



Research Article

Comparison of Spinal and General Anesthesia in Lumbar Disc Surgery

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Summary

Aim: The purpose of this study was to compare the perioperative advantage and disadvantage between general (GA) and spinal anesthesia (SA).

Material and Methods: Sixty patients (randomize GA,n=30, SA,n=30) undergoing lumbar disc surgery were enrolled. Patients were matched for demographic data, perioperative physiological changes, pain score, amount of blood loss, surgeon 'satisfaction, perioperative complications and length of stay in hospital.

Results: Intraoperatively and postoperatively, the incidence of tachycardia and hypertension were more frequent with GA ($p<0.05$). The surgeon's satisfaction was reported to be higher in the GA group ($p<0.05$). Anesthetic and operative times were longer for patients in GA group ($p<0.05$), in whom more nausea, vomiting, pain and greater requirements for antiemetic and pain medication were also during PACU ($p<0.05$). 24 hours after surgery, PACU time, ambulation of day of surgery, hospital stay, requirement of antiemetic and analgesic medication, pain score, nausea, urinary retention and headache were similar in two groups ($p>0.05$), however vomiting was more frequent in GA group in this period ($p<0.05$).

Conclusion: For patients undergoing lumbar disc surgery, spinal anesthesia was as safe and effective as general anesthesia. Specific advantages to spinal anesthesia include decreased antiemetic and analgesic medication and reduced overall complication rate.

Key words: Spine surgery, spinal anesthesia, general anesthesia

Lomber Disk Cerrahisinde Spinal ve Genel Anestezi Uygulamasının Karşılaştırılması Özet

Amaç: Bu çalışmanın amacı genel (GA) ve spinal (SA) anestezinin perioperatif avantaj ve dezavantajlarını karşılaştırmaktır.

Yöntem ve Gereç: Lomber disk operasyonu geçirecek rasgele 60 hasta (GA,n=30, SA,n=30) seçildi. Hastalar demografik veriler, peroperatif vital bulgular, ağrı skorları, kan kaybı miktarı, cerrah memnuniyeti, perioperatif komplikasyonlar ve hasatanede kalış süresi yönünden karşılaştırıldı.

Bulgular: İntraoperatif ve postoperatif dönemde hipertansiyon ve taşikardi GA grubunda daha sıkı ($p<0.05$). Cerrah memnuniyeti GA grubunda daha yüksekti ($p<0.05$). Anestezi ve cerrahi süre GA grubunda daha uzun idi ($p<0.05$), bu grupta bulantı, kusma, ağrı, daha fazlaydı ve antiemetik ve analjezik ihtiyacı yüksek bulundu ($p<0.05$). Cerrahi sonrası 24 saat içinde derlenme odasında kalma zamanı, mobilizasyon, hastanede kalma zamanı, antiemetik ve analjezik gereksinimi, ağrı skoru, bulantı, üriner retansiyon ve baş ağrısı iki grupta benzerdi ($p>0.05$), bununla birlikte bu dönemde kusma GA grubunda daha sıkı ($p<0.05$).

Sonuç: Lomber disk operasyonu geçirecek hastalar için spinal anestezi genel anestezi kadar güvenli ve etkindir. Spinal anestezinin spesifik avantajları antiemetik ve analjezik ihtiyacının daha az olması ve düşük komplikasyon oranıdır.

Anahtar Kelimeler: Spinal cerrahi, spinal anestezi, genel anestezi**INTRODUCTION**

Both general and regional anesthetic agents have been used during surgical treatment of lower thoracic and lumbar spine disorders, but general anesthesia is used far more widely, and exclusively, in many practices. The broad preference for general anesthesia does not appear to be based on any scientifically or clinically established superiority but, rather, more on surgeon bias and, perhaps, lack of exposure to the option of spinal anesthesia. Both general and regional anesthetics have been shown to be suitable for patients undergoing lower thoracic and lumbar spine surgery, but general anesthesia is used routinely in most practices⁽⁹⁾. General anesthesia may be preferred because it is seen as the routine accepted practice, because of greater patient acceptance and the ability to perform longer operations, or because the anesthesiologist feels more comfortable seeing that the airway is secured before placing the patient in the prone position. There are variety anesthetic options available for use during spine surgery, broadly classified as general, regional and local anesthesia.

