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ORIGINAL ARTICLE

The effect of erector spinae plane block on the use of anesthetic medications in lumbar spine surgery

Erektör spina plan bloğunun bel omurgası cerrahisinde anestezik ilaç kullanımı üzerindeki etkisi

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Summary

Objectives: To reduce the drug side effects and facilitate the emergence from anesthesia after complex spine surgery, various methods have been proposed. One of these methods is ESPB, which has been less studied. Hence, we conducted this study to evaluate the effectiveness of ESPB on the use of anesthetic drugs in lumbar spine surgery.

Methods: In this study, 70 patients undergoing lumbar spine fusion surgery were studied. Patients were randomly divided into two groups: the case group (n=35), in which bilateral ESPB was done, and the control group (n=35). After standard anesthesia protocols, anesthesia was maintained with isoflurane in both groups. Intraoperative isoflurane and perioperative opioid consumption were recorded. Statistical analysis was performed using SPSS software version 21.

Results: Intraoperative use of fentanyl in the case group was significantly lower than the control group (14.29±21.5 vs. 65.96±73.33 µg, p<0.001). Furthermore, isoflurane consumption in the intervention group compared to the controls was significantly lower (20.71±5.02 versus 28.83±8.68 mL, p<0.001). Moreover, the emergence time was significantly shorter in the case group than in the control group (8.49±4.30 minutes versus 15.00±4.94, p<0.001). In the post-anesthesia care unit 1 h after surgery, the pain scores in the case group were significantly lower than the controls (p<0.001).

Conclusion: ESPB under ultrasound guidance is an effective method of regional anesthesia/analgesia for lumbar spine surgery (fusion) by decreasing the consumption of anesthetics during and following the surgery.

Keywords: Anesthetia; erector spinae plane block; isoflurane; lumbar spine; neuroanesthesia; pain; surgery; ultrasound-guided nerve blocks.

Özet

Amaç: Karmaşık omurga cerrahisi sonrası ilaç yan etkilerini azaltmak ve anesteziden çıkışı kolaylaştırmak amacıyla çeşitli yöntemler önerilmiştir. Bu yöntemlerden biri daha az çalışılmış olan ESPB'dir. Bu yüzden, bu çalışmayı ESPB'nin bel omurgası cerrahisinde anestezik ilaç kullanımı üzerindeki etkinliğini değerlendirmek amacıyla yürüttük.

Gereç ve Yöntem: Bu çalışmada, bel omurgası füzyon cerrahisi geçiren 70 hasta incelendi. Hastalar rastgele iki gruba ayrıldı: Bilateral ESPB uygulanan olgu grubu (n=35) ve kontrol grubu (n=35). Standart anestezi protokollerinden sonra, her iki grupta anestezi isofluran ile sürdürüldü. Ameliyat sırasındaki isofluran ve perioperatif opioid tüketimi kaydedildi. İstatistiksel analiz SPSS yazılımı versiyon 21 kullanılarak yapıldı.

Bulgular: Olgu grubunda intraoperatif fentanil kullanımı kontrol grubuna göre anlamlı derecede düşüktü (14.29±21.5 ve 65.96±73.33 µg, p<0.001). Ayrıca, müdahale grubunda isofluran tüketimi kontrol grubuna göre anlamlı derecede daha düşüktü (20.71±5.02 ve 28.83±8.68 mL, p<0.001). Ayrıca, olgu grubunda çıkış süresi kontrol grubuna göre anlamlı derecede daha kısaydı (8.49±4.30 dakika ve 15.00±4.94, p<0.001). Cerrahi sonrası bir saatte anestezi bakım ünitesinde, olgu grubunun fentanil dozu ve ağrı skorları kontrol grubuna göre anlamlı derecede düşüktü (sırasıyla, p=0.030 ve <0.001).

Sonuç: Ultrason eşliğinde ESPB, cerrahi sırasında ve sonrasında anesteziklerin tüketimini azaltarak bel omurgası cerrahisi (füzyon) için etkili bir bölgesel anestezi/analjezi yöntemidir.

