurrence of symptoms in conventional cases on long-term follow-up.

Conclusion

Though the minimally invasive surgery and the open procedure for lumbar disc prolapse do not show a strong clinical significance in the outcome in the immediate postoperative period, the minimally invasive surgery resulted in a better functional outcome when estimated on a long run about 12-18 months postoperatively. The two procedures do not show any significant difference in terms of the period of recovery and the complications, while the MISS procedure requires significantly more time when compared to the open procedure.

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