Regional techniques may reduce blood loss and hemodynamic instability, an effect of decreased peripheral venous pressure and may also lower the incidence of pulmonary complications, compared with general anesthesia⁽⁴⁾. An additional advantage to spinal anesthesia is the ability for the patient to reposition their extremities and chest as needed to avoid nerve injury, brachial plexus palsy, or pressure necrosis to either the face or chest wall.

This prospective, case-controlled study was conducted to assess the notion that spinal anesthesia is both safe and efficacious in the treatment of healthy patients undergoing lumbar discectomy for herniated nucleus pulposus.

MATERIAL AND METHODS

After approval by the institutional review board, all patients undergoing one or two level lumbar discectomy at our institution were accepted to the study. A total of 60 patients, 30 from each group (general vs spinal anesthetic method), were allowed. The patients selected for study were adult men and women with a physical status between ASA I-II, who underwent either one or two level discectomy for herniated nucleus pulposus. Patients were assigned to either the general or spinal anesthesia group by computer-generated randomization. Patients were excluded if they were ASA I II or more or if they had an infectious process, or spinal instability. Patients with hepatic or renal disease, severe cardiac disease, or bleeding abnormalities that would require a nonstandard anesthetic technique and those undergoing revision surgery or requiring surgical stabilization or fusion were excluded from study. All procedures were performed by same surgeons and anesthetist, and all data were collected, collated and analyzed by an independent observer.

30 patients were included in each anesthesia treatment group. Selected patients were consecutively recruited because they met inclusion and exclusion criteria, and were treated for the indicated disorders. The anesthetic protocols were established by members of the Department of Anesthesiology with a focused interest in spinal surgery. Protocols were maintained without variation during the study period.

In the operating theater, each patient in two groups was prepared for continuous noninvasive blood pressure monitoring, peripheral pulse oxymetry, and electrocardiography.

Patients undergoing general anesthesia (GA) were typically given propofol 2 mg.kg⁻¹ and fentanyl 2-5 µg.kg⁻¹ IV. All patients underwent endotracheal

intubation, which was facilitated by administering rocuronium (0.6 mg.kg^{-1}). Anesthesia was maintained desflurane (6%) in nitrous oxide/oxygen (60/40%). No additional muscle relaxants were administered. After the patients were intubated, they were placed in the prone position on a standard operating frame using either a flexed position or a knee-chest position. At the completion of the surgical procedure, the patient was returned to the supine position. At completion of general anesthetic, the anesthetic agents were discontinued and the patients breathed 100% O_2 and they were extubated in operating room. The patients were monitored one on one by nursing staff in the PACU until awake, alert and responsive and intravenous analgesia was maintained by the PACU nurse.

The spinal anesthetic (SA) patients were typically placed in the seated position on arrival in the operating room. For those in whom a spinal anesthetic was administered, prehydration was performed in the anesthesia pre-induction area with 300-500 ml of lactated Ringers solution intravenously. After sterile preparation, the best interspace at L_{2-3} , L_{3-4} or L_{4-5} was identified and a local anesthetic was injected using a 25 gauge needle, and a subarachnoid block was achieved with 10 mg of 0.5% plain levobupivacaine. The patients were returned to the supine position and as soon as there was clear evidence of subarachnoid block at T_{12} or above, the patients were turned to the prone position and placed in either the flexed position. Oxygen was administered by a nasal cannula at 2 L.min^{-1} . At the completion of procedure, the patient was rolled from the prone position and transferred to the PACU.