Anahtar sözcükler: Erektör spina plan bloğu; bel omurgası; cerrahi; anestezi; isofluran; ağrı; nöroanestezi; ultrason ile yönlendirilmiş sinir blokları.

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Introduction

Surgery for acute low back pain, especially more advanced types such as spinal fusion, is increasing worldwide.[1] Therefore, it is mandatory to consider general points in most major spinal surgeries.[2] Enhanced recovery after surgery (ERAS) is a multidimensional approach to improve surgical patients' care using evidence-based protocols and specific procedures. This method improves performance, reduces postoperative complications, reduces costs, and improves the patients' mental experience.[3] In 2019, Mazin Elsarrag examined the implementation of the ERAS protocol in spinal surgery. This approach in spine surgery in the preoperative phase recommends limiting patient's fasting to 6 h, using a carbohydrate beverage 2 h before surgery, using regional blocks, and planning for discharge and medical care at home.[4] On the other hand, opioids are an essential part of general anesthesia. However, reducing opioid use is an important issue because of its side effects, such as delayed recovery from anesthesia and intervening in a thorough postoperative neurologic examination, unwanted sedation, postoperative nausea and vomiting (PONV), pruritus, urinary retention, respiratory depression, and gastrointestinal dysfunction, all of which could be dangerous.[5] It also increases the risk of drug dependence, which has recently drawn so much attention. Obviously, preventing the progression of dependence will be more successful in saving lives. Early prevention of opioid dependence is possible with less opioid use perioperatively.[6]

Several methods have been proposed to reduce intraoperative anesthetic consumption, including some medications and nerve blocks. Erector Spinae Plane Block (ESPB) was introduced by Forero et al.[7] to control thoracic pain and was rapidly introduced as an alternative method for controlling and reducing pain caused by various pathologies such as post-thoracotomy, major abdominal surgery, breast surgery, and various types of chronic or acute pain in laparoscopy, thoracic, abdominal, breast, shoulder, femor, and spine surgery.[5,8–15] Accordingly, many physicians have used this method for postoperative pain in the abdomen and thoracic surgery.[16] This method is relatively simple and is considered a low-risk and safe method in the current studies.[7] Although its mechanism is still controversial, some believe that ESPB blocks the posterior roots of the spinal nerve and causes para-spinal block by drug release.[17] Moreover, recent studies have shown that the use of ESPB reduces analgesic demand in breast and bariatric surgery, which routinely require huge amounts of opioids as postoperative analgesia.[16]

Although the ESPB has been extensively used in the field of anesthesia in recent years, data on its use during anesthesia and its benefits in different types of surgery are still unclear. We conducted this study to evaluate the effects of this method on the use of anesthetic drugs in lumbar spine surgery.

Material and Methods

Design and Population

The present study was a prospective case-controlled randomized trial that included a total of 70 elective candidates for lumbar posterior spinal fusion of 2 or 3 levels with or without laminectomy or discectomy who visited a tertiary healthcare hospital.

Randomization and Intervention

All enrolled patients met the study inclusion criteria, such as 18–65 year-old adults, classes 1 and 2 of the American Society of Anesthesiologists (ASA), body mass index between 18 and 35 kg/m^2, lack of prior reaction to any of the medications used during the study, and no previous history of opioid addiction or coagulopathies of any kind. In case of increasing the scope of surgery to more than 3 levels, the presence of any sign of infection at the site of injection, the need for total intravenous anesthesia, or opioid use within 6 h before surgery, the candidates were excluded from our study. Patients' characteristics (age and sex) and vital signs (blood pressure and heart rate) were recorded at the time of entrance to the operating room. The visual analog scale (VAS) criteria, from 0 to 10 (0 without pain and 10 the worst pain possible), was explained to the patient to facilitate postoperative pain evaluation.

