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Bilateral continuous erector spinae plane block for cardiac surgery: case series

Bloqueo bilateral continuo del plano erector de la espina para cirugía cardiaca: serie de casos

Iván Fernando Quintero-Cifuentes[a,b], Juan Camilo Clement[c], Gustavo A. Cruz-Suárez[a,b], Katheryne Chaparro-Mendoza[a,b], Alejandra Holguín-Noreña[b], María A. Vélez-Esquivia[b]

[a] Fundación Valle del Lili, Department of Anesthesiology. Cali, Colombia.
[b] Universidad Icesi, School of Health Sciences, Department of Anesthesiology. Cali, Colombia.
[c] Universidad ICESI, School of Health Sciences. Cali, Colombia.

Correspondence: Fundación Valle del Lili, carrera 98 No. 18-49, Cali, Colombia. **Email:** ivanquint@gmail.com

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Abstract

Multimodal analgesia in cardiac surgery sternotomy includes bilateral continuous erector spinae plane block (BC-ESPB). However, the effectiveness of the local anesthetic regimens is still uncertain. The purpose of this study was to assess pain control achieved with a multimodal analgesia regimen including BC-ESPB at the level of T5 with PCA with a 0.125 % bupivacaine infusion and rescue boluses. This is a descriptive case series study which recruited 11 adult patients undergoing cardiac surgery through sternotomy in whom multimodal analgesia including BC-ESPB was used, between February and April 2021, at a fourth level institution. All patients reported pain according to the numeric rating scale (NRS) ≤ 3 both at rest and in motion, at extubation and then 4 and 12 hours after surgery. After 24 hours the pain was NRS ≤ 3 in 100 % of the patients at rest and in 63.6 % in motion. At 48 h 81 % of the patients reported pain NRS ≤ 3 at rest and in motion. At 72h all patients reported pain NRS ≤ 3 at rest and 82 % in motion. The average intraoperative use of fentanyl was 2.35 µg/kg and postoperative hydromorphone was 5.3, 4.1 and 3.3 mg at 24, 48 and 72 hours, respectively. Hence, bilateral ESP block in continuous infusion plus rescue boluses allows for proper control of acute intra and post-operative pain.

Key words: Regional anesthesia; Heart surgery; Sternotomy; Erector spinae plane block; Postoperative pain; Anesthesiology.

Resumen

En cirugía cardiaca mediante esternotomía, la analgesia multimodal incluye el bloqueo bilateral continuo del plano erector de la espina (BBC-ESP). Sin embargo, existe incertidumbre sobre la efectividad de los esquemas de dosificación del anestésico local. Se busca evaluar el control del dolor proporcionado por un esquema de analgesia multimodal que incluye el BBC-ESP a la altura de T5 con ACP de bupivacaína 0,125 % en infusión y bolos de rescate.
Se trata de un estudio descriptivo, serie de casos. Se reclutaron 11 pacientes adultos sometidos a cirugía cardiaca mediante esternotomía en quienes se usó analgesia multimodal que incluía BBC-ESP, entre febrero y abril del 2021, en una institución de cuarto nivel. Todos los pacientes refirieron dolor, según la escala numérica (EN) ≤ 3 tanto en reposo como en movimiento, a la extubación, a las 4 y a las 12 horas. A las 24 horas el dolor fue EN ≤ 3 en el 100 % de los pacientes en reposo y en el 63,6 % en movimiento. A las 48 h el 81 % de los pacientes refirieron dolor EN ≤ 3 en reposo y en movimiento. A las 72 h todos los pacientes presentaron dolor EN ≤ 3 en reposo y 82 % en movimiento. El consumo intraoperatorio promedio de fentanilo fue de 2,35 µg/kg y de hidromorfona posoperatoria de 5,3, 4,1 y 3,3 mg a las 24, 48 y 72 horas. Así, el BBC-ESP en infusión continua más bolos de rescate permiten el control del dolor agudo intra y posoperatorio.

Palabras clave: Cirugía cardiaca; Esternotomía; Bloqueo plano erector de la espina; Dolor posoperatorio; Serie de casos; Anestesiología.

