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Original Research Article

A Hospital Based Prospective Outcome Assessment of Minimally Invasive Spine Decompression in Lumbar Spinal Stenosis and Intervertebral Disc Prolapse

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Conflict of interest: Nil

Aim: The purpose of the present study was to assess the outcome in terms of improvement in neurology, extent of pain relief in the postoperative period and complications in patients undergoing minimally invasive spine decompression by tubular retractors.

Methods: We conducted a prospective interventional study in the Department of Orthopaedics, Sri Krishna Medical College and Hospital, Muzaffarpur, Bihar, India for the period of 6 months. 20 patients were included in the study. Patients with low back ache and leg pain between 18-60 age who were diagnosed with lumbar canal stenosis and intervertebral disc prolapse who failed to respond to trial of conservative management for 6 weeks were included.

Results: 4 patients belonged to 21-40 years of the age group and 16 patients belonged to 41-60 years of the age group. Patient's age ranges from 24 years to 60 years. 12 patients (460%) were male and 8 patients (40%) were female. Out of 20 patients, 13 (65%) patients had intervertebral disc prolapse and 7 patients (35%) had lumbar spinal stenosis L4L5 (55%) was the most commonly involved level, 11 patients had L4L5 level, 4 patients had L3L4 (20%) and 4 patients had L5S1 (20%). Only one patient (5%) had L2L3 involvement who had sacralised L5.

Conclusion: Minimally invasive spine decompression using tubular retractors is an excellent surgical option for patients suffering from lumbar spinal stenosis and intervertebral disc prolapse due to its minimally invasive nature, high success rate, and long-term outcomes.

Keywords: Intervertebral Disc Prolapse, Lumbar Spinal Stenosis, Minimally Invasive Spine Decompression.

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Introduction

Lumbar disc disease (LDD) and lumbar canal stenosis (LCS) are two of the most common conditions affecting the lumbar spine. Low back pain with associated radicular pain and paresthesia is a cause of significant morbidity, leading to loss of workdays and rising healthcare

expenditure with its obvious implications. [1] Laminectomy and discectomy were done for LDD in 1934 by Mixter and Barr. [2]

The current trend is toward minimally invasive techniques. [3] In minimally invasive tubular discectomy of spine (MITDS) and minimally invasive tubular decompression (MITD), smaller incision size and sparing of paraspinal muscles, including the traditional detachment of multifidus muscle from the spine, avoids surgery-related morbidity like denervation atrophy of paraspinal muscles and subsequent occurrence of chronic axial back pain. [4-7] Minimally invasive procedures commonly employed for discectomy are microscopic discectomy using tubular retractor system (MITDS), percutaneous endoscopic lumbar discectomy (PELD). The tubular retractor system could use either an endoscope or a microscope akin to microdiscectomy. In cases of lumbar canal stenosis, "over the top" decompression (MITD) of the contralateral side can be performed by certain subtle technical modifications using the tubular retractor system. [8]

Decompression surgery in the spinal stenosis is usually done by removing medial one-third of the upper facet and, if necessary, the lower facet of the spine. [9] These procedures are the cause of instability in some of the patients that necessitates to fusion and instrumentation. Despite the increasing growth of science and the emergence of different surgical methods, nucleotomy method is used as an effective method with less pain and complications than other methods. This type of surgical procedure requires less time than other methods, and complications such as bleeding, prolonged hospitalization, and infection are less frequently observed in this method. [10]

In spite of years of advancement in spine surgery, direct decompression of the neural elements by removal of herniated portion of the intervertebral disc, bone structures such as the lamina, medial facet, and ligamentum flavum, all that can cause central and lateral recess stenosis, is still the gold standard treatment for both disorders. Both conditions are traditionally treated by a midline lumbar incision, after which the paraspinal muscles are separated from the spinous processes and lamina and retracted laterally and extensively causing significant muscle damage. [11] In minimally invasive spine decompression, the paraspinal muscle is not separated from the spinous processes, favouring a lateral incision and muscle splitting technique over a subperiosteal dissection technique used in earlier treatments. Instead, the Para spinous muscle fibres are separated to create a spinal column corridor. This method is intended to result in less soft tissue injury and hence less postoperative pain. [12]

The purpose of the present study was to assess the outcome in terms of improvement in neurology, extent of pain relief in the postoperative period and complications in patients undergoing minimally invasive spine decompression by tubular retractors.