We randomly assigned patients with a 1:1 aspect ratio to case and control groups employing a computer-based program that follows a random number generator protocol. The patients were categorized into two groups of 35 participants. The participants

were classified via an online calculator at www.calculator.net, and based on the calculator's output; each patient was randomly assigned a number. The control group includes numbers 1 to 35, and the intervention group contains numbers 36 to 70. Further, both groups were the same regarding age and gender distribution.

Standard general anesthesia for all patients in the intervention and control groups was induced using midazolam 0.02 mg/kg, fentanyl 2 µg/kg, sodium thiopental 3–5 mg/kg, and atracurium 0.5 mg/kg while maintained by isoflurane (to achieve BIS of 40–60) in a mixture of oxygen and air (FiO_2: 0.5) and atracurium (according to train-of-four monitoring to maintain surgical relaxation). Following anesthesia induction and change of position to the prone, under sterile conditions, the intervention group received the ESPB nerve block using a 25G×90 mm needle (Dr. J disposable spinal needle, Japan) guided by the SonoSite S-Nerve ultrasound system on both sides. Twenty ml of 0.25% bupivacaine (aspen) was injected into each side by a trained anesthesiologist according to standard guidelines. A 5-8 MHz liner probe was used for proper visualization. After selecting the target transverse process (TP), a sagittal paramedian probe was placed approximately 2 cm outside the spinous process to see the TP in the same direction. The needle was inserted in line according to the probe at 1 or 2 levels cephalad to the surgical level and then advanced caudally until the tip of the needle hits the TP. One to two ml of local anesthetic was injected to visualize and ensure the correct location of the needle before injecting 20 mL of bupivacaine 0.25% at the injection site.

The intraoperative anesthesia regimen was the same between the two groups. The amount of isoflurane was adjusted based on the evaluation of anesthesia depth (maintaining the Bispectral Index [BIS] in the range of 40–60). Doses of fentanyl were given based on the patient's heart rate and blood pressure (in the range of 70–130% of baseline) during the surgery. In addition, an air and oxygen mixture (FiO_2 0.5) was administered with controlled ventilation in both groups. All patients were monitored by electrocardiography, non-invasive and invasive blood pressure, pulse oximetery, capnometry, neuromuscular monitoring, and monitoring of depth of anesthesia (BIS).

Outcomes

The primary outcome was the intraoperative amount of isoflurane and opioids that were recorded. At the end of the operation, 4 mg of ondansetron was given to prevent nausea and vomiting. Muscle relaxation was reversed with intravenous neostigmine 0.05 mg/kg and atropine 0.02 mg/kg. After confirmation of a BIS index above 80, eye-opening, adequate spontaneous breathing, and complete improvement of motor functions, the trachea was extubated. Secondary outcomes included the time from isoflurane closure to endotracheal extubation (emergence time), PONV, postoperative shivering, and postoperative pain. Then, the patient was transferred to the post-anesthesia care unit (PACU). In PACU, the patient was evaluated for nausea, vomiting, and shivering during the 1st h after admission. The nausea score was recorded as zero: no nausea and vomiting; 1: only nausea without vomiting; and 2: having nausea and vomiting. The shivering score was also recorded as: zero: no shivering; 1: fasciculation in the head and neck; 2: obvious tremor in one or more muscle groups; and 3: activity of all muscles of the body. VAS was examined, and in cases of a score of more than 3, he or she was treated with analgesics to reduce the pain score below 3. The amount of analgesics (opioids and non-opioid) was recorded in PACU. The patients who scored higher than 3 in the recovery room were treated with analgesics such as fentanyl, meperidine, morphine, and ketorolac to reduce the pain score below 3.

Statistical Analyses

The collected data were inserted in the statistical package for social sciences, SPSS (version 21, IBM Corporation, Armonk, NY, USA). To describe the data, descriptive statistics, including mean (standard deviation) for quantitative variables, and number (%) for qualitative variables were reported.

Student's t-test was used to compare the mean of parameters in each of the two groups. If necessary, a Mann–Whitney non-parametric test was used. The Chi-square test was also employed to make a comparison between the qualitative variables and qualities for the two groups. Indeed, Fisher's exact test was used if needed. $P<0.05$ was considered statistically significant.

