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Praveen Goparaju
Yashoda Hospital


Abhijith Shetty
Bombay Hospital & Medical Research Centre


Mani Kant Anand
Bombay Hospital & Medical Research Centre


Vishal Kundnani
Bombay Hospital & Medical Research Centre

# Awake Microtubular Spinal Decompression: A Step Towards Better Peri-Operative Patient Safety, and Satisfaction

Goparaju VNR Praveen[1], Amit Chugh[1], Ameya Rangnekar[1], Vishal Kundnani[1], Mani Kant Anand[1], Abhijith Shetty[1]

## Abstract

**Introduction:** Microtubular decompression (MTD) being a short-duration surgery, with many advantages has gained popularity and can be done either in general anaesthesia (GA) or awake techniques like spinal anaesthesia (SA). The authors ventured to assess perioperative parameters, quantify peri-operative complications as the primary aim and determine patient satisfaction as the secondary aim of the study.

**Materials and Methods:** It was a retrospective study performed over a period of ten years (2009–2019) and included 625 patients. The patients included were aged greater than 18 years, American Society of Anaesthesiologists (ASA) score 1, 2, or 3. Patients with ASA 4 or 5, spinal instability, infection, or revision surgeries were excluded.

**Results:** There is no significant difference in the complication rates. The clinical outcome in the form of VAS and ODI score showed significant differences both in SA and GA groups at final follow-up. The total anaesthetic, surgical times, the mean arterial pressure (MAP), and the heart rate (HR) perioperatively were longer in the GA group ($P < 0.05$). The perioperative blood pressures are lower in the SA group. The dissatisfaction rate is about 3.5%, of which the patients and a total of 88.5% of patients would like to opt for SA for future surgeries.

**Conclusion:** This study represents the ten-year experience with MTD operated either with SA or GA. Awake spinal surgery is promising and has the glaring benefits of better peri-operative hemodynamic stability, and faster recovery with reduced surgical and anaesthetic duration. Dissatisfaction rates can be decreased by better explanation and the patient's decision.

**Keywords:** Awake spine surgery, Microtubular decompression, Hemodynamic parameters, Complications, Patient satisfaction.

## Introduction

The micro-tubular spinal decompression (MTD), reported by Foley and Smith in 1997 to perform discectomy using tubular retractors for lumbar disc herniation [1]. Later, because of its advantages like decreased blood loss, minimal soft tissue footprint, and better cosmesis, it has been routinely used for both disc herniation and lumbar canal stenosis. As described by Poletti, bilateral decompressive laminotomy can also be done using a unilateral approach preserving the interspinous ligaments and spinous process [2].

The MTD is a short-duration surgery, it can be done either in general anaesthesia (GA) or spinal anaesthesia (SA), but general anaesthesia is practiced more routinely worldwide. The advantages of awake surgeries with SA are hemodynamic stability, lesser blood loss, better postop analgesia, and safer in comorbid patients [3]. Even though the literature supports the SA for lumbar spine surgeries, still GA is a routinely accepted practice for lumbar surgeries for reasons citing anesthesiologist familiarity of the procedure, better securing of the airway, and patient's comfort [4, 5].

We present a very large study done over a period of ten years comparing spinal anaesthesia versus general anaesthesia for single/multilevel lumbar canal stenosis (LCS) operated with MTD with a minimum of a two-year follow-up period. The primary aim of this study was to compare and review perioperative parameters, intraoperative parameters, and peri-operative complications of MTD procedure done for single/multilevel LCS using general versus spinal anaesthesia. The secondary aim was to determine patient satisfaction, the factors causing dissatisfaction as well as the reasons leading to future refusal for spinal anaesthesia.

## Materials and Methods

It was a retrospective study done with data collected prospectively, performed over a period of ten years (2009–2019) at a single institute. The institutional ethical and review committee approved the study. A total of 625 patients who underwent MTD for stable (grade 1) degenerative spondylolisthesis along with stenosis and

[1]Department of Orthopaedics, Bombay Hospital and Medical Research Centre, Mumbai, Maharashtra, India.

