

# Ultrasound-Guided Erector Spinae Plane Block for Lumbar Spinal Stenosis Surgery

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## Abstract

**Background:** In this retrospective observational study, we evaluated patients who underwent elective lumbar stenosis surgery between February 1, 2019, and April 1, 2019. Patients who underwent surgery for lumbar spinal stenosis under general anesthesia alone were compared with those who underwent general anesthesia combined with erector spinae plane block. **Aims:** We aimed to retrospectively evaluate whether erector spinae plane block reduced opioid consumption following surgery for spinal stenosis. **Study Design:** A retrospective observational study. **Methods:** We collected data on the pain scores, time for the first requirement for patient-controlled analgesia with tramadol, the cumulative patient-controlled analgesia dose, requirement for rescue analgesia, time to first stand up postoperatively and the incidence of postoperative nausea and vomiting. **Results:** Sixty patients were included in the study. The numerical rating scale's pain scores were significantly lower in the erector spinae plane group at 1, 2, 4, 6, 12 and 24 hours than in the general anesthesia group. The cumulative dose of patient-controlled analgesia with tramadol was higher in the general anesthesia group than in the ESP group [212.0 (6.6) mg, vs. 107.3 (36.9) mg), ( $p < 0.001$ )]. The time to first stand up after surgery was significantly longer in the general anesthesia group ( $p = 0.011$ ). **Conclusion:** ESP block appear to be an effective method to relieve pain after lumbar surgery.

## Keywords

Erector Spinae Plane Block, Ultrasound Guidance, Lumbar Surgery, Regional Anesthesia

## 1. Introduction

Lumbar spinal stenosis surgery may be performed using different techniques and incurs a cost of approximately 1.65 billion dollars per year in the USA. It is a complicated surgical procedure that leads to significant postoperative pain and adequate analgesia requirement [1]. Lumbar spine surgery may lead to prolonged hospital stay with progression from acute to chronic pain [2]. Adequate postoperative pain relief is essential as patients may already be suffering from chronic pain [3]. Intravenous opioids may be used for postoperative pain relief; however, the relatively high dose required may lead to complications, including nausea, vomiting, respiratory depression, and delirium [4]. Surgeons do not prefer epidural anesthesia as it involves injection at the operative site [5].

Erector Spinae Plane block (ESP) was first described in 2016 by Forero *et al.* for the treatment of thoracic neuropathic pain [6]. It is safer than the paravertebral block and avoids complications, including pneumothorax [7]. Several recent case reports have described novel indications for ESP block [8] [9] [10] [11] [12]. Several retrospective studies and prospective, randomized, controlled trials have also been published [7] [13]-[18].

The exact mechanism of action of the ESP block remains unclear. Spread of local anesthetics thorough ventral and dorsal rami of spinal nerves [6] [19] [20] or into the paravertebral space has been suggested. Recent cadaveric and magnetic resonance imaging studies also reported conflicting results [20] [21] [22].

Therefore, we aimed to retrospectively evaluate whether erector spinae plane block reduced opioid consumption following surgery for spinal stenosis.