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INTRODUCTION

Postoperative pain management, in addition to relieving patient's suffering, is essential to reduce morbidity, length of stay and hospital costs. (1) The perception depends on multiple factors such as the site, extension and severity of the surgical trauma, preoperative anxiety and analgesic techniques used. (2) Furthermore, postoperative pain is associated with cardiovascular and pulmonary complications, poor response to surgical trauma, delirium, chronic pain and persistent use of opioids. (2)

Regional analgesia is essential in perioperative pain management (3), and it is recommended by the ERAS (Enhanced Recovery After Surgery) program in heart surgery to reduce the use of opioids and decrease its side effects. (1,4) Different regional anesthesia techniques have been studied, whether as single dose or via continued infusion catheters, for surgery with sternotomy; these include epidural analgesia (5), paravertebral (6) and interfascial plane blocks such as the Erector Spinae Plane Block (ESP) and parasternal blocks, inter alia. (4,7,8) All of these techniques have shown analgesic benefits and limitations or relevant considerations. For instance, epidural analgesia is associated with hypotension, urinary retention, epidural hematoma, motor block, dura mater rupture, and may also be affected by anti-aggregation or anticoagulation. (9,10) The paravertebral block is operator-dependent and variable with regards to the ultrasound visualization of the anatomic structures, with a high risk of developing pneumothorax and a lack of conclusive evidence about its safety in terms of intra and post-operative anticoagulation. (4,10) Parasternal blocks—such as the pecto-intercostal block or the transversus thoracic plane block, facilitate pain control but do have limitations in terms of the duration of analgesia and of the limited sensitive block area. (11-13) Consequently, regional analgesia with bilateral continuous erector spine plane block (BC-ESPB) represents an alternative because of its analgesic effect similar to paravertebral block (14), provides improved safety by limiting the invasion to the neuroaxis in patients that will be anticoagulated (15), is easy to perform under ultrasound guidance and allows for placement of catheters for continuous analgesia.

The BC-ESPB with catheter for continuous analgesia, although was initially described for thoracic surgery and breast surgery (16,17) in sternotomy approaches, has shown adequate postoperative pain control, decreased opioid use, favors early mobilization and exhibits less adverse effects and complications as compared to the other techniques discussed. (1,14,18-20) However, the information in the literature varies with regards to programming of continuous analgesia regimens with local anesthetic agents through catheters, describing the use of ropivacaine or bupivacaine in intermittent automatic boluses or as a continuous infusion during the first 48 hours. (1,14,20) This study assessed postoperative pain control in patients undergoing cardiac surgery through sternotomy, who received a multimodal analgesia regimen including BC-ESPB at the level of T5, with catheter-based continuous infusion and rescue boluses of 0.125 % bupivacaine.

METHOD

Scenario and data collection

This is a case series study with prospectively collected information, which recruited adult patients undergoing cardiac surgery through sternotomy, who received a multimodal analgesia strategy including BC-ESPB in continuous infusion plus 0.125% bupivacaine rescue boluses, between February and April 2021, at Fundación Valle del Lili, a fourth level university hospital in Cali, Colombia. The data were prospectively collected and were complemented with the patients' medical record review. The study was approved by the Ethics in Biomedical Research Committee of Fundación Valle del Lili, under minutes N.° 09, dated April 25, 2022.

Patients and follow-up

All of the adult – over 18 years old – patients who underwent cardiac surgery through sternotomy were included; the patients received multimodal analgesia including BC-ESPB in continuous infusion plus rescue boluses. Patients with chronic pain, mini-sternotomy approach, emergency surgery and/or reintervention, history of neurological and/or cognitive disfunction, severe liver failure, body weight < 40 kg, or with any contraindication for BC-ESPB were excluded.

The relevant demographic and clinical information was recorded; the informed consent was signed and a multimodal analgesic management as described hereunder was administered. The ESP catheter insertion was conducted by cardiovascular anesthesiologists, pursuant to a standardized technique as described in this section.

Anesthetic technique

The patients were premedicated with 1 g of oral acetaminophen 2 hours prior to the induction of anesthesia, or 1 gram of intraoperative IV acetaminophen, balanced general anesthesia with remifentanil and/or fentanyl; opioids were used as needed by the patient, in accordance with the vital signs and the depth of the anesthesia. Inhaled halogenated anesthetic was also administered to achieve a BIS 40-60 goal, neuromuscular block with rocuronium or cisatracurium, dexmedetomidine at a dose of 0.2-0.5 µg/kg/h in the intraoperative period. Analgesia at the end of the procedure with dipyrone at a dose of 20 mg/kg IV, ketamine 10-15 mg/kg IV, antiemetic prophylaxis with ondansetron 4 mg IV, monitoring of the neuromuscular block at the end of surgery to ensure TOF (train of

four) > 90 %, with a view to extubating the patient in the operating room (ultra-fast track) or during the first 6 hours following the end of surgery (fast-track).