Table 1. Baseline characteristics, surgery time, number of involved spine levels and ASA classification findings of two groups

Variable	Intervention group (n=35)	Control group (n=30)	p
Sex (male/female)	18 (51.4%) / 17 (48.6%)	14 (46.7%) / 16 (53.3%)	0.702
Age (year)	50.06±10.42	52.13±12.33	0.465
Weight (Kg)	77.40±11.00	74.93±10.25	0.356
American Society of Anaesthesiologist Classification (ASA Class)			0.968
I	22 (62.9%)	19 (63.3%)	
II	13 (31.7%)	11 (36.7%)	
Surgery time (minutes)	151.86±37.26	159.50±37.68	0.353
Number of operated spine levels			0.878
2	18 (51.4%)	16 (53.3%)	
3	17 (48.6%)	14 (46.7%)	

Values are mean±SD (or SEM); SD: Standard deviation.

Sample Size Justification

According to the information from a pilot study, the mean intraoperative fentanyl consumption in the control group was 140±77.2 µg (SD=26.5 in the treatment group). The sample size required for detecting a 30% difference in total fentanyl consumption between the two groups with the power of 80% and α = 5% was determined to be at least 30 patients in each group.

Oversight

The present study was registered at irct.ir with a registration number of IRCT20210415050983N1. Likewise, it was approved by the institutional review board of Vice-Chancellor in Research Affairs-Shahid Beheshti University of Medical Sciences and won the approval of the Ethical Committee (IR.SBMU.RETECH.REC.1400.281). Indeed, it should be noted that written informed consent was obtained from all the participants in the study. This research met the Ethical Principles for Medical Research Involving Human Subjects, outlined in the Helsinki Declaration of 1975 (revised 2013).

Results

Patients

Subjects' enrollment in the trial was started by including eligible patients. 70 subjects were assigned to randomly undergo either general anesthesia only (n=35) or general anesthesia plus ESPB (n=35). After the exclusion of five patients whose operation was extended to more than three levels, a total of 65 patients were analyzed. The participants' mean age was 50.06±10.42 and 52.13±12.33 years in the case and control groups, respectively (p=0.46). Table 1 shows baseline characteristics, surgery time, number of involved spine levels, and ASA classification findings for two groups. There were not any significant differences between the two groups when comparing demographic data.

Clinical Efficacy end Points

The use of fentanyl and isoflurane in the case group was significantly lower than the control group (p<0.001). The emergence time from the time of discontinuation of inhalational anesthesia to extubation was 8.49±4.30 and 15.00±4.94 minutes in the case and control groups, respectively, and the difference was statistically significant between the two groups (p<0.001). Furthermore, the pain scores in PACU 1 h after surgery were recorded in the patients, which in the intervention group were significantly lower than the controls, the details of which can be seen in Table 2.

Patients in the two groups were compared in terms of shivering, nausea and vomiting, and duration of hospitalization; there was no significant difference comparing all three variables (Table 3).

Discussion

The number of lumbar spine surgeries is increasing worldwide.[1] Perioperative intravenous opioid use impose the patients to side effects such as PONV, delayed emergence, and reduced patient satisfaction.

Table 2. Intraoperative fentanyl and isoflurane consumption, emergence time, and pain score of patients during post-anesthesia care admission in two groups

Variables	Intervention group (n=35)	Control group (n=30)	p
Intraoperative fentanyl consumption (µg	14.29±21.25	73.33±65.96	<0.001
Intraoperative isoflurane consumption (ml)	20.71±5.02	28.83±8.68	<0.001
Emergence time (min)	8.49±4.30	15.00±4.94	<0.001
Pain score in PACU (0–10)	2.60±1.85	4.53±1.48	<0.001

Values are mean±SD (or SEM); PACU: Post anaesthesia care unit; SD: Standard deviation.