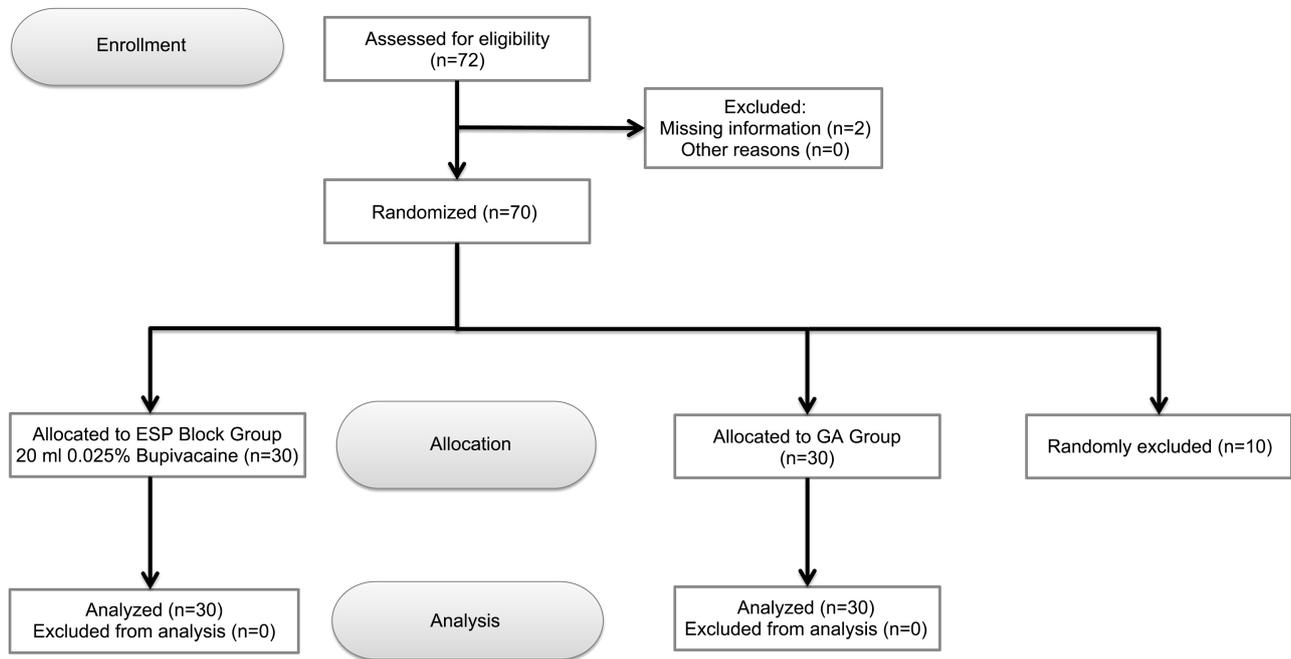
## 2. Materials & Methods

Approval was obtained from Namık Kemal University ethics committee with the protocol number 2019.197.10.18, dated October 30, 2019. The study was conducted under the Consolidated Trial (CONSORT) statement and the Helsinki Declaration (Figure 1).

### 2.1. Study Design

This retrospective observational study of a historical cohort was conducted in a university hospital. The ethics committee of the university approved the study design as a retrospective review of patient records. The medical records of patients who underwent lumbar spinal stenosis surgery between February 1, 2019, and April 1, 2019, were reviewed by a resident who was not involved with the study. Patients with American Society of Anesthesiologist (ASA) physical status I-II, aged 18-65, underwent elective lumbar spinal stenosis surgery and received patient-controlled analgesia (PCA) postoperative pain relief were included in the study. Patients with missing data were excluded from the study.

Lumbar spinal stenosis surgery is performed in our clinic by a single surgical team, and General Anesthesia (GA) is routinely carried out. Information about ESP block is provided to all patients with no contraindications for the procedure



**Figure 1.** Consolidated Standards of Reporting Trials (CONSORT) diagram. ESP, Erector Spinae Plane Block. GA, General Anesthesia.

during the preoperative visit. The block is performed under GA just before the commencement of surgery after obtaining written informed consent. PCA with tramadol is prepared as part of the postoperative analgesia protocol regardless of the block's performance. Postoperative pain management is routinely followed up and documented in patients who receive PCA.

We collected demographic and surgical information, such as age, gender, height, weight, body mass index, surgery duration, and anesthesia. Clinical information such as the Visual Analog Score (VAS) in the Post-Anesthesia Care Unit (PACU), time to the first requirement for PCA, the total tramadol dose administered by PCA, the requirement for rescue analgesia, the time taken to stand up for the first time after the surgery, and the incidence of Postoperative Nausea and Vomiting (PONV) were obtained from patient records.

## 2.2. Patient Groups

We enrolled patients who underwent lumbar spinal stenosis surgery between February 1st, 2019, and April 1st, 2019. After reviewing archived files, patients who underwent GA were included in the "GA group"; patients who had GA combined with ESP block were included in the "ESP Group." All information was collected from patient records from the file archive of our clinic.