In prolonged cases, spinal anesthesia was occasionally augmented with an intrathecal injection through a 25 gauge needle, with no adverse events and no subsequent episodes of dural leakage.

During the course of the anesthetic, hypotension or bradycardia was defined as the reduction of MAP or HR to less than 80% of the baseline amounts and treated with ephedrine 5 mg IV. Hypertension or tachycardia was considered when mean arterial blood pressure (MAP) or HR had raised to more than 120 % of the baseline values and treated by either increasing the inhaled concentration of desflurane in the GA group or by giving propofol 20-30 mg IV in SA group.

The amount of blood loss was assessed by measuring the bloody gauzes weight plus the volume calculated from the difference of suctioned fluid and the volume calculated from the difference of suctioned fluid and the volume of irrigation solutions administered. The numbers of blood bags injected to patient during the operation, the preoperative and postoperative hemoglobin values were recorded.

Patients were discharged from the recovery room based on TOF ratio equal to 0.85 in GA patients and the regression of at least 4 dermatomes block in SA patients and all the patients were assessed to be hemodynamically and comfortable at the time of discharge. The total stay of the patients in PACU was also recorded.

In PACU, severity of pain and nausea were assessed for all patients using 100-mm visual analog scales (VAS) (0=minimum effect, 100= maximum effect). Baseline readings for these variables were obtained in the patient's room. If patients required analgesia (pain scores ≥ 50), morphine 2 mg IV was given until pain scores decreased to ≤ 20 . If nausea scores were still greater than 50, antiemetic therapy consisted of metoclopramide 10 mg IV, which could be repeated after 30 min if necessary, until vomiting ceased or nausea scores decreased to less than 20. PACU administration of analgesics, antiemetic administration and total length of PACU stay were recorded.

Age, sex, height, weight and ASA physical status were recorded along with heart rate

and mean arterial pressure at the time the patients first entered the operating room and peripheral pulse oxymetry, heart rate, and blood pressure (systolic, diastolic and mean) were monitored sequentially thereafter. Total anesthesia time and surgical time were calculated. Postoperative variables and complication (such as spinal headache, urinary retention, and pulmonary dysfunction) were reviewed.

Surgeon's satisfaction was evaluated using a 100-mm VAS based on the satisfaction from the amount of blood in the surgical field, being motionless, muscular relaxation and the possibility of assessing neurological status immediately after the operation and the satisfaction rate of surgeon was recorded.

Over the next 24 h, occurrences of vomiting and nausea (VAS scores of 50 or more) were recorded. Need for analgesics were recorded during same period and treatment consisted of although, mild discomfort was controlled with oral acetaminophen.

Statistical Analysis:

Parametric data for the two anesthetic groups were compared by Student's t-test. Frequency data were compared using a nonparametric one-way analysis (Kruskal-Wallis) test for significance. All parametric values are reported as mean $\pm$ SEM with significance determined for repeated measures at $p<0.001$ and at $p<0.05$ for all other variables.

RESULTS

Demographic characteristics, surgical diagnosis, number of involved vertebral levels, baseline heart rate, mean arterial blood pressure and ASA class did not differ between the two groups (Table 1). Surgical and total anesthetic time were longer for the general anesthetic group, and actual time dedicated specifically to anesthetic care (total anesthetic time-surgical time) was longer in the general group compared with spinal group ($p<0.05$) (Table 1).

Intraoperative complications were not significantly distributed to either group. Two of patient induced with spinal anesthesia had discomfort during the operation. In 1 cases of SA group, coughing impeded the surgeons from proceeding for a while and that, in 1 cases, hiccups made the condition tense. On the other hand, surgeon's satisfaction measured by VAS was higher in GA patients (80.4 ± 5.3 mm) compared with SA patients (68.5 ± 5.8 mm), which was statistically significant ($p=0.030$). The mean of sensorial block level was at T8-10. Intraoperatively, blood loss, hypotension, bradycardia occurred with equal frequency ($p>0.05$). However, hypertension and tachycardia were more frequent in the GA group. During this period, 9 of GA cases (30%) had hypertension episodes, whereas just 2 (6.6%) cases of the SA group experienced it ($p<0.001$) and tachycardia was more frequent in GA compared with SA group (GA: 23.3%, SA: 10%, $p=0.012$) (Table 2).

