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Original Article

Benefits of Erector Spinae Block in Lumbar Vertebral Surgical Fixation Procedures: Beyond the Perioperative Analgesic Outcomes

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BACKGROUND: The incidence of chronic pain, or failed back surgery syndrome (FBSS), is common after spinal fixation operations. Proper control of acute perioperative pain is thought to decrease its transition to chronic one. Erector spinae (ES) block is a recent paraspinal technique that proved its efficacy after spinal surgery.

OBJECTIVE: We aimed to evaluate the effects of ES block on perioperative, short-term and intermediate-term outcomes in patients undergoing spinal fixation procedures.

PATIENTS AND METHODS: This prospective randomized controlled study included 124 patients in each of the included two groups; the ES block group and the control group. The former group underwent an ultrasound-guided ES block before surgery. Our main outcome was the functional outcomes along with the incidence of FBSS. Secondary outcomes included operative parameters, perioperative analgesic profile, and patient satisfaction.

RESULTS: All preoperative variables were statistically comparable between the two groups. Although fixation levels did not differ between the two groups, operative time, intraoperative isoflurane consumption, and intraoperative blood loss showed a significant decline in association with the ES block. The same group showed a significant decline in postoperative pain scores, less opioid consumption, and longer time for rescue analgesics. At follow-up, the incidence of FBSS was lower in the ES block group, and these patients had improved functional scores that were statistically significant.

CONCLUSION: The beneficial perioperative effects of preemptive ES block were reflected on short-term and intermediate-term chronic pain incidence, which in turn was manifested by improved functional scores.

KEYWORDS: Chronic pain, Erector spinae block, Failed back surgery syndrome, Spinal fixation.

INTRODUCTION

The prevalence of patients with degenerative spinal disorders has been increasing,[1,2] and some of this population requires surgical intervention.[2] Postoperative pain, which is usually severe after such interventions, delays patient mobilization which hinders their recovery.[3,4] It was previously reported that improper pain management during the early postoperative period following spinal surgery increases the risk of chronic postoperative pain. This, in turn, negatively affects patients' quality of life.[2,5]

Most anesthesiologists prefer to use epidural analgesia or patient-controlled analgesia (PCA) to manage pain after these operations. Nevertheless, each of the two techniques has its own drawbacks.[1,6] Opioids added to the PCA can induce undesirable gastrointestinal side effects and decrease patient recovery,[7] along with the high financial cost of the device and the injectate.[8,9] Neuraxial blocks are associated with an increased risk of hypotension, urine retention, dural puncture, infection, and hematoma.[2,10]

The introduction of paraneuraxial nerve blocks has been widely accepted in the field of pain management because of its analgesic efficacy and safer profile.[11] Erector spinae (ES) block is a recently adopted paraspinal fascial block technique. This method was published in 2016 by Forero and his coworkers.[12] Its efficacy has been confirmed in breast,[13] thoracic,[14] abdominal,[15] and lumbosacral spinal operations.[16] In this analgesic technique, the local anesthetic agent is injected into the plane between the transverse spinal processes and the adjacent erector spinae muscle.[12] This block is characterized by its simplicity when performed under ultrasound (US) guidance, with minimal risk for pleural or thecal injury. The autonomic block associated with the epidural technique is greatly decreased with ES block.[17]

We hypothesized that proper perioperative analgesia provided by the ES block might have a beneficial impact on the occurrence of chronic postoperative pain, manifested by failed back surgery syndrome (FBSS),[18] and its associated postoperative functional outcomes. Herein, the main objective of our study was to evaluate

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the effects of ES block not only on perioperative outcomes but also on the short-term and intermediate-term outcomes.

PATIENTS AND METHODS

The current prospective randomized controlled study was conducted in the neurosurgery departments in collaboration with the anesthesia, critical care, and pain management departments of both Helwan and Tanta Universities. The study was conducted over the period of three years, from January 2019 to December 2021, after obtaining ethical approval from the local scientific committee (institutional review board (IRB) code: REC-FMHU 32-2023). The study was designed for adult patients diagnosed with degenerative lumbosacral spine disease (spondylolisthesis or multiple level spinal canal stenosis with overlapping or jacked facets) who underwent surgical fixation during the previous period.

