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ORIGINAL ARTICLE

Spinal anesthesia efficiency in thoracolumbar stabilizations

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Background and purpose – Spinal surgery has an important place in neurosurgery practice. Surgical procedures on the lumbar spine include stabilization, discectomy, foraminotomy and decompression. Lumbar and lower thoracic spinal surgery can be safely performed under spinal anesthesia (SA). However, there are not many studies on the safety and efficacy of spinal anesthesia in patients who have undergone long segment stabilization surgery.
Methods – Patients who underwent lumbar and lower thoracic spinal instrumentation operations with general anesthesia (GA) or spinal anesthesia were included in the study. Demographic characteristics and American Society of Anesthesiologists (ASA) physical status of the patients were all recorded. Visual analog scale and quality of life scores were obtained before and after the operation.
Results – 572 patients with SA and 598 patients with GA were included in the study, 352 / 347 had only-lumbar region and 220 / 251 had thoracolumbar region operations, respectively. All patients underwent short/long segment stabilization. Mean operating time was 106.1 / 156.7 minutes. Average blood loss was 375 / 390 mL. All patients were mobilized 16-24 / 24-36 hours after surgery. In our patient group, there were both high-risk and normal-risk subgroups in terms of ASA physical status. During the clinical follow-up, a statistically significant improvement was found for VAS and quality of life scores for both groups ($p<0.05$).
Conclusions – Spinal anesthesia appears to be a very effective method in lumbar and thoracolumbar surgery. Along with careful patient selection, using this highly effective

A spinalis anesztézia hatékonysága thoracolumbalis stabilizációban
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Háttér és cél – A gerincsebészet fontos helyet foglal el az idegsebészeti gyakorlatban. Az ágyéki gerinc sebészeti eljárásai közé tartozik a stabilizáció, a discectomia, a foraminotomia és a dekompresszió. Az ágyéki és alsó mellkasi gerincműtétek biztonságosan végezhetők spinalis anesztéziában (SA). A gerincvelői érzéstelenítés biztonságosságáról és hatékonyságáról azonban nem sok tanulmány áll rendelkezésre a hosszúszegmentum-stabilizációs műtéten átesett betegek esetében.
Módszerek – A vizsgálatba olyan betegeket vontunk be, akik lumbalis vagy alsó mellkasi gerincműtéten estek át általános érzéstelenítésben (GA) vagy spinalis érzéstelenítésben. A betegek demográfiai jellemzőit és az Amerikai Aneszteziológustársaság (American Society of Anesthesiologists, ASA) által előírt fizikai státuszt rögzítettük. A műtét előtt és után vizuális analóg skálán fájdalompontszámokat és életminőségi pontszámokat mértünk.
Eredmények – A vizsgálatba 572 SA-s és 598 GA-s beteget vontunk be, 352 / 347 esetben csak a lumbalis régióban, illetve 220 / 251 esetben a thoracolumbalis régióban végeztünk műtétet. Minden betegnél rövid/hosszú szegmensstabilizációt végeztünk. Az átlagos műtéti idő 106,1 / 156,7 perc volt. Az átlagos vérveszteség 375 / 390 ml volt. Minden beteget 16–24 / 24–36 órával a műtét után mobilizáltunk. Betegcsoportunkban az ASA fizikai státusz szempontjából magas és normálkockázatú alcsoport egyaránt volt. A klinikai utánkövetés során mindkét csoportban statisztikailag szignifikáns javulást tapasztaltunk a VAS- és életminőség-pontszámok tekintetében ($p < 0,05$).
Következtetés – A spinalis érzéstelenítés nagyon hatékony módszernek tűnik az

method provides a comfortable space for the surgeon.

Keywords: thoracolumbar, lumbar, stabilization, spinal, anesthesia

ágyéki és thoracolumbalis gerincműtéteknél. Gondos betegkiválasztás mellett ennek a rendkívül hatékony módszernek az alkalmazása kényelmes teret biztosít a sebész számára.