Table 3. Shivering score, nausea and vomiting score and duration of hospitalization

Variables	Intervention group (n=35)	Control group (n=30)	p
Shivering (0–3)	0.26±0.50	0.10±0.31	0.163
Nausea and vomiting (0–2)	0.34±0.68	0.60±0.81	0.145
Duration of hospitalization (days)	3.03±1.01	3.43±1.28	0.206

Quantitative variables were expressed as mean±standard deviation and qualitative variables were expressed as number (percentage). Shivering score: zero: no shivering, 1: fasciculation in the head and neck, 2: obvious tremor in one or more muscle groups, and 3: activity of all muscles of the body. Nausea and vomiting score: zero: No nausea and vomiting, 1: only nausea without vomiting and 2: having nausea and vomiting. Values are mean±SD (or SEM); SD: Standard deviation.

The well-known epidural technique for postoperative analgesia causes hypotension and urinary retention.[16] Peripheral nerve blocks are getting more favorable as a pain control method. In the present study, by examining the effect of ESPB on lumbar vertebral surgeries, we found that this technique reduces the intraoperative use of fentanyl and isoflurane and significantly reduces the time to emergence. Decreased emergence time could be translated into accelerated operating room turnover and decreased costs. There was also less PONV and length of hospital stay with this technique, although this difference was not significant. Since our hospital is a referral center for spine surgery, some of the patients admitted from long distant centers, that makes the patients follow-up a difficult task; therefore, surgeons tend to postpone the hospital discharge and have considerations for patients discharge rather than other well-known criteria such as postoperative analgesia.

Regional anesthesia techniques have benefits such as improved hemodynamic stability during the operation, a better postoperative pain score, and reduced demand for analgesia in the postoperative period. Reducing the use of analgesics leads to fewer associated side effects. In addition, the use of ultrasound to perform regional anesthesia has increased the safety of this technique. On the other hand, in neurosurgery, maintaining a stable cerebral and spinal blood pressure is one of the most important considerations, which depends on maintaining hemodynamic stability and changes in pain intensity in different stages of surgery. In the face of these concerns, maintaining general anesthesia with inhaled or intravenous drugs has been a traditional method of anesthesia for neurosurgery patients.[18] As mentioned, the major benefits of regional anesthesia plus general anesthesia for spinal surgery include hemodynamic stability, reduced postoperative pain, decreased incidence of opioid adverse effects, and reduced postoperative analgesia use.[19] Epidural analgesia is the most common regional technique for postoperative analgesia in lumbar spine surgery, but catheters may interfere in surgery. Furthermore, if an injury occurs to dura matter during surgery, there is a possibility of intrathecal penetration of local anesthesia, which could be complicated by further undesirable events such as extreme elevation in the motor and autonomic block level or neurotoxicity.[20,21]

The ESPB is a fascial plane block performed by injection of local anesthesia into the fascial plane deep into the erector spina muscle (ESM), affecting the dorsal and ventral branches of the primary dorsal root. ESM consists of the muscles of the spinalis, longissimus thoracis, and iliocostalis, which stabilize

the spine. They extend bilaterally from the skull to the sacral region longitudinally and from the spinus process to the TP to the ribs horizontally. The main purpose of performing ESPB is local anesthetic deposition at a fascial level at the depth of the ESM in the target vertebral TP.[22]

This block is performed after induction of anesthesia, when the patient's position has been changed to the prone position, although it can also be performed in the sitting or lateral decubitus position. Like most other blocks, this block is performed under ultrasound guidance and aseptic conditions. One of the advantages of this block is the ease of ultrasound guidance and less complication compared to the paravertebral block and its alternatives. Multiple injections, epidural, intrathecal, or intravascular injections, and nerve injury are potential adverse events that are more prevalent in paravertebral blocks than ESPB.