The required sample size was calculated via the Power Analysis & Sample Size (PASS) software program for windows, with the incidence of FBSS as the primary outcome. To the best of our knowledge, based on intensive literature research, no previous study has addressed this issue in a prospective manner. An effect size of 0.4 (moderate effect size) was set as the target effect size. In order to achieve 80% power and 0.05 significance level, a minimal sample size of 99 patients was needed in each group. As 25 patients were expected to be dropped at follow-up, a total of 124 patients were included in each group.

All patients were properly assessed before surgery. This included history taking, clinical examination, preoperative laboratory investigations, and lumbosacral magnetic resonance imaging (MRI). Patients were also evaluated and classified according to the American Society of Anesthesiologists (ASA).[19] Patients with a recent history of trauma, uncontrolled systemic comorbidities, bleeding diathesis, malignancy, previous back surgery, or major psychiatric illness were excluded. Patients who developed surgical complications after surgery were also excluded. The included participants were randomly allocated into two groups, using the sealed envelope method, the ES group included 124 patients who received preoperative ES block, and the control group included the remaining 124 patients who did not receive that intervention.

Before surgery, all patients had signed an informed consent after a simple explanation of the benefits and possible complications of the surgical approach and pain management protocols. The participants were also informed how to express their pain via the visual analogue scale (VAS) 0 – 10 scale.[20] The participants were admitted to the ward the night before surgery, and they were transferred to the operative theater the next morning. After attaching basic hemodynamic monitoring, an 18-gauge cannula was inserted into a peripheral vein in the ventral arm. Two milligrams (mg) of intravenous (IV) midazolam were commenced for preoperative sedation. All surgeries were performed under general anesthesia, which was induced by IV propofol (2 mg/kilogram (kg)) and fentanyl (2 microgram/kg) when the patient was in the supine position. Atracurium (0.5 mg/kg) was given to help with endotracheal intubation. Anesthesia was maintained by isoflurane, 50% air, and 50% oxygen. The patient was then turned to the prone position.

The ES block group received the ultrasound-guided block before the surgical incision, using Toshiba US device (Xario 100, Toshiba company, Minato, Tokyo, Japan) and its linear probe. After proper skin sterilization, the probe was longitudinally placed 3 centimeters lateral to the midline at the level of the third lumbar vertebrae. The transverse spinous processes and erector spinae muscle were identified. Using the in-plane technique **(Fig. 1),** a sonovisible needle was inserted in a craniocaudal direction until its tip reached the proper injection plane located between the transverse spinous process and the erector spinae muscle deep fascia. About 20 milliliters (ml) of the injectate was injected through that plane, and distension of the correct plane by the injecting fluid was noticed by the aid of the US. The mixture included 15 ml of bupivacaine 0.25%, 2 ml of dexamethasone 8 mg, 1 ml of epinephrine 1:100000, and 2 ml of normal saline. The same procedure was repeated on the other side with the same injectate. The block procedure was omitted in the control group.

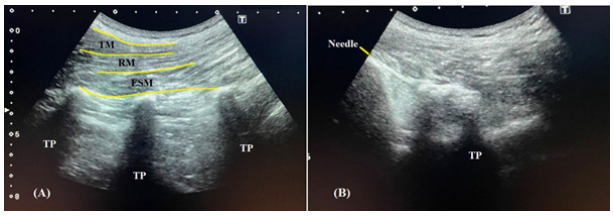

Fig 1: A: Ultrasonographic view before block installation, B: Ultrasonographic view after installation of the block into the erector spinae plane. (ESM: Erector spinae muscle. RM: Rhomboid muscle. TM: Trapezius muscle. TP: Transverse process).

