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Original Article

Orthopaedics Section

Outcome Analysis of Minimally Invasive Single Level Microdiscectomy in Awake Spine Surgery: A Prospective Interventional Study

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ABSTRACT

Introduction: Lumbar Prolapsed Intervertebral Disc (PIVD) is a common cause of low back pain with radiculopathy, frequently affecting the economically productive age group and leading to significant functional disability. When conservative management fails, surgical intervention is indicated, with minimally invasive microdiscectomy increasingly preferred due to reduced tissue trauma, blood loss, and faster recovery. Awake spine surgery performed under Spinal Anaesthesia (SA) has emerged as an alternative to General Anaesthesia (GA), offering potential advantages such as early mobilisation, shorter hospital stay, and fewer anaesthesia-related complications. However, limited evidence exists regarding clinical and functional outcomes of minimally invasive single-level microdiscectomy performed under awake conditions, particularly in the Indian setting, justifying the present study.

Aim: To analyse outcome of minimally invasive single level microdiscectomy in awake spine surgery.

Materials and Methods: The present prospective interventional study was conducted in the Department of Orthopaedics, AVBRH, Sawangi, Wardha, Maharashtra, India from February 2023 to August 2025 among 40 patients undergoing minimally invasive micro-discectomy using awake spine surgery technique in for single level lumbar PIVD. Pre and postsurgery; every patient had a neurological examination as part of their clinical evaluation and Visual Analogue Scale (VAS) was used to measure pain; Oswestry Disability Index (ODI) was used for functional evaluation, Roland-Morris Disability Questionnaire (RMDQ) was used to measure physical disabilities. The Short Form-36 Health Survey (SF-36) was used to measure health-related quality of life. Means and standard deviations of the measurements for each group were employed using Statistical Package for Social Sciences (SPSS) software version 25. The t-test and Chi-square test were used to statistically analyse the data for each assessment point.

Results: The study participants' preoperative mean VAS score was 5.45±1.08. After surgery, the mean VAS continued to drop on days 7, 30, and 90. The study participants' preoperative mean ODI was 50.925±8.13. After surgery, the mean ODI continues to improve on days 7, 30, and 90. The study participants' preoperative mean RMDQ was 17.05±2.99. On days 7, 30, and 90 after surgery, the mean RMDQ was 10.725, 7.50, and 4.65, respectively. When compared to baseline, the mean RMDQ continues to improve considerably ($p<0.01$) at days 7, 30, and 90 after surgery. When compared to baseline, the mean SF-36 continued to improve considerably ($p<0.01$) at days 7, 30, and 90 after surgery.

Conclusion: Minimally Invasive Spine Surgery (MISS) performed under SA was associated with low blood loss, efficient operative timing, significant pain and functional improvement, enhanced quality of life, and acceptable complication rates.

Keywords: Low back pain, Lumbar disc herniation, Spinal anaesthesia

INTRODUCTION

Lumbar disc prolapse is a common spinal disorder that affects people between the ages of 30 and 50. It results in disc herniation, which causes radicular discomfort and may or may not induce neurological impairments. At the beginning, conservative management is used to treat it; if conservative management is ineffective for at least four weeks and interferes with everyday activities, surgery is used to treat the condition [1,2]. Due to longer lifespans and a higher incidence of degenerative disease in the elderly, the number of spinal fusion procedures has significantly increased in recent decades [3]. Cloward used a spinous process autograft to introduce the Posterior Lumbar Interbody Fusion (PLIF) procedure. Because stand-alone grafts have a high prevalence of pseudoarthrosis, instrumented fixation was added to the PLIF procedure in the 1950s using the Harrington rods, Hartshill rectangle, and pedicle screws [4].

In 1982, Harms J and Rolinger H first developed Transforaminal Lumbar Interbody Fusion (TLIF), a posterolateral approach to lumbar fusion that became well-known in 1992 following research by Harms JG and Jeszenszky D [5,6]. This approach, in contrast to PLIF, entails extensive muscle retraction and dissection but lowers the risk of harm to neural structures. Due to the risk of iatrogenic soft-tissue and muscle damage associated with open TLIF procedures, Foley KT et al., introduced a novel minimally invasive transforaminal lumbar interbody fusion surgical technique in early 2003 that has since gained popularity [7]. This technique uses serial tubular dilators and a muscle retracting approach.