Methods

We conducted a prospective interventional study in the Department of Orthopaedics, Sri Krishna Medical College and Hospital, Muzaffarpur, Bihar, India for the period of 6 months. 20 patients were included in the study. Patients with low back ache and leg pain between 18-60 age who were diagnosed with lumbar canal stenosis and intervertebral disc prolapse who failed to respond to trial of conservative management for 6 weeks were included. Patients with acute cauda equina syndrome, history of previous spine surgery and neoplastic lesion were excluded.

Socio-demographic details such as age, sex, gender were obtained. Neurological examination was done and deficits were documented. Patient reported outcome

measures (PROM) were used preoperatively and postoperatively to assess the pain severity and functional disability. Visual analogue score (VAS) for both low back pain and leg pain, Modified Oswestry Disability Index (MODI), Roland Morris Disability Questionnaire (RMDQ) were the outcome measures used. All patients underwent minimally invasive spine decompression by tubular retractors under general anesthesia. Postoperatively patients were shifted to post-operative ward following surgery. Patients were mobilised on the night of surgery or postoperative day 1 and discharged after wound inspection and dressing. Appropriate physiotherapy was advised to the patients. Suture removal was done on postoperative day 12 in outpatient department. Then patients were followed up at 6 weeks, 3 months, 6 months and outcomes were assessed. Statistical analysis was performed using Statistical Package for Social Sciences (SPSS) for windows 26.0. (SPSS, Inc. Chicago, Illinois). Descriptive statistics were applied for demographic details. Categorical variables were presented in the form of a frequency. Continuous variables were presented as Mean ± Std. Deviation form. Paired t test was applied to compare pre-operative and subsequent follow-up such as 6 weeks, 3 months and 6 months for all the parameters.

Results

Table 1: Patient demographics

Gender	**N**	**%**
Female	8	40
Male	12	60
Age in years		
21-40	4	20
41-60	16	80
Pathology		
IVDP	13	65
LCS	7	35
Level		
L2L3	1	5
L3L4	4	20
L4L5	11	55
L5S1	4	20

4 patients belonged to 21-40 years of the age group and 16 patients belonged to 41-60 years of the age group. Patient's age ranges from 24 years to 60 years. 12 patients (460%) were male and 8 patients (40%) were female. Out of 20 patients, 13 (65%) patients had intervertebral disc prolapse and 7 patients (35%) had lumbar spinal stenosis L4L5 (55%) was the most commonly involved level, 11 patients had L4L5 level, 4 patients had L3L4 (20%) and 4 patients had L5S1 (20%). Only one patient (5%) had L2L3 involvement who had sacralised L5.

Table 2: Comparison of Visual Analog Score for Leg Pain, back pain, Modified Oswestry Disability and Roland Morris Disability

Visual Analog Score for Leg Pain		**Mean± Std. Deviation**	**p-value**
Pair 1	Pre-Operative	6.88±1.25	0.001
	6 weeks	1.63±0.88	
Pair 2	Pre-Operative	6.88±1.25	0.001
	3 months	1.19± 0.75	

Pair 3	Pre-Operative	6.88±1.25	0.001
	6 months	0.50±0.63	
Visual Analog Score for Back Pain			
Pair 1	Pre-Operative	4.44±1.50	0.001
	6 weeks	1.94±0.68	
Pair 2	Pre-Operative	4.44±1.50	0.001
	3 months	1.56±0.62	
Pair 3	Pre-Operative	4.44±1.50	0.001
	6 months	1.31±0.63	
Modified Oswestry Disability			
Pair 1	Pre-Operative	66.38±8.26	
	6 weeks	24.50±6.21	
Pair 2	Pre-Operative	66.38±8.26	
	3 months	13.94±4.71	
Pair 3	Pre-Operative	66.38±8.26	
	6 months	6.69±3.77	0.001
Roland Morris Disability			
Pair 1	Pre-Operative	11.31±2.57	0.001
	6 weeks	4.31±1.30	
Pair 2	Pre-Operative	11.31±2.57	0.001
	3 months	2.75±0.85	
Pair 3	Pre-Operative	11.31±2.57	0.001
	6 months	1.38±0.61	