The surgical operation was performed by the neurosurgical authors via the standard technique of fixation **(Fig. 2).** The level of fixation differed according to disease nature and surgical expertise. At the end of surgery, anesthesia was antagonized by neostigmine and atropine. The duration of operation, intraoperative blood loss, and total isoflurane consumption were recorded. The amount of blood loss was estimated by adding the blood amount in the suction jar to the added weight of the used gauzes and dressings. The amount of washing saline was considered, and every 1 gram added to the preoperative weight was considered equivalent to 1 ml of blood.[21] Total isoflurane consumption was estimated using the multifas analyzer.

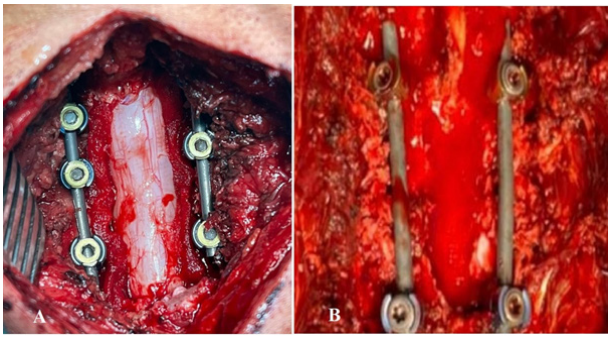

Fig 2: A: Intraoperative photographs showing nearly bloodless field in the erector spinae group as compared to. B: bloody field in controls.

After the operation, the patients were transferred to the post-anesthesia care unit (PACU) and then to the internal ward, where frequent monitoring was done. In both groups, analgesia was maintained via IV acetaminophen (1 gram/8 hours) and ketorolac (30 mg/12 hours). The VAS was recorded at PACU, then every 2 hours during the initial 12 hours after surgery, then after 24 hours. If the patient reported a breakthrough pain (VAS > 4), it was managed by IV incremental morphine (3 mg per dose, which was repeated every 30 minutes until desirable or side effects occurred). The time interval before the first analgesic request and the total analgesic consumption was calculated for each group. Before discharge, patients were asked to report their satisfaction with their pain management protocol on a five-point Likert scale (Excellent, very good, good, fair, or poor).[22]

After stitch removal, follow-up visits were scheduled at 3, 6, and 12 months after surgery. During these visits, clinical and radiological (if required) assessment of the cases was done **(Fig. 3).** Patients were asked to express their disability associated with postoperative low back pain via the Oswestry Disability Index (ODI),[23] and these values were recorded during these visits. The incidence of FBSS was also recorded. It was defined as low back pain of unknown etiology that appears at the same topographic location following the surgical intervention for spinal pain. This also included patients with persisting pain despite surgery.[24] The main outcome of this study was functional outcomes after ES block, along with the incidence of FBSS. Secondary outcomes included operative parameters, perioperative analgesic profile, and patient satisfaction.

We used the Statistical Packages for the Social Sciences (SPSS) software program for the statistical analysis of the collected data. The Kolmogrov-Smirnov test was used to test data for normality. Normally distributed quantitative data were expressed as mean (and standard deviation), while categorical data were presented as frequency (and percentages). The student t-test and Chi-square test were used to compare two groups of quantitative and categorical data, respectively. A p-value less than 0.05 was considered statistically significant.

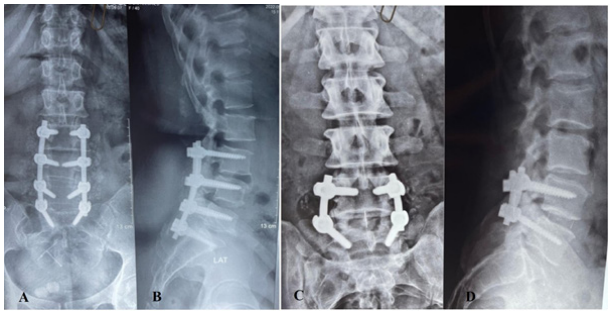

Fig 3: A & B: Postoperative anteroposterior and lateral views plain radiography showing L3 to S1 fixation system. C & D: Postoperative anteroposterior and lateral views plain radiography showing L4, 5 fixation system with interbody cage in place.