**Address of Correspondence**
Dr. Goparaju VNR Praveen,
Fellow, Association of Spine Surgeons in India,
Bombay Hospital & Medical Research Centre, Mumbai, Maharashtra, India.
**E-mail:** praveen.gvnr@gmail.com

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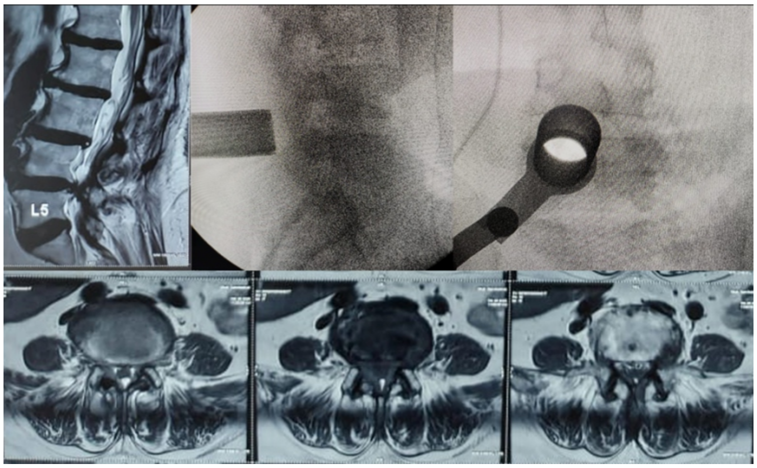


**Figure 1:** 56-year-old Male with L4-5 lumbar canal stenosis with failed conservative management was treated with awake microtubular decompression

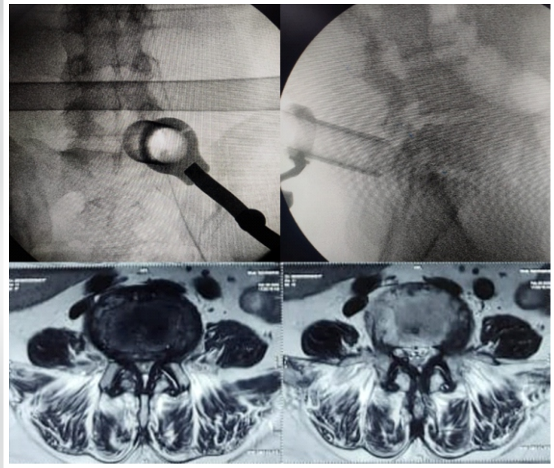

**Figure 2:** 63-year-old female with L4-5 lumbar canal stenosis with sacralized L5 was treated with awake microtubular decompression.

single/multilevel primary degenerative LCS were included in the study. All participants provided written informed consent for participation in the study (Figure 1 & 2).

The patients included were aged between 51-80 years, American Society of Anesthesiologists (ASA) score 1, 2, or 3, undergoing one, two, or three-level MTD. Patients with ASA class 4 or 5, spinal instability, infection, or revision surgeries were excluded from the study. All operations were performed by a single senior spine surgeon.

The patients underwent surgery using either GA or SA which. Initially the anaesthetist decides for the type of anaesthesia based on the patient comorbidities and general health condition. The procedure was explained to patients selected for SA before surgery and an option was provided to decide. Post-operatively, the survey was conducted by trained professionals, asking a constructed questionnaire like satisfaction rate, understanding the techniques and modes of anaesthesia, and willingness to accept or refuse spinal anaesthesia for a similar surgery again.

Patients undergoing GA have typically given thiopental 3 to 5 mg/kg IV and fentanyl 2 g/kg IV and was augmented with isoflurane and endotracheal intubation was facilitated with vecuronium 0.1 mg/kg IV. Maintenance anaesthesia consisted of $N_2O$ 70% with $O_2$ with isoflurane 0.5% to 1%.

The SA patients were given 0.75% bupivacaine in 8.5% dextrose solution. The patients were positioned and a stable spinal level at T6–T10 was achieved.