## 2.3. Anesthetic Technique

GA was administered to all the patients. The patients were monitored with 3-channel electrocardiography, non-invasive blood pressure, peripheral oxygen saturation, and Bi-Spectral index (BIS) in the operating room. After obtaining

intravenous access, an infusion of normal saline was commenced. After 3 minutes of pre-oxygenation with 100% oxygen, anesthesia was induced intravenously with 2 - 3 mg/kg of propofol, one mcg/kg of fentanyl, and 0.6 mg/kg of rocuronium. After ensuring adequate muscle relaxation, orotracheal intubation was carried out by an experienced anesthesiologist. Anesthesia was maintained with 1% - 2% sevoflurane in 4 L of 40%:60% O<sub>2</sub> and air mixture. An infusion of remifentanyl was commenced at 0.1 - 2 mcg/kg/min after intubation until skin closure. Intravenous ondansetron, 4 mg was administered for PONV, and 20 mg tenoxicam was administered for preemptive analgesia. The concentrations of sevoflurane and remifentanyl were set to a target BIS level between 40 and 60. Intravenous rocuronium was administered in a dose of 0.1 mg/kg to maintain adequate muscle relaxation. After skin closure, all anesthetic agents' administration was ceased, and neuromuscular blockade was reversed with 0.01 mg/kg atropine and 0.04 mg/kg neostigmine intravenously once the patient started breathing spontaneously.

Following successful extubation, patients were transferred to the Post-Anesthesia Care Unit (PACU) for continued monitoring. Supplemental oxygen was administered at 2 L/min through an oxygen mask for 20 - 30 minutes. Patients with a nine or more score on the modified Aldrete score were discharged from the unit to the surgical ward after 30 minutes.

#### **2.4. Application of Block**

Patients were carefully placed in the prone position after induction of anesthesia, before the commencement of surgery. All necessary precautions were taken to avoid complications involving the prone position after anesthesia induction with continued orotracheal intubation. We used an ultrasound machine with a high-frequency (1 - 8 MHz) convex probe. After aseptic preparation, the ultrasound probe was first placed in a cephalo-caudal orientation at the mean surgical level's spinous process. It was then moved laterally to one side by 3 cm. The sono-anatomic landmarks, including the erector spinae muscles and the transverse process at the block's predetermined level, were identified. A 100-mm 21-gauge needle was inserted using an in-plane technique in a cephalo-caudal direction under real-time ultrasound guidance. After confirming the position of the tip of the needle over the transverse process by hydrolocalization with 2 - 3 ml isotonic saline solution, 20 ml 0.25% bupivacaine was injected. The spread of local anesthetic in a plane below the erector spinae muscle was visualized. The procedure was repeated on the contralateral side. The surgical procedure was commenced after the completion of the block. In patients who did not consent for the block, surgery was carried out under general anesthesia alone. None of our patients experienced any complications related to regional or general anesthesia.

#### **2.5. Evaluation of Pain**

Evaluation of postoperative pain was commenced in the PACU and continued in the surgical ward using the 11-point Numerical Rating Scale (NRS). The NRS is

a segmented, numeric version of the visual analog scale with scores ranging from 0 to 10, with 0 representing “no pain” and ten indicating “the worst pain imaginable”. Pain scores were recorded by one of the researchers at 30 min (in the PACU), and 1, 2, 4, 6, 12, and 24 hours postoperatively according to our post-operative pain management protocol.

## **2.6. Routine Analgesia Protocol and Rescue Analgesia**

Intravenous PCA was administered to all patients with a solution of 3 mg/ml of tramadol (300 mg tramadol mixed in 100 ml isotonic saline). The bolus dose was set at 20 mg with a lockout period of 20 minutes, with no background infusion. PCA was commenced in the PACU and continued for at least 24 hours in the surgical ward. Rescue analgesia was administered as follows: 1 g paracetamol intravenously if the VAS score was four and above, and 50 mg meperidine intravenously if it persisted after 1 hour.

## **2.7. Outcome Measures**

The study outcomes included the total postoperative tramadol consumption in the first 24 hours and the NRS scores in the PACU and at 1, 2, 4, 6, 12, and 24 hours postoperatively. The incidence of postoperative nausea and vomiting and the requirement of rescue analgesia were also evaluated.

## **2.8. Sample Size**

The sample size was calculated using G\*Power 3.1.9.3 for the Mac program based on previous studies found in the literature. A reduction in tramadol consumption by at least 30% in the 24-hour postoperative period was considered clinically significant. Assuming an alpha error = 0.05 with a power of 80%, we calculated a minimum sample size of 28 patients in each group.