Kulcsszavak: thoracolumbalis, lumbalis, stabilizáció, spinalis, anesztézia

Spinal surgery has an important place in neurosurgery practice. Considering the high number of patients with low back and accompanying radicular pain, it is very important to minimize the complications associated with general anesthesia. Perioperative cardio-pulmonary stability is critical because of the increasing proportion of elderly patients and their comorbidities. So, the perioperative risk profile must have been modified[1, 2].

Surgical procedures on the lumbar spine include stabilization, discectomy, foraminotomy and decompression. Lumbar and lower thoracic spinal surgery can be safely performed under general endotracheal anesthesia (GA) or spinal anesthesia (SA)[3, 4]. Patients typically receive GA for these procedures[5].

Although it has been stated that SA can be used safely in operations such as simple discectomy and single-level decompression, and even in high-risk patients[6, 7], there are not many studies about the results in high-risk patients undergoing long segment stabilization. Thanks to SA, pulmonary and cardiovascular complications, hemorrhage and hypoxia are reduced. Especially in traumatic patients, it is very important to provide better postoperative pain and perioperative neural control. These complications can be seen after GA[8].

There are various studies in the literature in terms of postoperative nausea, postoperative pain, operation time, time spent in the post-anesthesia care unit and cost-effectiveness. In these studies, the effect of GA and SA on lumbar surgery was compared[9]. However, there are not many studies on the safety and efficacy of SA in patients who have undergone long segment stabilization surgery. In this study, we aimed to demonstrate that effective and beneficial results that can be obtained in patients undergoing thoracolumbar stabilization with spinal anesthesia.

Materials and methods

This study was performed in accordance with the Declaration of Helsinki. Patients or their legal caregivers, in cases of patients with intellectual disability, gave their informed signed consent and permitted their information to be used for scientific purposes.

We retrospectively analyzed the medical charts of all patients undergoing lumbar spine surgery in the period January 2014 – December 2020. 1170 patients who underwent lumbar and lower thoracic spinal instrumentation operations were included in the study. Patients aged 18 to 75 years with multilevel spinal involvement, patients with pain resistant to conservative treatment (at least 6 weeks), and patients with progressive neurological deficit were included in the study. Only cases operated on the lower thoracic region and thoracolumbar junction were included in the study. Patients with additional comorbidities such as cardiovascular, neuromuscular, renal, hepatic or metabolic disease, obesity, bleeding abnormalities and patients with cauda equina syndrome were not included in the study.

All surgical procedures were carried out by the same surgeons and same anesthesiologists with similar surgical and anesthetic techniques. No preemptive analgesia application was performed in our patients. SA was achieved with a heavy spinal dose of bupivacaine of 3-3.5 mL. Preloading was performed with normal saline (8 mL/kg) over 13 minutes. The patients were placed in a sitting position. Local anesthesia was achieved by local infiltration of 2-3 mL of 2% prilocaine. L1 level was determined as the upper point for SA. In the upper levels, local anesthetic and sedative agents were supported. The sensory level of the block was assessed by pinprick test. When the patient became anxious, midazolam 1-2 mg was given intravenously. After surgery, the patients remained in the PACU until they regained the adequate motor function of their lower extremities.

In the GA group, technically, total intravenous anesthesia (TIVA) was used. In the TIVA technique, when intravenous analgesic agents are titrated and administered, a fast, easy and reliable anesthesia is provided, while the total amount of anesthetic drug administered is reduced. Anesthesia induction was performed with 2 mg/kg iv propofol and 1 mcg/kg iv remifentanil. For endotracheal intubation, 0.1 mg/kg iv vecuronium was administered. After the prone position was placed, anesthesia was maintained with 50% O_2 and air together with 0.1 mcg/kg×min remifentanil and propofol infusion. Propofol infusion was administered for 20-30 minutes, respectively, as 12, 9 and 6 mg/kg×h.