In postoperative period, there were no major cardiopulmonary complications in either group whereas at PACU admission, tachycardia (26.6% vs. 6.6%, $p<0.001$) and hypertension (33.3% vs. 6.6%, $p<0.001$) were more frequent in those undergoing GA (Table 3).

In the PACU, the peak nausea score (GA: 29.6 ± 3.2 , SA: 12.4 ± 4.7 $p=0.021$), antiemetic given (GA: 26.6%, SA: 10% $p=0.025$) incidence of nausea (GA: 23.3%, SA: 6.6% $p=0.015$) and vomiting (GA: 16.6% SA: 6.6% $p=0.011$) were significantly higher in the GA group (Table 3). In this period, the peak pain scores (GA: 61.2 ± 4.9 , SA: 23.2 ± 3.8 $p<0.001$) and analgesic requirements (GA: 73.3%, SA: 26.6 $p<0.001$) were higher in the GA group (Table 3).

Table 1: Demographic data and surgical characteristics

Variable	General anesthesia (n=30)	Spinal anesthesia (n=30)	P value
-Sex (%)			
male	58	55	0.16
female	42	45	0.45
-median age (years)	49	51	0.46
-Diagnosis (%)			
NPH	68	65	0.82
SS	33	35	0.96
-Op levels (%)			
Single	70	63	0.54
Double	30	37	0.76
-ASA class			
I	19	16	0.29
II	11	14	0.38
-Total anesthesia time (min)	112.6±8.9	136.4±11.2	0.038*
-Surgical time (min)	73.6±6.9	89.5±9.8	0.032*
-Actual time (total anesth-surgical time) (min)	39.7±5.3	27.6±6.1	0.023*

NPH: nucleus pulposus herniation; SS: spinal stenosis

*p<0.05 versus spinal anesthesia group

The patients were reevaluated 24 hours after the operation. The PACU occupancy times, ambulation on day of surgery and hospital stay no statically significant difference was observed between two groups ($p<0.05$) (Table 4). In this period, the analgesic requirement (GA: 66.6%, SA: 70%, $p=0.72$) and pain assessed with VAS (GA: 52.6 ± 6.9 , SA: 49.2 ± 4.7 , $p=1.00$) showed no differences between two groups (Table 4). The day after

surgery, the incidence of nausea, but not vomiting, was still higher in GA group (GA: 23.3% SA: 6.6, $p=0.013$) (Table 4). Both groups had similar incidence of vomiting and antiemetic requirement ($p>0.05$) (Table 4). Urinary retention requiring catheterization of the bladder did not differ between the two groups and headache was similar during the 24 h after discharge PACU ($p>0.05$) (Table 4).

Table 2: Intraoperative Data for Two Groups

Variables	General anesthesia (n=30)	Spinal anesthesia(n=30)	P value
Bradycardia (%)	6.6 %	3.3%	0.42
Tachycardia (%)	23.3 %	10.0 %	0.012*
Hypertension (%)	30.0 %	6.6 %	<0.001*
Hypotension (%)	13.3 %	10.0%	0.74
Blood loss (mL)	492.23±56.43	448.34±47.45	0.86
IV fluids (mL)	2780.0±310.6	2975.6±365.5	0.91
Surgeon's satisfaction (VAS, mm)	80.4±5.3	68.5±5.8	0.032*
Patients discomfort (%)	-	6.6%	0.39
Coughing (%)	-	3.3%	0.32
Hiccups (%)	-	3.3%	0.32

*p<0.05 versus spinal anesthesia group

Table 3: Recovery Outcomes in the Postanesthesia Care Unit (PACU)