In order to accomplish the same surgical objectives as open spine surgery, MISS uses tiny incisions, minimises tissue destruction, and respects tissue planes [8]. As surgical equipment and imaging methods for spine surgery advanced throughout the 20th century, MISS was created. The conventional 6-inch incision open method for lumbar discectomy was changed to a far less invasive surgery with the Williams microdiscectomy, which was first reported in 1978 [9]. The development of MISS has expanded dramatically in the last few years. Surgeons can perform spine operations through tiny ports thanks to the widespread use of tubular retractors in MISS. Using an endoscope and related tools through one or two subcentimeter openings, endoscopic spine surgery is sometimes referred to as the future of MISS [10].

Both SA and GA can be used for lumbar discecotomy [11]. Because it provides the benefit of a secured airway in a prone posture, GA is the most often chosen of these [12]. Aside from reducing the need and adverse effects of reversal medication associated with GA, SA offers benefits such as the ability to reposition the patient during surgery, prevent compression injuries, improve neurocognitive dysfunction, and reduce pulmonary complications and postoperative analgesia with a lower need for painkillers and antiemetic medications [13].

Fewer studies have examined differences between spinal and GA in spine surgery [14]. Studies have associated shorter recovery times, less time spent in the operating room, reduced rates of postoperative discomfort, nausea, vomiting, and urine retention, and most importantly lower costs with SA [14,15]. The growing number of minimally invasive fusion surgeries has led to significant advancements in surgical, anaesthetic, and rehabilitation techniques with the goal of reducing the length of hospitalisation following surgery and promoting an early return to work [16,17]. While awake spine surgery is better than standard procedures on their own, there was little information on the results of combining microdiscectomy with awake spine surgery when the literature on the subject was reviewed. Therefore, the purpose of this study was to investigate the outcome analysis of awake spine surgery using minimally invasive single-level microdiscectomy with the following objectives:

1. To assess the surgical outcome, the scores from the Roland Morris Disability Questionnaire (RMDQ), Owestry Disability Index, VAS, and the SF-36 (Short Form 36 Health Survey) were compared between pre-op, postoperative, and at follow-up.
2. To examine intraoperative complications;
3. To evaluate the expected blood loss, and perioperative time;

MATERIALS AND METHODS

The present prospective interventional study was conducted in Acharya Vinoba Bhave Rural Hospital in Department of Orthopaedics, Sawangi, Wardha, Maharashtra, India from February 2023 to August 2025 with IEC approval of number DMIHER(DU)/IEC/2023/539.

Inclusion criteria:

- Patients having a single level lumbar PIVD undergoing a minimally invasive microdiscectomy using the awake spine surgery technique;
- Patients who are willing to participate in the trial following informed consent.

Exclusion criteria:

- Patient's refusal to participate in the study;
- More than one operative levels;
- Lumbar spine trauma;
- History of lumbar spine reoperation;
- Spinal or other infections;
- Primary or secondary spinal tumour.

Sample size: A convenient sample size was used and 40 patients were included in the study.

Study Procedure

Patients were recruited who were having PIVD. In order to identify the potential cause of PIVD, a thorough history of the symptoms was obtained. A neurological and clinical evaluation was conducted. Information on the patient was recorded, along with his radiological and clinical results. According to a predetermined proforma, every aspect of the patient's history, examination, diagnosis, Magnetic Resonance Imaging (MRI) results, investigation results, treatment plan, and follow-up information were recorded. The nature of the illness, its progression, and the expected prognosis were communicated to the patients. Additionally, postoperative rehabilitation programs and intra and postoperative problems were explained to them. Blood tests were performed on the patient once the final surgical plan was determined to assess the physician's suitability to post the patient for surgery. On the day of surgery, the patient was informed in their native tongue about all aspects of the procedure and anaesthetic, and their written and informed consent was obtained.

Assessment prior to surgery: Every patient had a neurological examination as part of their clinical evaluation.

The VAS was used to measure pain [18], score from 0 (no pain) to 10 (debilitating pain). The ODI [19] was used for functional evaluation. Each of the 10 section was scored from 0 (no disability) to 5 (maximum disability).

The total score was summed and expressed as a percentage using the formula: ODI (%)= (Total score/50) × 100, where 50 is the maximum possible score. Interpretation of ODI scores is as follows: 0-20% indicates minimal disability; 21-40%, moderate disability; 41-60%, severe disability; 61-80%, crippled; and 81-100%, bed-bound or exaggerated symptoms.