Patient-Controlled Analgesia (PCA) treatment was applied to the patients in both groups in the postoperative period. Opioids and local anesthetics are generally preferred in PCA. Among them, opioids are widely used. Morphine is often used because it is cheap and effective. If morphine-related side effects develop, fentanyl or oxycodone is also preferred.

Demographic characteristics and American Society of Anesthesiologists (ASA)[10] physical status of the patients were all recorded. The clinical outcome was determined by the presence of postoperative pain, the absence of anesthesia-related complications, and the overall postoperative recovery. Intra- and postoperative variables including duration of operation, blood loss, complications, and patient satisfaction rate were documented. The patients were diagnosed with detailed neurological and radiological imaging examinations. Visual analog scale (VAS)[11] and quality of life scores were obtained before and after the operation. The VAS is a validated, subjective measure for acute and chronic pain. Quality of life was assessed using the SF-36 Health Survey[12]. At the time of discharge, usually two or three days after surgery for SA and four or five days for GA, postoperative clinical assessments were performed and patients were requested to complete the questionnaire again. In addition, the same procedures were repeated at the post-op third and 12th months. The groups were compared both within themselves and with each other.

Table 1. *Summarized data of patients*

Variables	Patients with SA (n = 572)	Patients with GA (n = 598)
Age, years	45.23±18.52	49.13±19.67
Male/Female	264/308	283/315
Operation site (%) Thoracolumbar Lumbar	 220 (38.4%) 352 (61.6%)	 251 (41.9%) 347 (58.1%)
Mean weight (kg)	75.3	81.2
Mean Operating Time (min)	106.1	156.7
Average blood loss (mL) Average hospital stay (day) Mobilization time (hour)	375 3-4 16-24	390 5-6 24-36
ASA physical status I II III IV	 49 (8.5%) 192 (33.6%) 217 (38%) 114 (19.9%)	 47 (7.8%) 200 (33.4%) 221 (37%) 130 (21.8%)
PACU VAS score	1.5±0.8	3.1±0.8
VAS 24h score	1.7±0.9	2.7±0.9

ASA: American Society of Anesthesiologists; PACU: post anesthesia care unit; VAS: visual analogue scale (0–10).
SA: spinal anesthesia; GA: general anesthesia

Statistical analysis

All statistical analyses were performed using IBM SPSS 20.0 software (SPSS Inc, Chicago, IL, USA). The data are reported as the mean ± SD for normally distributed continuous variables and as the number and percentage for dichotomous variables. Data were compared between groups using the chi-square test for categorical data and the t-test for continuous data. A two-tailed $p < 0.05$ was considered to indicate statistically significant differences.

Results

Of the 1170 patients who were included in the study, 699 had only lumbar region operations and 471 had thoracolumbar region operations. The patients consisted of 547 (46.8%) males and 623 (53.2%) females with a mean age of 47.18 ± 19.09 years (range 19–75 years) and mean weight 78.25 kg (range, 54-108 kg) at initial symptom onset. The characteristic data and the surgical procedure for these patients and their pathologies are detailed in **Table 1** and **2**. Surgery was successfully completed in all cases.

In our patient group, there were both high-risk and normal-risk subgroups in terms of ASA physical status. In addition, there was no obvious difference in proportion **(Table 1)**. All patients underwent short (<2 level) / long (>2 level) segment stabilization operation **(Table 2)**. Mean operating time was 106.1 minutes (range, 82-158

Table 2. *Surgical procedure and preoperative diagnosis*

Procedure and diagnosis	Lumbar (n = 699)	Thoracolumbar (n = 471)
Short segment stabilization	341 (29.1%)	165 (14.1%)
Long segment stabilization	363 (31.1%)	301 (25.7%)
Recurrent disc herniation	152 (12.9%)	73 (6.2%)
Multilevel spinal stenosis	215 (18.4%)	147 (12.6%)
Vertebrae fracture	107 (9.1%)	112 (9,6%)
Spondylolisthesis	92 (7,9%)	64 (5.5%)
Revision of ınstrumentation	86 (7.4%)	122 (10.4%)