	General anesthesia (n=30)	Spinal anesthesia (n=30)	P value
Tachycardia (%)	26.6%	6.6%	0.010*
Hypertension (%)	33.3%	6.6%	<0.001*
Peak pain score	61.2±4.9	23.2±3.8	<0.001*
Analgesic given (%)	73.3%	26.6%	<0.001*
Peak nausea score	29.6±3.2	12.4±4.7	<0.001*
Vomiting (%)	16.6 %	6.6%	0.011*
Nausea (%)	23.3%	6.6%	<0.015*
Antiemetic given	26.6%	10.0%	<0.025*

*p<0.05 versus spinal anesthesia group

Table 4: Recovery Outcomes after 24 hours

	General anesthesia (n=30)	Spinal anesthesia (n=30)	P value
PACU time (min)	92.3±5.7	95.8±9.7	0.92
Ambulation of day of surgery (%)	46.6%	36.6%	0.28
Hospital stay (day)	2.3±1.2	1.7±1.3	0.86
Peak pain score (VAS-100)	52.6±6.9	49.2±4.7	1.00
Analgesic given (%)	70.6%	66.6%	0.72
Nausea (%)	23.3%	6.6%	0.013*
Vomiting (%)	13.3%	6.6%	0.062
Antiemetic given (%)	10.0%	6.6%	0.087
Urinary retention (%)	16.6%	10.0%	0.064
Headache (%)	6.6%	10.0%	0.078

*p<0.05 versus spinal anesthesia group
PACU: Post-anesthetic Care Unit

DISCUSSION

Traditionally, general anesthesia is used in lumbar disc surgery; nevertheless, regional anesthesia, either spinal or epidural, has been a successful alternative in spinal surgery. Although discectomy has been performed under regional anesthesia, spinal anesthesia is not a commonly used technique. This technique avoids the deleterious physiological consequences of the prone position under general anesthesia. The maintenance of spontaneous ventilation results in less distention of the epidural veins and produces an excellent surgical field. Although spinal anesthesia has previously been reported for discectomy and is mentioned in anesthetic textbooks, it is unclear exactly how widely the technique has been practiced^(1,4,5). In general, spinal anesthesia has been shown to carry a very low risk of serious complications⁽⁹⁾.

Spinal anesthesia advantages include patients self-positioning, so that they could regulate the respiratory functions and it also has the advantage of decreasing intraoperative bleeding by decreasing peripheral venous pressure⁽¹⁸⁾. The reduced bleeding reported in previous studies may also be due to relatively fewer episodes of intraoperative hypertension because a spinal anesthetic inhibits surgically induced stress levels to a greater degree than general anesthesia^(3,7,10). Jellish et al⁽⁶⁾ have shown that patients who receive a spinal anesthetic bleed less during lumbar disc procedures compared with those whom general anesthesia is induced. They suggested that the reduce blood loss was due to a combination of sympathetic blockade (producing vasodilation and relative hypotension) and lowered intrathoracic pressure experienced when patients are allowed to breath spontaneously, as during procedures when a spinal anesthetic is administered^(2,10). In

our study, there was no significant difference between the patients operated under the spinal anesthesia and general anesthesia.

Jellish et al⁽⁶⁾ said that the decreased blood loss during spinal anesthesia likely contributed to the lower surgical time observed in spinal anesthesia group and less bleeding would facilitate dissection and removal of the disk and result in less time needed to effect hemostasis prior to surgical closure. In other previous studies, amount of bleeding was found to be more in general anesthesia group than spinal anesthesia group. The reduced bleeding reported in our study, however there was no statistically significance for bleeding in two groups but surgical and total anesthetic time were longer for the general anesthetic group compared with spinal group. Reduced rate of bleeding within the wound has been suggested as one factor that may contribute to a shorter surgical time in patients in whom a spinal anesthetic is administered. In addition, although surgeons are interested in spinal anesthesia as a more reliable method, experience shows the prolonged operation performed in the prone position under spinal anesthesia increases the surgeon's stress and anxiety.