RESULTS

No dropouts were encountered in our study, and all patients fulfilled their one-year follow-up. All preoperative patient criteria were statistically comparable between the two groups **(Table 1)**. The included patients in the ES and control groups had mean ages of 56.19 and 54.68 years, respectively. Males constituted 48.4% and 54% of patients in the same two groups, respectively. They had mean body mass index (BMI) values of 32.03 and 32.05 in the same groups, respectively. Regarding their ASA class, most cases had an ASA class I (66.9% and 69.4% of cases in the same two groups, respectively), and the remaining cases had ASA class II.

The level of fixation did not differ between our two groups, and the majority of cases had either one-level or two-level fixation procedures ($p = 0.357$). However, operative time, intraoperative isoflurane consumption, and intraoperative blood loss showed a significant decline in association with the ES block **(Table 2).** Most hemodynamic parameters were statistically comparable between the two groups. Nonetheless, the ES group showed lower heart rate readings during the operation compared to controls **(Fig. 4).**

The ES group expressed significantly lower pain scores after the operation compared to controls, and that was evident during PACU admission and continued for 10 hours after the operation ($p < 0.05$). The subsequent readings were comparable between the two groups **(Table 3).** As shown in **Table 4** the time to the first analgesic request showed a significant prolongation in the ES group (5.97 hours versus 1.92 hours in controls – $p < 0.001$). In addition, total opioid consumption was markedly decreased in the same block group (7.19 mg versus 9.99 mg in controls – $p < 0.001$). Patient satisfaction showed marked improvement in the ES group ($p < 0.001$).

The ES group expressed lower ODI values at the scheduled follow-up visits compared to controls. This indicates better postoperative functional outcomes in the ES group. FBSS was detected in 16.1% and 27.4% of patients in the ES and control groups, respectively, with a significant decline in the ES group ($P = 0.031$) **(Table 5).**