Total surgical time (time from incision to dressing) and anaesthesia time (The time parameter includes surgical time along with two additional time parameters like the time from entry into operation theatre to incision time and after bandaging to exit time) were documented. Post-operatively, the mean heart rate and mean arterial pressure were recorded in the recovery room.

The authors have divided the perioperative complications into five broad groups based on time of occurrence (early: <3 months post-surgery and late: >3 months post-surgery), the severity of complications, and with respect to the system affected. All the patients were followed up evaluating the clinical outcome in the form of Visual Analogue Scale (VAS) score, Oswestry Disability Index (ODI), Wang and Bohlmann's criteria, and complications were noted in regular intervals (immediate post-op, 6 weeks, 3 months, 6 months followed by yearly intervals). The VAS and ODI scores were compared with the open techniques in the literature.

Statistical analysis was established with student t-test, chi-square test, and the Mann-Whitney U test. P-value <0.05 was considered statistically significant. The data was collected and analyzed with a Microsoft Excel 2010 (Microsoft Corp., Seattle, Washington, USA) spreadsheet.

## Results

The study included 625 patients who underwent MTD for single/multilevel LCS with 272 females and 353 males, with the mean age of the SA group being 67.4 and the GA group being 70.8 (age range 51–90 years). The mean body mass index (BMI) and other demographics are included in Table 1. A total of 302 patients, out of which 162 in the SA group and 140 in the GA group were found to have single-level stenosis, 267 out of which 145 in the SA group and 122 in the GA group were with two-level stenosis and a total of 56 out of which 17 in SA group and 39 in GA group were with three-level stenosis (Table 1). A total of 218 patients (132 in the SA group and 86 in the GA group) were without any morbidity, 261 patients (144 in the SA group and 117 in GA group) were with single comorbidity, 146 patients (49 in SA group and 97 in the GA group) were with two or more (Table 1). The most common level of stenosis or MTD was L4–L5 (50.8%) (182 in the SA group and 136 in the GA group) (Table 2). The mean operative time, the mean hospital stay, and blood loss were significantly higher in both groups for three-level MTD (Table 2). The complication rates and their occurrence in SA and GA were given in (Table 3)

The clinical outcome in the form of VAS and ODI score showed significant differences both in SA and GA and in both the groups at the final follow-up (Table 4). The functional outcome and patient satisfaction were assessed in the form of Wang and Bohlmann's criteria that showed excellent to a good outcome in both the groups with the highest outcome rate in single-level MTD (Table 4).

The total anaesthetic and total surgical times were longer for the GA group ($P < 0.05$) (Table 5). The perioperative blood pressures are

| Table 1: Demographic data | | | |
|---|---|---|---|
| | SA | GA | Total |
| Mean Age | 67.4 | 70.8 | 69.1+/-18.6 |
| Male | 186 | 167 | 353 |
| Female | 139 | 133 | 272 |
| Mean body mass index ($kg/m^2$) | 29.5+/- 3.3 | 28.6+/- 3.5 | 29.1+/- 3.4 |
| No Comorbidities | 132 | 86 | 218 |
| Single | 144 | 117 | 261 |
| More than one | 49 | 97 | 146 |
| 1 level | 162 | 140 | 302 |
| 2level | 145 | 122 | 267 |
| 3 level | 17 | 39 | 56 |
| Mean duration of symptoms (Months) | 9.7+/-1.9 | 9.8+/-2.9 | 9.6 +/- 2.3 |
| Mean followup | 26.3+/-3.1 | 26.1+/-2.6 | 26.1 +/-2.8 |
| SA- Spinal Anaesthesia | | | |
| GA- General Anaesthesia | | | |