Mean preoperative VAS score was 6.88 + 1.25 for leg pain, there was a significant reduction in the leg pain postoperatively at 6 weeks, 3 months and 6 months. There was a 76%, 88% and 92.7% decrease in leg pain at 6 weeks, 3 months and 6 months postoperatively. Mean preoperative VAS score for backache was 4.44 + 1.50, there was significant reduction in the postoperatively 6 weeks, 3 months and 6 months. There was 56%, 65% and 70% decrease in back ache at 6 weeks, 3 months and 6 months postoperatively. Roland Morris Disability was observed highest pre-operatively 11.31 + 2.57, followed by 6 weeks 4.31 + 1.30, 3 months 2.75 + 0.85 and 6 months 1.38 + 0.61. There was significant reduction in disability postoperatively at 6 weeks, 3 months and 6 months. There was a mean improvement of 61.25 + 10.47 at 6 weeks, 74.93 + 8.65 at 3 months and 87.60 + 5.73 at 6 months postoperatively from the preoperative baseline score.

Table 3: MODI Interpretation

MODI	Preoperative		6 weeks		3 months		6 months	
	N	%	N	%	N	%	N	%
0-20	0	0	8	40	16	80	20	100
20-40	0	0	12	60	4	20	0	0
40-60	4	20	0	0	0	0	0	0
60-80	16	80	0	0	0	0	0	0
80-100	0	0	0	0	0	0	0	0

Mean MODI was observed highest pre operatively 66.38 + 8.26. At 6 weeks it was 24.50 + 6.21, at 3 months it was 13.94 + 4.71. It was lowest at 6 months 6.69 + 3.77. There was a significant reduction in

the disability was seen in the postoperative period at 6 weeks, 3 months and 6 months. Preoperatively 16 patients (80%) had crippling back pain, 4 patients (20%) had severe disability. There was a significant reduction postoperatively at 6 weeks and 3 months. At 6 months, all 16 patients had less than minimal disability. Two patients had complications. One patient had CSF leak intraoperatively and other patient has superficial surgical site infection postoperatively which settled with oral antibiotics and regular dressing. Eight (40%) out of 20 patients had a motor deficit. The average hospital stay of 4 days. Patients without intraoperative or postoperative complications were discharged on postoperative day 1 or postoperative day 2 after wound inspection. Minimum hospital stay was 3 days.

Discussion

The narrowing of the lower part of the spinal canal is called spinal canal stenosis which is in various forms and degrees. [13,14] Spinal canal stenosis often occurs in Middle Ages and due to degenerative changes. One of the most important causes of spinal canal stenosis is disc herniation which is one of the most common and important causes of low back pain in various societies and have a relatively high prevalence. [15,16] The most common type of canal stenosis is the intervertebral disc bulging toward the spinal canal, leading to reduced spinal canal space and narrowing of the canal (discogenic canal stenosis). Another cause of spinal canal stenosis is the thickening of various ligaments and bones around the spinal cord (especially ligamentum flavum). [17]

Lumbar spinal stenosis, a degenerative condition, is referred to as narrowing of central spinal canal, vertebral foramina, and/or lateral recesses, causing impingement on nearby neurologic structures. This condition largely affects the elderly and can cause a variety of debilitating symptoms, including back pain and radicular leg pain and neurogenic claudication. Similar symptoms can also occur due to vertebral disc herniation causing impingement on neurologic structures. In the absence of progressive neurologic deficit or intractable pain, first-line treatment is nonoperative, consisting of physical therapy and pharmacotherapy (analgesics, steroids). [18] The majority of MIS techniques currently use progressive dilators to dilate through the muscle onto the targeted level of the facet. Through the biggest dilation tube, interlaminar space is viewed, and inferior margin of lamina is removed with a kerrison or drill. For foraminotomies and discectomies, a piece of the medial facet is frequently resected. [19] Drills, pituitaries, kerrisons and knives are examples of long and angled devices that were invented for allowing visibility as well as dissection. The endoscope or microscope can be utilised for visualisation.