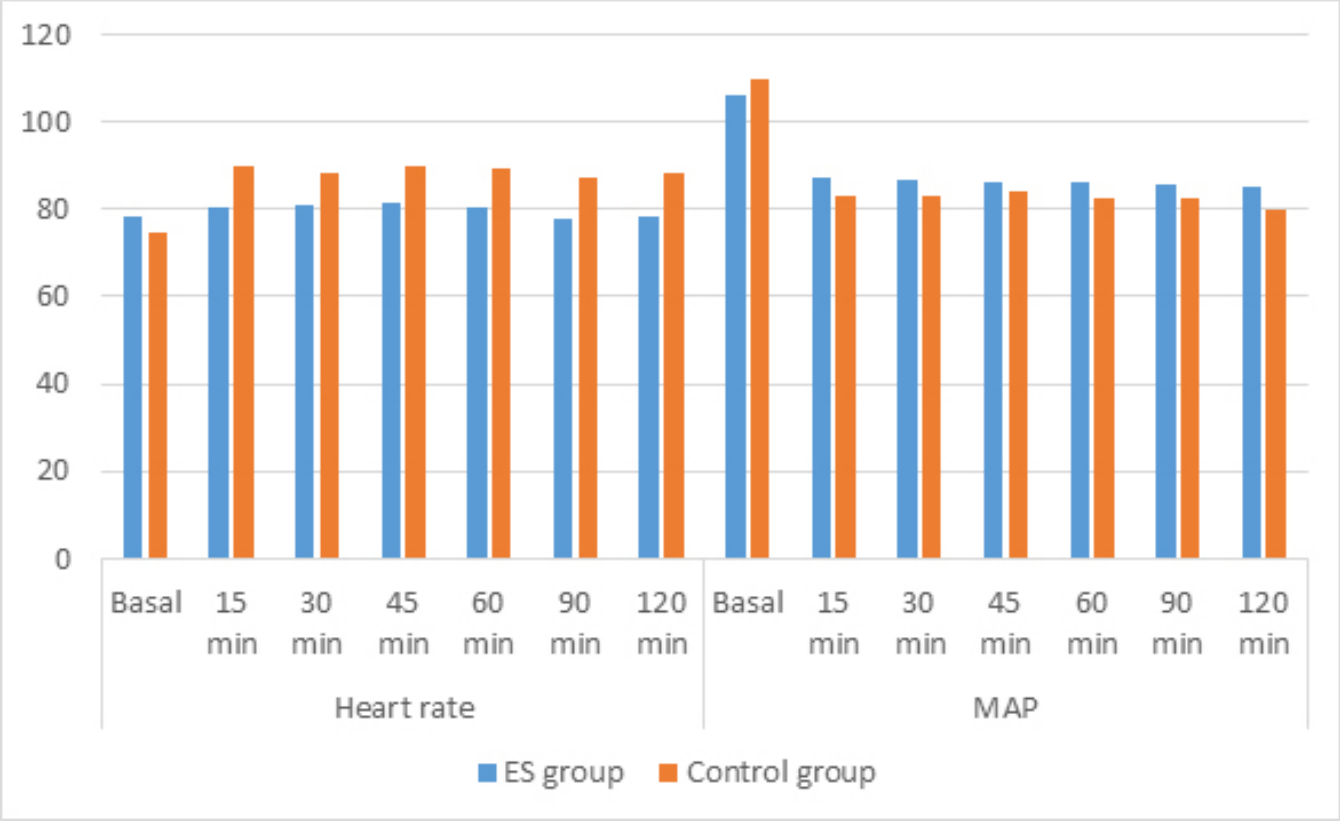

Fig 4: Hemodynamic changes in the two study groups. (ES: erector spinae, MAP: mean arterial pressure).

Table 1: Patient characteristics in the two study groups

		ES group (n= 124)	Control group (n= 124)	P
Age (years)		56.19 ± 6.003	54.68 ± 6.140	0.052
Gender	Male	60 (48.4%)	67 (54.0%)	0.374
	Female	64 (51.6%)	57 (46.0%)	
BMI (kg/m²)		32.0350 ± 3.614	32.0554 ± 2.579	0.959
ASA	1	83 (66.9%)	86 (69.4%)	0.683
	2	41 (33.1%)	38 (30.6%)	

ES: Erector spinae, n: Number, BMI: Body mass index, ASA: American Society of Anesthesiologists.

Table 2: Operative data of the two study groups

		ES group (n= 124)	Control group (n= 124)	95% CI	P
Duration of surgery (minutes)		133.91 ± 28.702	141.90 ± 20.900	-14.3, - 1.7	**0.013**
Isoflurane consumption (ml)		86.29 ± 14.509	93.06 ± 19.262	-11.0, -2.5	**0.002**
Bleeding (ml)		619.76 ± 102.572	664.11 ± 138.306	-74.8, -13.9	**0.004**
Fixation level	One level	61 (49.2%)	52 (41.9%)		0.357
	Two levels	58 (46.8%)	63 (50.8%)		
	Three levels	5 (4.0%)	9 (7.3%)		

ES: Erector spinae, n: Number, CI: Confidence interval, ml: Milliliter.

Table 3: Postoperative pain scores in the two study groups

VAS	ES group (n= 124)	Control group (n= 124)	95% CI	P
PACU	2.30 ± 1.119	3.32 ± 0.727	-1.3, -0.8	< 0.001
2 hours	2.35 ± 0.937	4.56 ± 1.038	-2.5, -2.0	< 0.001
4 hours	2.75 ± 0.925	4.38 ± 1.166	-1.9, -1.4	< 0.001
6 hours	3.52 ± 1.024	4.06 ± 1.114	-0.8, -0.3	< 0.001
8 hours	3.51 ± 1.078	3.94 ± 1.128	-0.7, -0.2	0.002
10 hours	3.39 ± 1.110	3.85 ± 1.223	-0.8, -0.2	0.002
12 hours	3.36 ± 1.107	3.65 ± 1.282	-0.6, 0.0	0.057
24 hours	3.26 ± 1.043	3.14 ± 1.650	-0.2, 0.5	0.491

VAS: Visual analogue scale, ES: Erector spinae, n: Number, CI: Confidence interval, PACU: Post-anesthesia care unit.