| Table 2: Surgical data | | | |
|---|---|---|---|
| | **SA** | **GA** | **Total** |
| **Levels of decompression** | | | |
| L3-4 | 101 | 137 | 238 |
| L4-5 | 182 | 136 | 318 |
| L5-S1 | 42 | 27 | 69 |
| Levels operated | | | |
| Single | 202 | 100 | 302 |
| Two | 116 | 151 | 267 |
| Three | 7 | 49 | 56 |
| Side of stenosis | | | |
| Unilateral | 190 | 174 | 364 |
| Bilateral | 135 | 126 | 261 |
| Mean operative time | | | |
| Single | 71.4+/-4.2 | 75.6+/-2.7 | 73.5+/-3.9 |
| Two | 119.3+/-9,7 | 134.3+/-8.4 | 126.8+/-9.6 |
| Three | 168.5+/-8.7 | 180.9+/-7.7 | 174.7+/-8.2 |
| Mean blood loss | | | |
| Single | 50.6+/-5.2 | 60.2+/-5 | 55.4+/-5.2 |
| Two | 95.5+/-7.9 | 97.9+/-7.9 | 96.7+/-7.9 |
| Three | 139.3+/-7.9 | 153.1+/-8.5 | 146.2+-8.2 |
| Hospital stay | | | |
| Single | 1.8+/-1.9 | 2.4+/-1.5 | 2.1+/-1.7 |
| Two | 2.3+/-1.5 | 2.7+/-1.3 | 2.5+/-1.4 |
| Three | 2.7+/-1.2 | 3.1+/-1.2 | 2.9+/-1.2 |
| SA- Spinal Anaesthesia | | | |
| GA- General Anaesthesia | | | |

| Table 4: Clinical outcomes | | | | |
|---|---|---|---|---|
| VAS | SA | SA | GA | GA |
| VAS | Pre-op | Final followup | Pre-op | Final followup |
| Single | 6.9+/-1.4 | 2+/-1.7 | 7.3+/-1.2 | 2.2+/-1.9 |
| Two | 7+/-1.6 | 2+/-1.6 | 7.4+/-2 | 2.6+/-1.6 |
| Three | 7.7+/-1.6 | 1.8+/-1.5 | 7.9+/-0.8 | 2.4+/-1.3 |
| VAS leg | | | | |
| Single | 7.9+/-1.7 | 1.3+/-0.7 | 7.9+/-1.9 | 1.1+/-1.1 |
| Two | 8.4+/-1.8 | 2.1+/1.4 | 8.2+/-1.6 | 2.1+/-1.3 |
| Three | 8.9+/-0.9 | 3.0+/-2.1 | 8.7+/-0.7 | 2.4+/-2.1 |
| ODI | | | | |
| Single | 63.2 | 20.87+/-2.11 | 59.18 | 22.91+/-1.3 |
| Two | 66.24+/-7.4 | 24.7+/-3.1 | 66.23+/-7.3 | 22.6+/-3.9 |
| Three | 66.58 | 22.1+/-3.9 | 71.58+/-4.6 | 26.1+/-3.2 |
| SA- Spinal Anaesthesia | | | | |
| GA- General Anaesthesia | | | | |
| VAS- Visual Analogue Scale score | | | | |
| ODI- Oswestry Disability Index | | | | |

| Table 3: Per-operative complications | | | | |
|---|---|---|---|---|
| Category | Complications | SA | GA | Total |
| General | Superficial infections (E) (m) | 4 | 6 | 19 |
| | Deep Infection (E) (M) | 1 | 1 | 2 |
| | Wound Dehisence (E) (M) | 0 | 1 | 1 |
| | Fever (E) (m) | 6 | 6 | 12 |
| | Total | 11 | 14 | 25 |
| Cardiopulmonary | Pneumonia (E) (m) | 1 | 1 | 2 |
| | ARDS (E) (M) | 0 | 1 | 1 |
| | Volume Overload (E) (M) | 0 | 1 | 1 |
| | IHD (E) (M) | 0 | 1 | 1 |
| | DVT (E) (M) | 1 | 0 | 1 |
| | Total | 2 | 4 | 6 |
| Neurological | Deficits (E, L) (m) | 3 | 4 | 7 |
| | Paresthesia (E, L) (m) | 4 | 7 | 10 |
| | Total | 7 | 11 | 18 |
| Urinary | UTI (E) (m) | 2 | 2 | 4 |
| | Prologed Catheterisation (E)(m) | 2 | 4 | 6 |
| | SIADH (E) (m) | 3 | 5 | 8 |
| | Total | 7 | 11 | 18 |
| Surgical | Screw malposition (E) (m) | 1 | 1 | 2 |
| | Intraoperative Bleedig | 1 | 0 | 1 |
| | Dural Tear (E) (M) | 1 | 0 | 1 |
| | Screw Loosening (E, L) (M) | 6 | 11 | 17 |
| | Pseudoarthrosis (L) (M) | 2 | 6 | 8 |
| | ASD (L) (M) | 1 | 2 | 3 |
| | Implant Failure (L) (M) | 2 | 7 | 9 |
| | Cage Slippage (L) (M) | 0 | 3 | 3 |
| | Total | 14 | 30 | 44 |