Table 3. *Complications*

Complications	Patients with SA (n = 572)	Patients with GA (n = 598)
Cardiac	6 (1%)	6 (1%)
Dural tear	5 (1%)	6 (1%)
Nausea-vomiting	17 (2.9%)	20(3.3%)
Bleeding	5 (1%)	7 (1.1%)
CSF-fistula	3 (0.5%)	5 (0.8%)
Headache	3 (0.5%)	1(0.1%)
Convert from SA to GA	12 (2.1%)	–
Allergy	4 (0.6%)	3 (0.5%)

Cardiac: rhythm disturbance, atrial fibrillation, bradycardia, hypotension; GA: general anesthesia; SA: spinal anesthesia; CSF: cerebrospinal fluid

minutes). Average blood loss was 375 mL (range, 190-875 mL), and no blood transfusion was required for the members of the SA group. On the other hand, mean operating time was 156.7 minutes (range, 95-218 minutes), and average blood loss was 390 mL (range, 205-1175 mL) for the GA group. No patient died in this series. For SA group, all patients were mobilized 16-24 hours after surgery and for GA group they were mobilized 24-36 hours after surgery. The average duration of hospital stay was 2-3 days for the SA group and 4-5 days for the GA group, respectively.

Cardiac complications (rhythm disturbance and atrial fibrillation) developed in two patients, and bradycardia and hypotension developed in four patients due to increased anesthesia level. Thereupon, the patients were placed in the supine position during the perioperative period and after the necessary medications were taken, they were placed in the prone position again and their operations were completed without any problems. In addition, primary suturation was performed due to dural tear development in five patients during surgery in the SA group. When the complication rates were compared between the two groups, no significant difference was observed.

In the SA group, 12 patients had to be converted to GA before starting the operation. In 10 of these patients, adequate anesthetic effect was not observed in the desired dermatome in the control examination, while problems occurred during lumbar puncture in 2 of them. The operations of the patients were completed without any problems. The postoperative complications are shown in detail in **Table 3**. In addition, patients' pain conditions during their early stay in the PACU were also noted **(Table 1)**.

Table 4 and **5** shows the changes in VAS scores after the intervention. Detailed quality of life scoring for the groups are shown in **Table 6** and **7**. When the VAS and quality of life scores of the patients were evaluated, statistically significant improvement was found in the early post-op period; no significant difference was found in the early post-op period and the last clinical follow-up. When the two groups were compared with each other, no statistically significant difference was found. However, VAS-PACU and VAS-24h scores were found to be lower in the SA group and a statistically significant difference was obtained ($p<0,05$).

Table 4. *VAS scores and clinical follow-up (with SA patients)*

	Lumbar (n = 352)	Thoracolumbar (n = 220)	p-value
Pre VAS score	7.8 ± 2.86	7.2 ± 2.14	
Post VAS score, months (3rd /12 th)	2.2 ± 0.41 / 3.1 ± 0.64	2.1 ± 0.61 / 3.0 ± 0.34	<0.05
Early clinical follow-up (Improve/Stable)	325 / 27	192 / 28	<0.05
Last clinical follow-up (Improve/Stable)	310 /42	173 / 47	<0.05

VAS: visual analogue scale (0–10); SA: spinal anesthesia

Table 5. *VAS scores and clinical follow-up (with GA patients)*

	Lumbar (n = 347)	Thoracolumbar (n = 251)	p-value
Pre VAS score	7.6 ± 2.27	7.4 ± 2.21	
Post VAS score, months (3rd /12 th)	2.0 ± 0.37 / 3.0 ± 0.68	2.2 ± 0.58 / 2.9 ± 0.29	<0.05
Early clinical follow-up (Improve/Stable)	317 / 30	221 / 30	<0.05
Last clinical follow-up (Improve/Stable)	307 /40	193 / 58	<0.05

VAS: visual analogue scale (0–10); GA: spinal anesthesia

Discussion

Our aim with this retrospective study conducted with a large cohort was to determine whether spinal anesthesia is safe in patients undergoing long/short segment stabilization surgery. In addition, we think that our study makes a significant contribution to the literature with the high number of patients with high-risk ASA physical status. Posterior lumbar stabilization can be per-

formed under SA without mortality and with very low morbidity[13].