Table 4: First analgesic request and total opioid consumption in the two study groups

		ES group (n= 124)	Control group (n= 124)	95% CI	P
The first request for analgesia (hours)		5.97 ± 3.651	1.92 ± 2.438	3.3, 4.8	< 0.001
Morphine (mg)		7.19 ± 2.321	9.99 ± 3.240	-3.5, - 2.1	< 0.001
Satisfaction	Poor	0 (0.0%)	6 (4.8%)	-	< 0.001
	Fair	1 (0.8%)	16 (12.9%)		
	Good	17 (13.7%)	52 (41.9%)		
	Very good	88 (71.0%)	43 (34.7%)		
	Excellent	18 (14.5%)	7 (5.6%)		

ES: Erector spinae, n: Number, CI: Confidence interval, mg: Milligram.

Table 5: Oswestry Disability Index and incidence of failed back surgery syndrome

		ES group (n= 124)	Control group (n= 124)	95% CI, Odds ratio	P
ODI	Three months	5.81 ± 6.602	8.09 ± 7.893	-4.1, -0.5	0.015
	Six months	6.45 ± 7.402	8.83 ± 8.532	-4.4, -0.4	0.020
	One year	6.97 ± 7.987	9.84 ± 9.747	-5.1, -0.6	0.012
FBSS		20 (16.1%)	34 (27.4%)	1.94	0.031

ES: Erector spinae, n: Number, CI: Confidence interval, ODI: Oswestry Disability Index, FBSS: Failed back surgery syndrome.

DISCUSSION

Management of postoperative pain following spinal surgery is often a challenging problem. Pain sensation is usually severe after these operations, and if not properly managed, it increases postoperative morbidity, delays patient recovery, and increases the risk of chronic pain syndromes.[25,26] In the current study, we hypothesized that good perioperative pain control would have a significant beneficial impact on delayed postoperative outcomes. Our two groups showed comparable statistical findings regarding all preoperative variables, which is a sign of proper randomization. This should also nullify any bias skewing our findings in favor of one group rather than the other.

We preferred to install the block procedure before surgery as we believe in the concept of "preemptive analgesia",[27] which prevents the occurrence of central sensitization triggered by the surgical trauma and its associated stress response.[28,29] It also decreases postoperative hyperalgesia and allodynia.[30,31] We also prefer to install the mixture before distortion of the normal anatomical planes induced by surgery. Furthermore, the decreased isoflurane consumption in the block group, which is indicative of a better analgesic profile, is believed advantageous for patient recovery together with decreased healthcare costs.[32] Nonetheless, these two variables were not assessed in our study and need to be investigated in the upcoming ones.

We found that preoperative installation of the injecting mixture was associated with a significant decrease in intraoperative blood loss and operative time. The former could be explained by two facts; installation of the mixture into the proper plane helped to make the dissection plane clear for the operating surgeon. Even the authors noticed a thin rim of fluid when reaching that plane. The second explanation is the effect of epinephrine added to the injected mixture, which is known to have a strong vasoconstrictor effect via acting on adrenergic alpha-receptors.[33] Of course, the previous advantages should have their benefit on total operative time. One should also mention that adding epinephrine was not

associated with any systemic adverse events, and the ES group expressed lower hemodynamic variables compared to controls during the operation, indicating better analgesia.