SA- Spinal Anaesthesia
GA- General Anaesthesia
E- early; L- Late;
M-Major; m- Minor
ARDS- Acute Respiratory Distress Syndrome
IHD- Ischaemic Heart Disease
DVT- Deep Venous Thrombosis
UTI- Urinary Tract Infections
SIADH- Syndrome of Inappropriate Anti-Diuretic Hormone
ASD- Adjacent Segment Disease.

| Table 5: Perioperative hemodynamic parameters | | | |
|---|---|---|---|
| | SA | GA | P-value |
| Anaesthetic grading | | | |
| ASA 1 | 153 | 84 | 0.06 |
| ASA 2 | 103 | 127 | 0.19 |
| ASA 3 | 69 | 89 | 0.23 |
| Anaesthetic time | 177 (145-210) | 196 (165-245) | 0.006 |
| Surgical time | 105 (75-135) | 125 (90-155) | 0.016 |
| Pre-operative HR (bpm) | 73 (67-81) | 74 (69-82) | 0.51 |
| Pre-operative MAP (mmhg) | 100 (92-111) | 101 (94-112 | 0.83 |
| Intra operative HR (bpm) | 78 (68-88) | 84 (70-98) | 0.099 |
| Intra-operative MAP (mmhg) | 91 (83-97) | 95 (84-100) | 0.096 |
| Recovery room initial HR (bpm) | 73 (66-82) | 84 (71-97) | <0.001 |
| Recovery room average HR (bpm) | 71 (61-81) | 80 (70-90) | <0.001 |
| Recovery room initial MAP (mm hg) | 94 (85-103) | 105 (96-114) | <0.001 |
| Recovery room average MAP (mmhg) | 92 (86-100) | 102 (93-109) | <0.001 |
| SA- Spina Anaesthesia | | | |
| GA- General Anaesthesia | | | |

lower in the SA group than the GA group and there were no hemodynamic complications in both groups (Table 5). At the recovery room, the mean arterial pressure (MAP) and the heart rate (HR) were higher, in the GA group compared to the SA group ($P<0.001$) (Table 5).

All patients were satisfied with the explanations provided by the anaesthetist regarding the advantages and disadvantages of the types of anaesthetic methods. However, 2% of patients, completely failed to understand the explanation, which may be because of their apprehension. The dissatisfaction rate is about 3%, of which the patients' needing subsequent GA were 1% and patients requiring further analgesics were 2%. In addition to that, a total of 88.5% of patients would like to opt for SA for similar surgical surgeries in the future while 3.5% of the patients were dissatisfied not sure and 8% of the patients would not opt for spinal anaesthesia.

## Discussion

The recent advances in surgical techniques, instrumentation, and anaesthesia techniques have made MTD safer with better outcomes and decreased complications [6-8]. The drift in the field of surgeries in general and particularly in the field of spine surgery is towards minimally invasive surgeries to reduce peri-operative complications, faster recovery, and better patient satisfaction [6, 7]. An extension to this is the use of awake surgeries using regional anaesthesia like spinal anaesthesia to further reduce the complications related to the anaesthesia technique. Many studies have demonstrated the clinical benefits of SA [7, 9]. But very few of the studies emphasized the perioperative parameters [10, 11], and as far as the author's knowledge, no study on patient satisfaction after awake spine surgery improves the patient and doctor relationship. So, the authors ventured to assess perioperative parameters and to quantify peri-operative complications for single/multilevel LCS using general versus spinal anaesthesia as the primary aim of the study. To improve the quality of SA and to enhance the patient and doctor relationship, the factors that cause dissatisfaction and refusal for further SA need to be studied [12]. So, the other aim was to determine patient satisfaction, the factors causing dissatisfaction as well as the reasons leading to future refusal for spinal anaesthesia.