## **2.9. Statistical Analysis**

Descriptive data are presented as numbers and percentages for categorical variables; continuous variables are expressed as mean (SD) or median (IQR). The normality test was performed for continuous variables using the Kolmogorov Smirnov test. We analyzed data including age, gender, height, weight, BMI, duration of anesthesia and surgery, duration of stay in the PACU, time to the first dose of PCA, the total PCA dose, and the time taken to stand up for the first time after surgery. The Pearson Chi-square test was used to analyze categorical variables per data type and distribution. The independent samples t-test was used for normally distributed variables; the Mann Whitney U test was used for variables that were not normally distributed. All analyses were performed using R-3.6.0 (for Windows. The R-project for statistical computing) and Jamovi project (2018) Jamovi (Version 0.9.6.9) [Computer Software] (Retrieved from <https://www.jamovi.org>). A p-value of less than 0.05 was considered statistically significant.

### 3. Results

Patients who underwent elective lumbar stenosis surgery between February 1st, 2019, and April 1st, 2019 were enrolled in the study. We obtained records of 62 patients who met the inclusion criteria from the file archive. Two patients with missing data were excluded.

Comparing the demographic and clinical characteristics of patients in the ESP and the GA groups is presented in **Table 1** and **Table 2**. Age, gender, weight, and BMI levels were similar between both groups ( $p > 0.05$  for each, **Table 1**). Patients in the GA group were significantly taller than those in the ESP group ( $p = 0.029$ ).

**Table 1.** Demographic and operational features according to groups.

	Group		P
	ESP (n = 30)	GA (n = 30)	
<b>Age (years)</b>	53.7 ± 9.9	55.1 ± 10.1	0.59 <sup>†</sup>
<b>Sex (%)</b>			
Male	11 (36.7)	16 (53.3)	0.299 <sup>‡</sup>
Female	19 (63.3)	14 (46.7)	
<b>Height (cm)</b>	167.9 ± 6.8	172.4 ± 8.6	<b>0.029<sup>†</sup></b>
<b>Weight (kg)</b>	81.7 ± 12.9	82.8 ± 11.6	0.730 <sup>†</sup>
<b>BMI (kg/m<sup>2</sup>)</b>	28.7 ± 4.8	27.6 ± 3.3	0.294 <sup>†</sup>
<b>Anesthesia Duration (minutes)</b>	173.2 ± 49.5	202.8 ± 57.1	<b>0.036<sup>†</sup></b>
<b>Surgery Duration (minutes)</b>	132.4 ± 45.4	163.0 ± 53.0	<b>0.020<sup>†</sup></b>

ESP: Erector Spinae Plane; GA: General Anesthesia; Descriptive statistics were given as mean ± standard deviation, median [IQR] and frequency (%); <sup>†</sup>Independent samples t test; <sup>‡</sup>Chi-square test.

**Table 2.** Clinical features according to groups.

	Group		P
	ESP (n = 30)	GA (n = 30)	
<b>PACU VAS Score (median [IQR])</b>	3.5 [3.0. 4.8]	6.0 [5.2. 7.0]	<b>&lt;0.001*</b>
<b>First PCA requirement Time (hours)</b>	4.0 [1.2. 10.5]	1.0 [1.0. 1.0]	<b>&lt;0.001*</b>
<b>Total Tramadol Based PCA Dose (mg)</b>	107.3 ± 36.9	212.0 ± 26.6	<b>&lt;0.001<sup>†</sup></b>
<b>Rescue Analgesic Requirement Count</b>	0.73	3.66	
<b>First Stand-up Time (hours)</b>	20.3 ± 4.1	23.7 ± 5.9	<b>0.011<sup>†</sup></b>
<b>PONV</b>	0	0	<b>N/A</b>

ESP: Erector Spinae Plane, GA: General Anesthesia, PACU: Post Anesthesia Care Unit, VAS: Visual Analog Scale, PCA: Patient Controlled Analgesia, PONV: Post-operative Nausea and Vomiting; Descriptive statistics were given as mean ± standard deviation, median [IQR] and frequency (%); \*Mann-Whitney U test; <sup>†</sup>Independent samples t test.