ESPB was just recently introduced to anesthesia practice by Forero in 2016.[7] In this regard, in 2016 and 2017, several case reports on the clinical use of this technique were published, and interesting results were reported by researchers.[23] In 2019, Lee et al.[24] examined the effect of the Serratus Plane block with general anesthesia in VATS (video thoracoscopic lobectomy) surgery and found that the use of the regional block could reduce intraoperative opioid use. They suggested this block as a safe and effective method for VATS surgery. A comparative interventional study was done by Tulgar et al.[2] on patients who underwent laparoscopic cholecystectomy. The results of that study were consistent with the present study, in which the costs and amounts of remifentanil, sevoflurane, and tramadol use in patients undergoing ESPB with general anesthesia were lower than in those who underwent general anesthesia alone without any regional block. Indeed, Leong et al.[25] investigated the efficacy of ESPB in breast surgery, and by reviewing 13 randomized controlled trials, they found that this block is more effective than general anesthesia alone at decreasing postoperative opioid use and pain scores 24 h after operation. In another novel systematic review study, twelve randomized control trials consisting of 590 patients were evaluated in 2020 to investigate the effect of ultrasound-guided ESPB on postoperative analgesia.[26] Finally, they found it to be the most effective way to reduce postoperative pain under general anesthesia. In a newly published study, Lonnqvist et al.[27] mentioned ESPB as a method that makes inter-pleural nerve blockade an obsolete technique and forecasted that it will be renamed the rest of the Peace II block in the future.

Various studies evaluated ESPB for postoperative analgesia in patients undergoing elective lumbar surgery and concluded that postoperative pain scores decreased, as well as the need for 24 h postoperative analgesia. The satisfaction scores in the ESP group of patients were much longer and more desirable. In this retrospective study, it was concluded that ESPB provides more effective analgesia for patients undergoing lumbar laminoplasty, which lasts until the morning of the second post-operative day.[28]

In line with the mentioned studies, in the present study, we showed that ultrasound-guided ESPB, combined with general anesthesia, significantly reduced intraoperative opioid (fentanyl) and hypnotic (isoflurane) use and decreased the emergence time compared to general anesthesia alone in patients undergoing lumbar spine surgery. It also reduced the pain score in PACU and thus reduced the use of analgesics. There were no block-related complications such as local anesthesia poisoning, bleeding, or infection.

There are several case reports of lumbar ESPB use in lumbar spine surgeries that combine ESPB with interfascial thoracolumbar block (TLIP) for perioperative pain control after lumbar laminectomy, which was beneficial and effective.[29] Another study reported a modified lumbar ESPB injection using a combination of lidocaine and ropivacaine to achieve a rapid onset of action[30] and ensure enough blockade at the commencement of surgery, thus avoiding the need for intraoperative analgesic supplementation with opioids. Additionally, in a retrospective study, the efficacy of classical lumbar ESPB in lumbar microendoscopic surgery plus multimodal analgesia (20 mL of 0.25% bupivacaine per side, total 40 mL) was evaluated and concluded to reduce the need for analgesics in the first 24 h and increase the quality of analgesia compared to the control group.[18,31]

Limitations

We focused on intraoperative anesthetic consumption as the primary goal, although it might be affected by other understudied variants as well. Our study was limited to patients without uncompensated respiratory or cardiac diseases, whereas many patients undergoing spinal fusion are suffering from these disorders, and this type of block might affect them distinctively. The postoperative effect of such intervention on hemodynamic variables should be followed at later time intervals.

Although a handful of studies have assessed the effectiveness of this technique in recent years, intraoperative medication use has not been thoroughly studied. Different types and doses of medications with or without adjuvants are yet to be studied as well. We also recommend further assessment of other types of surgeries to be held. Extreme age groups could also be another interesting field to explore.

Conclusion

Eventually, we showed that preoperative ESPB under ultrasound guidance reduces intraoperative hypnotic or opioid use and emergence time in lumbar spine surgery. 1-h pain scores are also reduced in PACU due to the continuation of the analgesic effect of the block. Therefore, ultrasound-guided ESPB can be an effective method of anesthesia and analgesia in lumbar spine surgery.

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Ethics Committee Approval: The Shahid Beheshti University of Medical Sciences Clinical Research Ethics Committee granted approval for this study (date: 15.08.2021, number: IR.SBMU.RETECH.REC.1400.281).

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