Spinal anaesthesia resulted in the reduction of both surgical and total anaesthetic times. The shorter operation theatre to the incision time and the time after bandaging to the exit in the SA group can be attributed to shorter anaesthetic time. The shorter duration in SA maybe because of the skipping steps of GA like giving pre-anaesthetic medication, preparation for induction, intubation, and postoperative extubation procedure. The confounding factors like post-anaesthetic care and medications were minimized by using the same operation theatre and same nursing staff. Also, the blood loss in SA is lesser compared to GA as described in previous studies [13-15]. Reduced blood loss is likely because of sympathetic blockade, producing vasodilation and hypotension [16].

SA group experiences lower levels of postop pain and fewer episodes of nausea and vomiting. This can be attributed to the direct sensory block by the SA continued to provide pain relief for a longer duration, even after the recovery of the motor blockade [17]. This can lead to improved post-anaesthetic comfort and satisfaction as stated in previous studies [11, 18].

There were no events of neurologic injury associated with the anaesthetic technique. Minor sequelae have been estimated to occur in 0.5% to 0.8% of patients undergoing SA [19]. Concerns of transverse myelitis or adhesive arachnoiditis with spinal injection appear largely historical [20].

All the patients from the study groups were divided and allotted into five categories as discussed earlier depending on the respective complications they developed in their follow-up periods (Table 3), The most common of those complications were urinary tract infections (UTI), followed by the syndrome of inappropriate anti-diuretic hormone secretion (SIADH), superficial wound infections, and paraesthesia in both the groups. All the above-mentioned complications were transient and occurs in the first three months.

There were no major intraoperative adverse events except dural tears with a total incidence of 1.6% (10/625) which is comparable to other previous studies [8, 21]. The dural leaks or spinal headaches among the SA patients are similar compared with the GA group in the study. The combination of a fine needle dural puncture and a decompressive surgical procedure did not increase the likelihood of cerebrospinal fluid leakage or spinal headache over the risk of the surgical procedure itself. One of the benefits of tubular MTD is that muscles and soft tissue collapse into place with no dead space for hematoma formation.

The urine retention, SIADH, and transient lower extremities paresthesia were the commonest early postoperative complications (Table 3). Acute urinary retention occurred in six patients, of which two were in the SA group and four were in the GA group. The patients with retention problems were managed by inserting foley's catheter in situ and keeping it for 24 hours which was later removed. Patients with urinary retention had, in turn, had a long time to discharge, only after urine was passed. This contrasts with previous studies, where urinary retention has been associated more with SA patients [22]. Some authors have noted a reversal in that trend, with no clinical significance. Silver et al reported a 3% incidence of urinary retention with SA as compared to 6% among GA patients [23]. Our findings can be attributed to the use of no subarachnoid opioids and lower doses of opioid medications in SA patients.

Consistent with other studies [24-26], this study describes significant improvements in clinical outcome at two years with MTD for single/multilevel LCS. The clinical improvements in VAS and ODI were comparable and slightly better than those of open lumbar decompression [27, 28] Potentially, the minimal soft tissue footprint by the MTD procedure have a positive effect on postoperative pain, recovery, and blood loss, and hence the authors recommend that this is subjected to further validation studies [7]. In this study, bilateral decompression was performed through a unilateral portal (over the top) microscopically as previously described in the literature [29-31]. The study showed a statistically significant difference ($P<0.0001$) in the functional outcome (ODI score) and the pain levels (VAS scores) at two years follow-ups. As per Wang and Bohlmann's criteria, more than 95% of patients showed excellent to good outcomes.