The duration of anesthesia ( $p = 0.036$ ) and surgery and ( $p = 0.020$ ) was significantly longer in patients in the GA compared to the ESP group. The Median VAS score in the PACU was higher in the GA group ( $p < 0.001$ ), and the median time for the first dose of PCA was less in the GA group ( $p < 0.001$ ). The mean cumulative PCA dose of tramadol was 212.0 (6.6) mg in the GA group compared to 107.3 (36.9) mg in the ESP group ( $p < 0.001$ ). The time to first stand up after surgery was significantly longer in the GA group ( $p = 0.011$ ).

Overall, 83.4% ( $n = 50$ ) of the patients were operated on in L3, L4, and L5 levels (L3-4, L3-4-5, L4-5). Further, 51.7% ( $n = 31$ ) of the patients were operated on two vertebral levels, and 48.3% ( $n = 29$ ) were operated on three levels. The patients' surgical levels are summarized in **Table 3**.

The VAS scores among patients in the ESP group were lower at 1, 2, 4, 6, and 12 hours compared to the GA group (**Table 4**). VAS scores according to groups are presented in **Figure 2**.

**Table 3.** Patients' surgical levels.

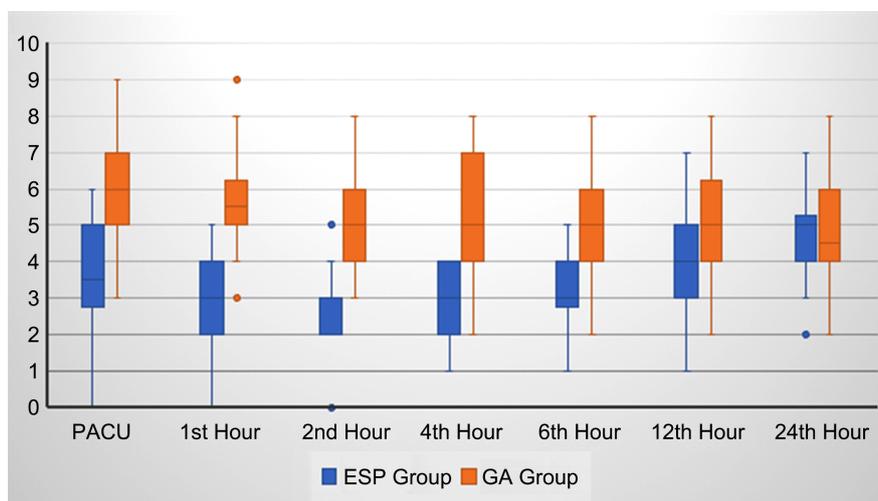
Surgical Level	n (%)
L2-3	3 (5)
L2-3-4	6 (10)
L3-4	3 (5)
L3-4-5	22 (36.7)
L4-5	25 (41.7)
L4-5 S1	1 (1.7)
Total	60 (100)

Descriptive statistics were given as frequency (%).

**Table 4.** Variation of time dependent visual analog scale scores.

VAS	Group		p
	ESP (n = 30)	GA (n = 30)	
1 <sup>st</sup> Hour	3 [2 - 4]	5.5 [5 - 6]	<0.001*
2 <sup>nd</sup> Hour	3 [2 - 3]	5 [4 - 6]	
4 <sup>th</sup> Hour	3 [2 - 4]	5 [4 - 7]	
6 <sup>th</sup> Hour	3 [3 - 4]	5 [4 - 6]	
12 <sup>th</sup> Hour	4 [3 - 5]	5 [4 - 6]	
24 <sup>th</sup> Hour	5 [4 - 5]	4.5 [4 - 6]	

ESP: Erector Spinae Plane, GA: General Anesthesia, VAS: Visual Analog Scale; Descriptive statistics were given as median [IQR]. \*Mann-Whitney U test.



**Figure 2.** Visual Analog Scale scores according to groups. X-axis, postoperative hours, PACU (Post Anesthesia Care Unit) Y-axis, VAS: Visual Analog Scale score.

#### 4. Discussion

This study evaluates the use of ultrasound-guided erector spinae plane block in providing postoperative analgesia after spine surgery. We found that the use of ultrasound-guided erector spinae plane block results in a significant reduction in postoperative opioid consumption and contributes significantly to pain relief.