It has been reported in the literature that SA can be used effectively in the lower thoracic and lumbosacral regions[14]. It has also been shown that SA and GA are reasonable anesthetic approaches, especially in the lumbar region, and do not outweigh each other in terms of mortality or morbidity[15]. The fact that GA is a widely accepted method for lumbar region operations has been associated with the comfort level of the anesthetists and the preference of the surgeon[16].

SA has become increasingly popular in recent years. Moreover, high-risk patients may not tolerate GA owing to complications or side effects[17]. Atelectasis and pulmonary aspiration, cardiovascular imbalance, respiratory collapse and nerve injury are several perioperative complications and can be associated with GA[18, 19]. It is known that the risk of spinal degenerative diseases increases with age. With the increase of risky patient rates in the elderly population, it is very important to reduce anesthetic complications as much as possible[20]. In our study, when we compared the two groups with different complication rates, similar results were obtained. Due to the high number of high-risk patients in our study, we think that SA can be used safely in this group as well.

Table 6. *Detailed Quality of Life Score (with SA patients)*

Mean scores for SF-36	Thoracolumbar	Lumbar	p-values
Physical functioning	81.32/92.08/	80.24/92.91/	<0.05
(Pre/3rd/12th)	91.17	91.77	
Role limitation caused by physical health	75.27/90.85/	76.29/91.34/	<0.05
(Pre/3rd/12th)	89.87	90.27	
Body pain	55.49/81.92/	55.72/81.99/	<0.05
(Pre/3rd/12th)	80.78	81.57	
General health	66.79/78.53/	65.79/79.32/	<0.05
(Pre/3rd/12th)	77.63	78.23	
Vitality (energy/fatigue)	56.87/64.21/	55.89/64.61/	<0.05
(Pre/3rd/12th)	63.88	64.28	
Social functioning	81.55/90.46/	81.78/91.13/	<0.05
(Pre/3rd/12th)	89.25	89.67	
Role limitation caused by emotional problems	91.31/95.56/	90.91/95.87/	<0.05
(Pre/3rd/12th)	94.63	94.42	
Emotional well-being	67.39/74.84/	68.01/75.27/	<0.05
(Pre/3rd/12th)	73.78	74.51	
Physical component score (PCS)	44.53/50.32/	45.17/51.02/	<0.05
(Pre/3rd/12th)	49.87	49.95	
Mental component score (MCS)	53.67/56.88/	53.52/56.71/	<0.05
(Pre/3rd/12th)	55.76	55.61	

The fact that patients did not complain about pain in the first few hours after the operation with SA was attributed to the inhibition of nociceptive pathways by this form of anesthesia. Thus, the reduction of sensorial block lasts longer than motor block. Moreover, acute pain scores were found to be lower in SA than in GA patients. Although postoperative VAS scores were significantly lower in SA patients in the first three hours, first analgesic requirement times were similar[21, 22]. The need for analgesic medication of our patients manifested itself between the third and fifth hours after the operation. In our study and in correlation with this, VAS-PACU and VAS-24h scores were found to be lower in the SA group and a statistically significant difference was obtained. The quality of life of the patients, which has not been mentioned in the literature before, was also evaluated in our study. We found no statistically significant difference between the two groups in long-term results in both quality of life and VAS scores. It was noteworthy that both groups achieved quite satisfactory results.