Researching on patient's satisfaction is very important in understanding the problems they experience with spinal anaesthesia, and this can help us in improving further. In this study, the dissatisfaction rate of SA was 3.5%, and the refusal of SA in future surgeries was 8%. According to the previous studies, awareness during surgery, number of attempts for a spinal block, inadequate analgesia, immobility of lower limbs, positioning during surgery, and tightly applied plasters were the main reasons for refusal [32]. This can be managed by explaining the advantages of SA which can avoid the incidence of GA-related complications. In our study, before SA was administered, symptoms such as numbness, transient sensory loss, and paralysis were explained to patients. Therefore, the dissatisfaction rate in our study is low compared to other studies.

Even though the data was collected prospectively, the main limitations are the retrospective nature of the study without randomization. The study is for mid-term analysis of two years follow-ups. It does not allow us to know the events happening at a longer follow-up. Another important drawback is that the post-operative survey is not blinded because the same anaesthesia team conducts the survey which might alter the results to some level. There is a chance of over-estimation of the satisfaction rates of patients because they may like to please the doctor by giving higher satisfaction rates.

## Conclusion

This study represents the ten-year experience with MTD for single/multilevel LCS operated either with SA or GA. Awake spinal surgery is promising and has the glaring benefits of better peri-operative hemodynamic stability, and faster recovery with reduced surgical and anaesthetic duration. The described classification for peri-operative complications is helpful to record, evaluate, and understand the etiology and risk factors based on its duration of occurrence in the peri-operative period. Dissatisfaction rates can be decreased by a better explanation about the type of anaesthesia and the patient's decision to choose the anaesthetic technique is of utmost importance.

**Declaration of patient consent :** The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his/her consent for his/her images and other clinical information to be reported in the Journal. The patient understands that his/her name and initials will not be published, and due efforts will be made to conceal his/her identity, but anonymity cannot be guaranteed.

**Conflict of Interest:** None; **Source of Support:** None

## References

[1] Foley KT, Smith MM (1997) Microendoscopic discectomy. Tech Neurosurg 3:301–307.

[2] Poletti CE (1995) Central lumbar stenosis caused by ligamentum flavum: unilateral laminotomy for bilateral ligamentectomy: preliminary report of two cases. Neurosurgery 37:343–347.

[3] Scott NB, Kehlet H. Regional anaesthesia and surgical morbidity. Br J Surg 1988;75:299–304.

[4] Greenbarg PE, Brown MD, Pallares VS, et al. Epidural anesthesia for lumbar spine surgery. J Spinal Disord 1988;1:139–43.

[5] Jellish WS, Thalji Z, Stevenson K, et al. A prospective randomized study comparing short and intermediate term peri-operative outcome variables after spinal or general anesthesia for lumbar disk and laminectomy surgery. Anesth Analg 1996;83:559–64.

[6] Pao JL, Chen WC, Chen PQ (2009) Clinical outcomes of microendoscopic decompressive laminotomy for degenerative lumbar spinal stenosis. Eur Spine J 18:672–678.

[7] Mannion R, GuilfoyleM, Efendy J et al (2012) Minimally invasive lumbar decompression long-term outcome,morbidity and the learning curve from the first 50 cases. J Spinal Disord Tech 25:47–51.

[8] Perez-Cruet MJ, Fessler RG, Perin NI (2002) Review: complications of minimally invasive spinal surgery. Neurosurgery 51(2 Suppl):26–36.

[9] Patel N, Bagan B, Vadera S et al (2007) Obesity and spine surgery: relation to perioperative complications. J Neurosurg Spine 6:291–297.

[10] McLain RF, Bell GR, Kalfas I, Tetzlaff JE, Yoon HJ. Complications associated with lumbar laminectomy: a comparison of spinal versus general anesthesia. Spine (Phila Pa 1976). 2004;29(22):2542-2547.

[11] Hassi N, Badaoui R, Cagny-Bellet A, et al. Spinal anesthesia for disk herniation and lumbar laminectomy: a propos of 77 cases. Cah Anesthesiol 1995; 43:21–5.