Our study used the Roland Morris Diability Questionnaire to study self-rated physical disability caused by low back pain. There was significant reduction in disability at 6 weeks, 3 months & 6 months postoperatively. It could be due to minimally invasive decompression decreasing surgical trauma, allowing earlier mobilization post-surgery. There was significant difference in SF-12 physical component score at 6 weeks, 3 months and 6 months compared to preoperative score and with respect to SF-12 Mental component, where a significant improvement was observed in 6 weeks postoperative period compared to pre-operative score. In a systematic review conducted in 2016, Phan et al. found that satisfaction rates in the minimally invasive group were considerably higher compared to open group (84 percent vs. 75.4 percent), whereas back pain Visual Analog Scale scores were lower. [20] Our data was not in line with SF-12 findings of Khanna et al. whose study population also demonstrated sustained and statistically

significant improvement beyond Minimum clinically importance difference in all Patient-Reported Outcome Measures (PROM) categories except for the SF-12 MCS at the 3-month, 6-month, 1-year, and 2-year follow-up. [21]

Our study reported complications in 2 out of 20 patients, one patient had intraoperative dural tear and other patient had superficial wound infection. The spinous processes, interspinous ligaments, bilateral lamina, sections of the facet joints and capsule, and LF are all resected extensively for typical LSS and IVDP treatment. These classic operations of a wide decompressive laminectomy, medial facetectomy, and foraminotomy have been used for decades with varying degrees of success. [22] However, such extensive open decompression is associated with significant pain, hospitalization, morbidity, a prolonged recovery period, and an increased incidence of complications. Extensive surgical tissue trauma can also have delayed long-term functional consequences. Loss of the midline supraspinous/interspinous ligament complex can lead to a loss of flexion stability, thereby increasing the risk of delayed spinal instability. [23,24]

Although open surgery is frequently seen as an excellent option and may be required for some subjects, MISD may be used for patients who may not tolerate a more invasive procedure and also it has a unique role as a solution when conservative therapies have failed, and the risks of more invasive approaches may not be warranted. It is important to note that MIS does not affect surgical options for the few patients who do not respond to this treatment. Because of the very minimally invasive approach and targeted subtle decompression, there is minimal or no scar tissue that would increase the risk of possible future open spine surgery. Patients that opt for open surgical decompression can no longer be candidates for less invasive treatments, which is another crucial factor in treatment planning. [25]

Our study reported an average hospital stay of 4 days. Patients without intraoperative or postoperative complications were discharged on postoperative day 1 or postoperative day 2 after mobilisation and wound inspection. The minimum hospital stay was three days, which matched findings from a systematic review conducted by Phan and colleagues in 2016, which found reduced blood loss and a shorter hospital stay (2.1 days). [20] Although dural injuries & CSF fluid leaks were similar, the minimally invasive cohort had reduced reoperation rates, which was not significant when only randomized evidence was included. [26]

Conclusion

Minimally invasive spine decompression using tubular retractors is an excellent surgical option for patients suffering from lumbar spinal stenosis and intervertebral disc prolapse due to its minimally invasive nature, high success rate, and long-term outcomes. LSS is the most frequent spinal pathology among the elderly frequently accompanied with DS. Conservative treatment is a successful method to choose first. However, a number of patients ultimately require surgical treatment because of debilitating back and/or leg pain. Surgery for patients with LSS aims to decompress narrowed spinal canals with preserved spinal stability. As an emerging technique of MISS, ESS has the beneficial hallmarks of less tissue injury, reduced complication rates, and quicker recovery. ESS has gained increasing popularity with wide application in recent years. However, the current evidence is restricted for ESS in LSS in terms of clinical outcome.

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