The Roland-Morris Disability Questionnaire (RMDQ) [20], a 24 item questionnaire used to measure physical disabilities with 1 score for each question. The score is the total number of items checked - i.e., from a minimum of 0 to a maximum of 24. Higher score indicates poor outcomes while lower score indicates improved outcomes.

a) The Short Form-36 Health Survey (SF-36) [21] is used to measure health-related quality of life. The scoring is typically done on a scale from 0 to 100, where higher scores indicate better health status. It evaluates both physical and mental health through eight scaled scores, which include:
b) Physical functioning: Ability to perform physical activities.
c) Role limitations due to physical problems: Impact of physical health on work or daily activities.
d) Bodily pain: Intensity of pain and its impact on normal work.
e) General health perceptions: Overall health status as perceived by the individual.
f) Vitality: Energy levels and fatigue.
g) Social functioning: Impact of physical or emotional problems on social activities.
h) Role limitations due to emotional problems: Impact of emotional issues on work or daily activities.
i) Mental health: psychological distress and well-being

To locate and describe the disc disease, preoperative MRI was used.

Techniques for anaesthesia and surgery: Twenty minutes prior to the administration of SA, individuals received a half-litre infusion of ringer lactate solution. The patient was seated as soon as they entered the surgery room. A 2.5 mL of 2% lidocaine was administered locally, and SA was obtained by lumbar puncture, usually with a 25-gauge needle. After the Cerebrospinal Fluid (CSF) fluid was visualised, bupivacaine and fentanyl were administered into the intrathecal space. A dosage of 0.5% heavy bupivacaine in an 8.25% dextrose solution was administered at a rate of 3 mg/kg. 0.5% Bupivacaine and 25 micrograms of fentanyl were administered together to enhance the antinociceptive effect of SA. The patient was placed in a supine position after the SA was given and sufficient anaesthesia was confirmed on the lower back and extremities. After that, the patient was placed on the operating table in the prone position. A nasal cannula was used to deliver oxygen, and the patient's vitals were continuously checked.

A variation of the common lumbar discectomy open surgery procedure is minimally invasive lumbar spine surgery. The lumbar spine was cleaned, painted, and draped sterilely. A little incision is made across the relevant facet joint and herniated disc area, around 1.5 to 2 cm from the midline. The bony surface of the inferior

edge of the lamina was then reached by passing a blunt dilator through the incision perpendicularly. The dilator position over the lamina/medial facet junction should then be verified with a lateral fluoroscopy image. Retractors are inserted after the position is satisfactory. The retractor was then positioned directly on the bone with little soft-tissue in between, as confirmed by fluoroscopy. A stiff holding arm was then used to secure the working channel, which was then angled somewhat medially towards the spinous process and lamina. It is necessary to specify the lamina's and the interlaminar space's edges. After that, a laminectomy was carried out with a drill and/or Kerrison rongeur. The cord retracted on the other side with Dura's assistance. A stab wound was made in the intervertebral disc using a long scalpel. The extruded or protruded disc was removed using disc retaining forceps. The incision site was thoroughly irrigated before being closed.

After the procedure was finished, the patient was moved to the Post-Anaesthesia Care Unit (PACU) to recuperate. Before being moved to the ward, the patients stayed in the PACU until haemodynamic stability was verified. After surgery, two intravenous injections of 1.5 g each of ceftriaxone and sulbactam were administered every 12 hours. Twelve hours apart, two injections of 1 mL of tramadol in 100 mL of normal saline were administered. On the second postoperative day, the wound was dressed. Beginning on the first postoperative day, the patient was given proper lifting techniques, full-weight bearing mobilisation, Mckenzie exercises, Williams' flexion exercises, and pelvic bridge exercises.

On the second day after the procedure, or once the patient was at ease following the surgery, they were released. Twelve days after surgery, the sutures were removed. Physical therapy and complete weight-bearing walking were recommended for the patients. Scoring was performed at postoperative day 7, 30, and 90 days and the results were recorded in the proforma.

STATISTICAL ANALYSIS

Under the direction of a statistician, the data was tallied in an Excel sheet. For statistical analysis, the means and standard deviations of the measurements for each group were employed and SPSS version 25 software was used. The t-test and chi-square test were used to statistically analyse the data for each assessment point. A significant threshold of $p<0.05$ was established.

RESULTS

Males and females comprised 70% (28) and 30% (12), respectively in the study population. Hence there was a male predominance in the present study. Maximum subjects were from age group of 31-40 years (16, 40%) followed by 41-50 years (12, 30%) with mean age of 42.60±11.99 years [Table/Fig-1].

Variables	N=40	%
Gender		
Female	12	30.0
Male	28	70.0
Age group (in years)		
18-30	5	12.5
31-40	16	40
41-50	12	30
51-60	3	7.5
>60	4	10
Total	40	100.0
Mean±SD	42.60±11.99	

[Table/Fig-1]: Demographic distribution among the study subjects.