Several studies and our series have compared spinal anesthesia and general anesthesia in lumbar laminectomy surgery, and many of which have concluded spinal anesthesia preferred method^(2,4,6,9,10). However Sadrolsadat et al⁽¹³⁾ did not support this hypothesis.

Spinal anesthesia also has some complications such as headache due to cerebrospinal fluid leakage and meningitis⁽¹⁸⁾, which we fortunately did not experience in our series. Spinal anesthesia has proven its superiority to general anesthesia in orthopedic procedures, showing less blood loss, thromboembolic complication, and short-term mortality⁽²⁾. The major advantages of regional anesthesia are the excellent postoperative

analgesia along with reduced nausea and vomiting. In this study, the increased incidence of nausea, its severity, and antiemetic use in the general anesthesia group was not likely related to patient factors such as age, gender, or obesity because both groups were demographically well matched⁽⁶⁾.

Anesthetic-related factors, however, may have played a larger role⁽¹⁶⁾. In the general anesthesia group, we used remifentanyl infusion for intraoperative analgesia and the general anesthesia group also had much higher pain scores and analgesic requirements in PACU. Increased use of narcotic analgesics would be associated with a higher incidence of nausea and vomiting because of the effect of nausea and vomiting because of the effect of narcotics on sensitizing the vestibular apparatus to movement and increase susceptibility to nausea; patients treated with higher narcotic doses in the PACU may have been more likely to experience nausea and vomiting and to require medication for these symptoms⁽¹²⁾. In previous studies supported that the increased incidence of nausea and vomiting among patients in general anesthesia group than regional anesthesia group^(6,9,10). In other study, Sadrolsadat et al⁽¹³⁾ have shown that the spinal anesthesia higher incidence of nausea and vomiting.

Urinary retention has been shown to be associated more with spinal rather than general anesthesia⁽¹²⁾, although in our study, we found no such difference in our patients. Our findings may be explained by the fact that our spinal anesthesia-induced patients required lower doses of opioid medications overall and because no subarachnoid opioids were included among the anesthetic agents.

Urinary retention has been shown to be associated more with spinal anesthesia rather than general anesthesia⁽¹⁷⁾. Mc Lain et al⁽¹⁰⁾ found that patients receiving a general anesthetic in their series experienced a significantly higher

incidence of symptomatic urinary retention, although Jellish et al⁽⁶⁾ found no such difference in general and spinal anesthesia. In this study, we found the incidence of urinary retention to be approximately the same for both groups. Silver et al⁽¹⁵⁾ reported a 3% incidence of urinary retention among 576 patients having lumbar surgery under spinal anesthesia and compared this with a 6% incidence among general anesthesia patients. This contradiction may be explained by the fact that when spinal anesthesia was associated with urinary retention, intrathecal opioids had been used in combination with local anesthetic⁽¹⁷⁾. Subarachnoid opioids clearly increase the incidence of urinary retention⁽⁸⁾. In this study no neuroaxial opioids were used and our findings may be explained by the facts that our spinal anesthesia technique used no subarachnoid opioids among the anesthetic agents and that these spinal anesthesia patients required lower doses of opioid medication for analgesia during the recovery period.

Patients receiving a spinal anesthetic experienced less postoperative pain. The general anesthesia group also had pain scores and analgesic requirement in the PACU. This suggests that the direct block of sensory function by the spinal anesthetic patients even after transfer to the PACU and for a further period after recovery from motor blockade⁽¹¹⁾.

In this study, there was no increase in the incidence of spinal headaches in patients treated with a spinal anesthetic injection, despite the lumbar puncture.

Although anesthesiologists are interested in spinal anesthesia as a more reliable method, experience shows the prolonged operations performed in the prone position under spinal anesthesia increases anesthesiologist's stress. Especially, the managing an apneic patient, providing an airway access and placing an endotracheal tube in the prone position are difficult⁽¹³⁾. Jellish et al⁽⁶⁾ said that the tolerance for

prone positioning on the frame to be reduces approximately two hours.