Regarding the analgesic parameters handled in our study, the application of ES block was associated with a significant decline in postoperative pain scores, less opioid consumption, and a longer time for rescue analgesia. This, in turn, was reflected in patient satisfaction level, which was significantly improved in the block group. The analgesic effects of ES block could be explained by the block of both dorsal and ventral spinal nerve rami when injecting the anesthetic agent in the proper plane. It is also believed that the injected local anesthetic agent could spread to the epidural space, which explains its efficacy in controlling both parietal and visceral pain.[12,25,34] Another point to be considered is that erector spinae comprises a complex group of muscles and tendons along the cervical, thoracic, and lumbar vertebral regions. This helps in the craniocaudal spread of the local anesthetic leading to providing analgesia to multiple dermatomes above and below the level of injection.[17,35]

Our findings agreed with those of Yayik and his colleagues where the block group showed better pain scores during the initial 24 hours after surgery during rest and movement. The first rescue analgesia was needed after 325.17 and 174.17 minutes in the block and control groups, respectively ($p < 0.001$).[25] Additionally, Singh et al. reported lower pain scores, lower need for post-operative morphine, and a longer time to requesting rescue analgesics in the ES block group. Only 45% of the ES block group required morphine compared to 100% of controls.[17] Furthermore, Beltrame and his associates also reported similar results in their recent randomized trial, but they included patients who underwent lumbosacral operations without fixation. The ES block group showed superior pain relief, with significantly lower pain scores compared to controls for the first seven hours following the surgery. Subsequently, opioid consumption, immobilization episodes, and hospitalization period decreased in the same group.[36] All of the previous studies confirmed the analgesic efficacy of the ES block technique in spinal operations, which is in the same context as our findings.

Zhao et al. concluded that the application of ES block was associated with a marked decline in postoperative narcotic consumption after thoracoscopic surgery, and that helped to decrease postoperative cognitive dysfunction in such patients.[37]

In our study, we found that the application of ES block in the perioperative period might have a potential beneficial impact on short-term and intermediate-term chronic pain and functional outcomes. The incidence of FBSS was significantly decreased in the block group, and consequently, functional scores were significantly improved. Of course, chronic postoperative pain is an annoying complaint that definitely affects patients' social and physical activities.[38,39] Hence, its proper prevention and management are crucial for both neurosurgeons and pain clinicians.

The incidence of chronic pain, or FBSS, after spinal surgery, is not low, as it ranges between 10% and 40% following spinal operations.[40,41] The management of this problem is challenging, so its prevention would be more appropriate. Proper management of acute postoperative pain is believed to be effective against the previous problem. Improper perioperative pain management is believed to induce sensitization of the central nervous system, which is a crucial element incriminated in the occurrence of chronic postoperative pain.[42] Therefore, decreasing nociceptive inputs to the nervous system via regional blocks, like ES block, will help to decrease this complication, as noticed in our study.

Although no previous study has evaluated such a perspective after spinal fixation, the same concept was already confirmed by numerous studies after different procedures. These studies have shown that proper control of acute perioperative pain led to a significant decline in the incidence of chronic postoperative pain following mammary,[43] thoracic,[44] abdominal,[45] and cranial procedures.[46]

Although our study included considerable sample size and handled a unique research point in the field of neurosurgery, it lacks long-term follow-up. More studies, including more cases from different neurosurgical centers, need to be conducted in the near future.

CONCLUSION

Based on the previous findings, ES block is associated with shorter operative time, lower anesthetic consumption, less intraoperative blood loss, and lower postoperative pain scores. The beneficial perioperative effects of preemptive ES block were reflected on short-term and intermediate-term chronic pain incidence, which in turn was manifested by improved functional scores. This block should be encouraged in the spinal fixation practice.

List of abbreviations

ASA: American Society of Anesthesiologists.
BMI: Body mass index.
ES: Erector spinae.
ESM: Erector spinae muscle.
FBSS: Failed back surgery syndrome.
IRB: Institutional review board.
IV: Intravenous.
Kg: Kilogram.
Mg: Milligram.
Ml: Milliliter.
MRI: Magnetic resonance imaging.
ODI: Oswestry disability index.
PACU: Post-anesthesia care unit.
PASS: Power Analysis & Sample Size.
PCA: Patient-controlled analgesia.

RM: Rhomboid muscle.
SPSS: Statistical Packages for the Social Sciences.
TM: Trapezius muscle.
TP: Transverse process.
US: Ultrasound.
VAS: Visual analogue scale.

Disclosure

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