In spine surgery, operation times can be extended. When the discomfort felt due to the prone position of the patients is added to this, there may be problems in the tolerance of the patients from time to time. Of course, this problem can be solved with certain medical treatments. Although the lack of tolerance sometimes causes distress to both the surgeon and the patient during surgery, SA is the preferred method due to low post-op PACU-pain scores and low complication rates. It should be kept in mind that the agents for sedation may cause airway obstruction requiring intervention[23, 24]. In addition, older patients demonstrate delayed recovery of psychomotor function after sedation. Although we had to give additional sedation in 25.6% of our cases, we did not encounter any complications.

The reported frequencies of serious complications are low and mainly due to the spread of anesthesia leading to circulatory and respiratory insufficiency. In the literature, it has been shown that cardiac parameters, heart rate and blood pressure are lower in patients undergoing SA. Thus, the findings that SA has short-term benefits were supported[7, 21]. In addition, different studies comparing SA and GA reported no significant difference in morbidity

Table 7. *Detailed Quality of Life Score (with GA patients)*

Mean scores for SF-36	Thoracolumbar	Lumbar	p-values
Physical functioning	79.27/91.12/	81.71/81.9/	<0.05
(Pre/3rd/24th)	90.42	80.08	
Role limitation caused by physical health	73.12/89.66/	75.63/75.9/	<0.05
(Pre/3rd/24th)	88.15	74.85	
Body pain	54.79/80.97/	55.98/56.1/	<0.05
(Pre/3rd/24th)	80.05	55.74	
General health	64.53/77.86/	67.03/67.3/	<0.05
(Pre/3rd/24th)	76.93	66.95	
Vitality (energy/fatigue)	55.21/63.80/	56.92/57.1/	<0.05
(Pre/3rd/24th)	62.45	56.84	
Social functioning	80.42/90.12/	82.56/82.6/	<0.05
(Pre/3rd/24th)	89.03	82.01	
Role limitation caused by emotional problems	89.67/95.47/	91.82/92.2/	<0.05
(Pre/3rd/24th)	94.17	92.11	
Emotional well-being	66.24/73.68/	67.91/68.2/	<0.05
(Pre/3rd/24th)	72.57	68.30	
Physical component score (PCS)	43.43/51.17/	44.88/44.9/	<0.05
(Pre/3rd/24th)	49.67	44.81	
Mental component score (MCS)	52.97/55.82/	53.44/53.6/	<0.05
(Pre/3rd/24th)	54.73	53.51	

and mortality[25]. Reductions in hospital stay, nausea and vomiting, and PACU pain scores were found in patients undergoing SA, and it provided additional benefits such as better perioperative hemodynamics and shorter anesthesia time[26]. There are also studies in the literature showing that no particular difference can be found between the two methods[3, 4]. Consistent with the literature data, we found no statistically significant difference in terms of operation time, amount of bleeding, mobilization time and hospital stay between the groups. However, it was noted that the SA group was better in all data. We attributed the shortening of the operation time to the decrease in the time spent in the PACU and the rapid recovery of the patients from the anesthesia effect.

The risk of hospital-acquired infections, pressure ulcers, and other adverse events increase with the length of hospital stays. Thus, increased hospital costs, and further prolonging hospital stay are seen. Shorter operative time and anesthesia time suggest a faster turnover rate and more efficient use of the operation room. Taken together, SA may be the more cost-effective method of anesthesia[27, 28]. However, before drawing any such conclusions, it is important to consider comparative postoperative complications[29]. As we have seen, in some patients, the desired dermatomal level of anesthetic effect may not be achieved. In addition, a successful lumbar puncture cannot be achieved in some patients. For this reason, proper patient selection and the surgeon's habits should always be kept in the foreground.

Limitations

The limitations of our study are the retrospective study design, and the selection of all patients from a single center.

Conclusion

Both general and spinal anesthesia have been previously reported to be effective techniques for use in 1-2 levels of lumbar laminectomy or disc surgery. However, spinal anesthesia appears to be a very effective method in lumbar and thoracolumbar surgery where long segment stabilization will be performed, including high-risk patients. Improvements in the quality of life of patients with low complication rates are pleasing. Along with careful patient selection, using this highly effective method provides a comfortable space for the surgeon.

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