In conclusion, spinal anesthesia is a suitable alternative to general anesthesia in the care of patients undergoing lumbar laminectomy.

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REFERENCES

1. Backofen JE, Schauble JR. Hemodynamic changes with prone positioning during general anaesthesia. *Anesth Analg* 1985;64:194
2. Covino BG. Rationale for spinal anesthesia. *Int Anesthesiol Clin* 1989;27:8-12
3. Davis FM, Laurenson VG, Lewis J, Wells JE, Gillespie WJ. Metabolic response to total hip arthroplasty under hypobaric subarachnoid or general anaesthesia. *Br J Anaesth* 1987;59:725-729
4. Demirel CB, Kalaycı M, Ozkocak I, Altunkaya H, Ozer Y, Acikgoz B. A prospective randomized study comparing perioperative outcome variables after

- epidural or general anesthesia for lumbar disc surgery. *J Neurosurg Anesthesiol* 2003;15:185-192
5. Hassi N, Badaoui R, Cagny-Bellet A, Sifeddine S, Ossart M. Spinal anesthesia for disk herniation and lumbar laminectomy. Apropos of 77 cases. *Can Anesthesiol* 1995;43:21-25
 6. Jellish WS, Thalji Z, Stevenson K, Shea J. A prospective randomized study, comparing short- and intermediate-term perioperative outcome variables after spinal or general anesthesia for lumbar disk and laminectomy surg. *Anesth Analg* 1996;83:559-564
 7. Kehlet H. The stress response the anesthesia and surgery: release mechanism and modifying factor. *Clin Anesth* 1984;2:315-339
 8. Mahan KT, Wang J. Spinal morphine anesthesia and urinary retention. *J Am Pediatr Med Assoc* 1993;83:607-614
 9. McLain RF, Bell GR, Kalfas I, Tetzlaff JE, Yoon HJ. Complications associated with lumbar laminectomy. *Spine* 2004;29:2542-2547
 10. McLain RF, Kalfas I, Bell GR, Tetzlaff JE, Yoon HJ, Rana M. Comparison of spinal and general anesthesia in lumbar laminectomy surgery: a case-controlled analysis of 400 patients. *J Neurosurg Spine* 2005;2:17-22
 11. Pflug AE, Aasheim GM, Foster C. Sequence of return of neurological function and criteria for safe ambulation following subarachnoid block. *Can Anaesth Soc J* 1978;25:133-139
 12. Riding JE. Minor complications of general anaesthesia. *Br J Anaesth* 1975;47:91-101
 13. Sadrolsadat SH, Mahdavi AR, Moharari RS, Khajavi MR, Khashayar P, Najafi A, Amirjamshidi A. A prospective randomized trial comparing the technique of spinal and general anesthesia for lumbar disk surgery: a study of 100 cases. *Surg Neurol* 2009;71:60-65
 14. Scott NB, Kehlet H. regional anesthesia and surgical morbidity. *Br J Surg* 1988;75:299-304
 15. Silver DJ, Dunsmore RH, Dickson CM. Spinal anesthesia for lumbar disc surgery: review of 576 operations. *Anesth Analg* 1976;55:550-554
 16. Watcha MF, White PF. Postoperative nausea and vomiting. Its etiology, treatment, and prevention. *Anesthesiology* 1992;77:162-184
 17. Young DV. Comparison of local, spinal, and general anesthesia for inguinal herniorrhaphy. *Am J Surg* 1987;153:560-563
 18. Yilmaz C, Buyrukcu SO, Cansever T, Gulsen S, Altinors N, Caner H. Lumbar microdiscectomy with spinal anesthesia: comparison of prone and knee-chest positions in means of hemodynamic and respiratory function. *Spine* 2010;35:1176-1184