Mean estimated blood loss (mL) among the study subjects was 35.875±14.05 with minimum and maximum of 15 and 70, respectively. Mean operative time (minutes) among the study subjects was 40.125±12.48 with minimum and maximum of 25 and 90, respectively [Table/Fig-2]. Preoperative mean VAS score among the study subjects was 5.45±1.0849. Mean VAS decreases significantly postoperatively at day 7, 30 and 90 ($p<0.01$) [Table/Fig-3].

Parameters	Mean value
Estimated blood loss (mL)	35.875±14.05
Operative time (minutes)	40.125±12.48

[Table/Fig-2]: Intraoperative parameters of estimated blood loss (mL) and operative time (minutes).

VAS	Minimum	Maximum	Mean±SD
Preoperative	4.0	9.0	5.450±1.0849
POD-7	2.0	5.0	3.025±0.7675
POD-30	1.0	4.0	2.100±0.7442
POD-90	1.0	3.0	1.725±0.5986
p-value			
Preoperative vs POD-7	<0.01*		
Preoperative vs POD-30	<0.01*		
Preoperative vs POD-90	<0.01*		

[Table/Fig-3]: Comparison of VAS at different intervals.
*Statistically significant (t-test applied)

Preoperative mean ODI among the study subjects was 50.925±8.13. Mean ODI improves postoperatively at day 7, 30 and 90 ($p<0.01$) [Table/Fig-4].

ODI	Minimum	Maximum	Mean±SD
Preoperative	36.0	80.0	50.925±8.1379
POD- 7	10.0	36.0	23.800±6.6379
POD- 30	6.0	28.0	16.050±6.1183
POD- 90	4.0	24.0	12.750±4.3368
p-value			
Preoperative vs POD-7	<0.01*		
Preoperative vs POD-30	<0.01*		
Preoperative vs POD-90	<0.01*		

[Table/Fig-4]: Comparison of ODI at different intervals.
*Statistically significant (t-test applied)

Preoperative mean RMDQ among the study subjects was 17.05±2.99. Mean RMDQ improved ($p<0.01$) postoperatively at day 7, 30 and 90 when compared to baseline [Table/Fig-5].

RMDQ	Minimum	Maximum	Mean±SD
Preoperative	11.0	22.0	17.050±2.9953
POD- 7	5.0	18.0	10.725±2.8643
POD- 30	4.0	13.0	7.500±2.4073
POD- 90	2.0	10.0	4.650±1.8886
p-value			
Preoperative vs POD-7	<0.01*		
Preoperative vs POD-30	<0.01*		
Preoperative vs POD-90	<0.01*		

[Table/Fig-5]: Comparison of RMDQ at different intervals.
*Statistically significant (t-test applied)

Preoperative mean SF-36 among the study subjects was 49.175±7.13. Mean SF-36 postoperatively at day 7, 30 and 90 was 78.825, 89.475 and 94.70, respectively. Mean SF-36 improved ($p<0.01$) postoperatively at day 7, 30 and 90 when compared to baseline [Table/Fig-6].

Only minor complications were seen among the study subjects postoperatively. Minor complications noted were postoperative headache in four patients and dural punctures in two patients.

SF-36	Minimum	Maximum	Mean±SD
Preoperative	40.0	75.0	49.175±7.1320
POD-7	68.0	90.0	78.825±5.9652
POD-30	75.0	95.0	89.475±4.3264
POD-90	90.0	98.0	94.700±2.1268
p-value			
Preoperative vs POD-7	<0.01*		
Preoperative vs POD-30	<0.01*		
Preoperative vs POD-90	<0.01*		

[Table/Fig-6]: Comparison of SF-36 at different intervals.
*Statistically significant (t-test applied)

DISCUSSION

In this study, minimal invasive single level microdiscectomy in awake spine surgery significantly reduced pain, improved physical outcome and health related quality of life. The study cohort comprised 70% males and 30% females, demonstrating clear male predominance. Similar gender distribution was reported by Sykes DAW et al., [22]. In contrast, Avila MJ et al., observed a slight female predominance (54%) in their series, though their study focused on an older population [23]. The mean age in the present study was 42.60±11.99 years, with most patients (40%) belonging to the 31-40-year age group, followed by 41-50 years (30%). This is considerably younger than the cohort described by Sykes DAW et al., (mean age 66.01 years) and Avila MJ et al., who reported an average surgical age of 72 years (range 65-86 years) [22,23].