[12] Dharmalingam TK, Ahmad Zainuddin NA. Survey on maternal satisfaction in receiving spinal anaesthesia for caesarean section. Malays J Med Sci. 2013;20(3):51-54.

[13] Davis FM, McDermott E, Hickton C, et al. Influence of spinal and general anaesthesia on haemostasis during total hip arthroplasty. Br J Anaesth 1987; 59:561–71.

[14] Cook PT, Davies MJ, Cronin KD, et al. A prospective randomized trial comparing spinal anaesthesia using hypobaric cinchocaine with general anesthesia for lower limb vascular surgery. Anaesth Intensive Care 1986;14: 373–80.

[15] Thorburn J, Louder JR, Vallance R. Spinal and general anaesthesia in total hip replacement: frequency of deep vein thrombosis. Br J Anaesth 1980;52: 1117–21.

[16] Covino BG. Rational for spinal anesthesia. Int Anesthesiol Clin 1989;27:8–12.

[17] Pflug AE, Aasheim GM, Foster C. Sequence of return of neurologic function and criteria for safe ambulation following subarachnoid block. Can Anaesth Soc J 1978;25:133–9.

[18] Riegel B, Alibert F, Becq MC, et al. Lumbar disc herniation with surgical option: general versus local anesthesia. Agressologie 1994;34:33–7.

[19] Vandam, LD, Dripps, RD. Exacerbation of pre-existing neurologic disease after spinal anesthesia. N Engl J Med 1956;255:843–9.

[20] Kennedy F, Effron AS, Perry G. The grave spinal cord paralysis caused by spinal anesthesia. Surg Gynecol Obstet 1950;91:385–97.

[21] Dekutoski MB, Norvell DC, Dettori JR et al (2010) Surgeons' perceptions and reported complications in spine surgery. Spine 35(Suppl):S9–S21.

[22] Young DV. Comparison of local, spinal and general anesthesia for inguinal herniorrhaphy. Am J Surg 1987;153:560–3.

[23] Silver DJ, Dunsmore RH, Dickson CM. Spinal anesthesia for lumbar disc surgery: review of 576 operations. Anesth Analg 1976;55:550–4.

[24] Guiot BH, Khoo LT, Fessler RG (2002) A minimally invasive technique for decompression of the lumbar spine. Spine 27:432–438.

[25] Ikuta K, Arima J, Tanaka T et al (2005) Short-term results of microendoscopic posterior decompression for lumbar spinal stenosis. Technical note. J Neurosurg Spine 2:624–633.

[26] Rahman M, Summers LE, Richter B et al (2008) Comparison of techniques for decompressive lumbar laminectomy: the minimally invasive versus the "classic" open approach. Minim Invasive Neurosurg 51:100–105.

[27] WilbyMJ, Seeley H, Laing RJ (2006) Laminectomy for lumbar canal stenosis: a safe and effective treatment. Br J Neurosurg 20:391–395.

[28] Weinstein JN, Tosteson TD, Lurie JD et al (2008) SPORT Investigators. Surgical versus nonsurgical therapy for lumbar spinal stenosis. N Engl J Med 358:794–810.

[29] Khoo L, Fessler RG (2002) Microendoscopic decompressive laminotomy for the treatment of lumbar stenosis. Neurosurgery 51(5 suppl):S146–S154.

[30] Palmer S, Turner R, Palmer R (2002) Bilateral decompression of lumbar spinal stenosis involving a unilateral approach with microscope and tubular retractor system. J Neurosurg 97(Suppl 2):213–217.

[31] Palmer S, Turner R, Palmer R (2002) Bilateral decompressive surgery in lumbar spinal stenosis associated with spondylolisthesis: unilateral approach and use of a microscope and tubular retractor system. Neurosurg Focus 13:E4.

[32] Sindhvananda W, Leelanukrom R, Rodanant O, Sriprajittichai P. Maternal satisfaction to epidural and spinal anesthesia for cesarean section.J Med Assoc Thai. 2004;87(6): 628–635.

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