Spinal surgery is associated with significant postoperative pain. Optimization of postoperative pain management is an essential consideration for the anesthesiologist [23]. Appropriate postoperative pain management is also associated with fewer postoperative complications and reduced hospital stay length [24].

Reducing opioid-based analgesia requirement is recommended to provide adequate postoperative analgesia with fewer side effects, including postoperative nausea and vomiting, respiratory depression, and hypotension [25] [26].

Regional anesthetic techniques, including epidural anesthesia, have been used to overcome postoperative pain after spinal surgery besides intravenous analgesic infusions [24] [27] [28] [29]. Central neuraxial blockade has been abandoned, and plane blocks under ultrasound guidance, including paravertebral block, ESP block, and thoracolumbar interfascial plane block have become more popular and performed more often [14] [30] [31] [32].

ESP block is currently popular and is used in routine anesthetic practice for spine surgery, cholecystectomy, gastric hernia repair, mastectomy, thoracotomy, analgesia for rib fractures, and treatment herpes zoster pain [15] [33] [34] [35] [36].

Several case reports, case series, and retrospective and prospective studies have recently been published confirming ESP block's postoperative analgesic effect following spine surgery [2] [5] [14] [31] [32] [37].

We aimed to retrospectively evaluate whether ESP block reduced opioid consumption following surgery for spinal stenosis. We preferred to perform the block after induction of GA under ultrasound guidance before the commence-

ment of surgery. Patients were placed in the prone position with the trunk slightly flexed. We used an infusion of remifentanyl and tenoxicam as part of multimodal analgesia after induction of GA, enabling surgery commencement soon after performing the block. Melvin *et al.* performed bilateral single shot and continuous ESP blocks under general anesthesia between the T10 and T12 levels for spine surgery and reported that ESP block provided adequate postoperative opioid-sparing analgesia [2].

Chaudhary *et al.* performed ESP block in three patients before induction of general anesthesia and inserted bilateral catheters at the T10 level for postoperative pain management after lumbar spine surgery [5]. As bilateral single injection ESP block provides adequate analgesia, we preferred not to insert a catheter due to difficulties in localizing the catheter tip and avoiding infection-related complications.

Singh *et al.* performed bilateral ESP block for lumbar spine surgery to evaluate patient satisfaction and morphine consumption postoperatively [38]. Due to side effects related to morphine, we preferred PCA with tramadol to maintain postoperative analgesia. Independent of the type of opioid used as PCA, ESP block provides adequate analgesia and patient satisfaction following lumbar spine surgery.

Ueshima *et al.* performed ESP block for lumbar spine surgery to evaluate the efficacy of postoperative analgesia. Postoperative fentanyl consumption was significantly less with ESP block with the injection of 20 ml of 0.375% levobupivacaine to each side.

Considering previous reports, we performed a bilateral ESP block with 20 ml 0.25% bupivacaine to each side under general anesthesia. Intraoperative analgesia was accomplished with remifentanyl infusion combined with tenoxicam. We aimed to demonstrate a reduction in PCA tramadol consumption with ESP block.

Like our study, Yayik *et al.* performed a bilateral ESP block with 20 ml of 0.25% bupivacaine for the ESP group (n = 30) and compared the analgesic effect with a control group. There was no difference in the incidence of PONV between groups in this study. The PCA regimen used by the investigators was similar. A mean cumulative tramadol PCA dose of 268.33 (71.44) mg was reported in this study, compared to 107.3 (36.9) mg in our study.

The studies by Yayik *et al.* and Singh *et al.* may be among the first randomized controlled studies that evaluated ESP block's efficacy in lumbar spine surgery. Consistent with our study's findings, both these studies reported a reduction in postoperative opioid consumption following ESP block.

ESP block is being reported in a wide range of surgical procedures to provide adequate postoperative analgesia. After lumbar spine surgery, postoperative analgesia is one of the reported indications in recently published prospective randomized controlled studies. Controlled studies using ESP block are limited by the need for placebo injections, the inability to confirm dermatomal levels, and the

requirement for large volumes of local anesthetic solution. Further prospective studies with a larger sample size are required to confirm ESP block's efficacy for postoperative analgesia after spine surgery.

## 5. Conclusion

The ESP block provides a practical postoperative analgesic effect for 24 hours in patients undergoing lumbar spinal stenosis surgery and reduced opioid consumption.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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