The mean estimated intraoperative blood loss was 35.88±14.05 mL (range 15-70 mL). These findings align with meta-analyses and review articles of spine procedures performed under SA, which demonstrate reduced intraoperative blood loss compared to GA (Urick D et al., Garg B et al., Xie Q et al.,) [24-26]. Avila MJ et al., reported an average blood loss of 43 mL, comparable to the present study [23]. In contrast, Habib A et al., documented mean blood loss of 163 mL in minimally invasive transforaminal lumbar interbody fusion (MIS-TLIF) and 366.8 mL in open TLIF [27]. Schwender JD et al., reported 140 mL blood loss under GA [28]. Collectively, these comparisons suggest that MIS performed under SA is associated with relatively lower blood loss. Relative hypotension induced by SA may contribute to this reduction, although the exact mechanism remains unclear.

The mean operative duration was 40.13±12.48 minutes (range 25-90 minutes), comparable to the findings of Jhala A et al., and Patel J et al., [29,30]. The omission of GA-related perioperative steps- such as pre-anaesthetic preparation, induction, intubation, and reversal-contributed to shorter overall theatre occupancy. Sykes DAW et al., however, found no statistically significant difference in operative duration between SA and GA groups [22].

Pain outcomes showed marked improvement following surgery. The mean preoperative VAS score was 5.45. Postoperatively, mean VAS scores decreased to 3.025 on day 7, 2.10 on day 30, and 1.73 on day 90, demonstrating sustained pain relief. Rangnekar A et al., similarly reported significant VAS improvement at all follow-up intervals compared to baseline ($p<0.01$) [31]. Avila MJ et al., observed a mean improvement of 5.6 points in Numeric Rating Scale (NRS) scores at six months ($p<0.05$) [23]. These findings support the effectiveness of awake MIS procedures in achieving meaningful pain reduction.

Functional outcomes also improved substantially. The mean preoperative ODI was 50.93. Postoperative ODI scores declined to 23.80, 16.05, and 12.75 on days 7, 30, and 90, respectively, reflecting significant functional recovery ($p<0.01$). Avila MJ et al., reported a 27% mean improvement in ODI at six months, with statistical significance at all follow-ups [23]. Rangnekar A et al., likewise demonstrated significant ODI improvements ($p<0.01$) [31]. The present findings are consistent with these results, indicating early and sustained disability reduction following surgery under SA.

The mean pre-operative RMDQ score was 17.05±2.99. Postoperative scores improved to 10.72, 7.50, and 4.65 on days 7, 30, and 90, respectively, with statistically significant reductions in disability from baseline ($p<0.01$). Direct comparison with prior studies was limited due to insufficient published data on RMDQ outcomes in awake spine surgery. Health-related quality of life, assessed using the Short Form-36 (SF-36), showed notable improvement. The mean preoperative SF-36 score was 49.17±7.13. Postoperative values increased to 78.82, 89.47, and 94.70 on days 7, 30, and 90, respectively ($p<0.01$). Although comparable literature is limited, these results demonstrate substantial enhancement in patient-reported quality of life following minimally invasive procedures under SA.

Regarding complications, 10% of patients experienced postoperative headache and 5% sustained dural puncture. Meta-analyses and review article of spinal procedures under SA report lower rates of postoperative nausea and vomiting compared to GA (Urick D et al., Garg B et al., Xie Q et al.,) [24-26], findings that correspond with the present study. McLain RF et al., documented lower urinary retention rates in SA patients but higher nausea incidence in GA groups [13]. Overall, complication rates in the present cohort were low and manageable.

Awake spine surgery is facilitated not only by SA but also by advances in MISS. The refinement of MIS techniques has minimised tissue disruption, reduced blood loss, shortened hospital stay, and lowered postoperative morbidity, including wound infection and dural injury. In addition, performing surgery under SA reduces the physiological stress associated with GA and may lessen psychological burden when patients are appropriately counselled. Together, these developments have made awake spine surgery a practical, efficient, and patient-centered approach.

In summary, the present study demonstrates that MISS performed under SA is associated with low blood loss, efficient operative timing, significant pain and functional improvement, enhanced quality of life, and acceptable complication rates. Comparative evidence from the literature supports these findings. Awake MIS spine surgery therefore represents a safe and effective alternative to conventional procedures under GA, particularly in appropriately selected patients.

Limitation(s)

Study's limitations were that intraoperative haemodynamic alterations were not taken into account and it was a single centre study.

CONCLUSION(S)

The results of the present study concludes that minimally invasive single-level microdiscectomy performed under SA significantly reduces pain while improving physical function and health-related quality of life among patients. By decreasing overall operating room time and shortening PACU stays, this approach enhances operating room efficiency. Consequently, with fewer side-effects and improved patient outcomes, SA can be considered a safe and effective alternative for elective lower lumbar discectomy procedures.

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