Regional BC-ESPN analgesia technique

PCA via catheters: At the beginning of the anesthesia and before surgery, under general anesthesia, the patient was placed in lateral decubitus and the dorsal region was washed with chlorhexidine soap. The block plane was localized using a previously disinfected and coated ultrasound probe. The erector spinae plane was localized at the level of T5-T6, positioning the probe in a paramedial sagittal orientation, approximately 2 cm from the midline (spinous processes) and visualizing the transverse process. The catheter needle was inserted in plane, in a cephalic orientation; when the erector spinae block space was identified, the space was hydro dissected to leave a pocket on each side with ten mL of saline solution and an E-Cath® Pajunk or Contiplex® S Ultra 360 B. Braun catheter was inserted, at a depth of at least 3 cm inside the space, and the catheter was fixed. This procedure was repeated on the opposite side. Twenty minutes after the catheters were inserted, 20 mL of 0.375 % levobupivacaine were administered on each side. Then 0.125% bupivacaine was initiated on each side with an 8 mL/h infusion if the patient's body weight was between 40 and 80 kg or 10 mL/h if the body weight exceeded 80 kg; all the rescue boluses were 5 mL on each side, with a minimum safety interval between boluses of 1 hour.

Table 1. Demographic characteristics of the surgical procedure and of the postoperative period.

Variable	(n, %)
Age, years Average (range)	74 (65-89)
Sex, n (%) - Male - Female	 9 (81 %) 2 (19 %)
Race, n (%) - Mestizo - Caucasian	 10 (91 %) 1 (9 %)
Body Mass Index Median (range)	25.9 (21.5-30.8)
History	
High blood pressure, n (%)	8 (72.7 %)
Diabetes mellitus, n (%)	2 (18.1 %)
Chronic kidney disease, n (%)	2 (18.1 %)
Hypothyroidism, n (%)	6 (54.5 %)
Dyslipidemia, n (%)	2 (18.1 %)
Characteristics of the procedure	
Surgical procedure conducted, n (%) - Myocardial revascularization - Valve replacement	 7 (63.6 %) 4 (36.3 %)
Duration of myocardial ischemia, minutes Median (range)	50 (0-93)
Extracorporeal circulation time, minutes Median (range)	68 (0-112)
Intraoperative fentanyl, micrograms Median (range)	2.35 (0-4.7)
Characteristics of the postoperative period	
Use of hydromorphone, milligrams Median (range) - Total - In 12-24 hours - In 24-48 hours - In 48-72 hours	 13.2 (0-50) 5.6 (0-17) 4.1 (0-11) 3.3 (0-23)
Duration of the mechanical ventilation, minutes Median (range)	111 (10-360)
ICU length of stay, days Media (range)	3 (2-5)
Hospital length of stay, days Median (range)	7 (5-13)
Postoperative delirium	1 (9 %)
Postoperative nausea	4 (36.25 %)
Postoperative vomiting	2 (18.1 %)
Complication Puncture site ecchymosis	 1 (9 %)

Source: Authors.

Pain assessment

Prior to the induction of anesthesia, each patient was educated on the pain assessment method using a pain numeric rating scale (NRS) of 11 points, ranging from 0 to 10 in intensity. In order to assess the pain in motion, the patient was asked to raise or rotate the upper extremities. A NRS of ≤ 3 points was considered as controlled pain. To assess pain in patients experiencing delirium, the Pain Assessment in Advanced Dementia Scale (PAINAD) was used.

Postoperative multimodal analgesia

500 mg acetaminophen at an oral dose of 1 gr every 6 hours was used, dipyrone 20 mg/kg IV every 8 hours, and a rescue IV dose of 0.4 mg hydromorphone only if pain was ≥ 4 in the NRS.

Table 2. Postoperative pain assessment.

Patient	1	2	3	4	5	6	7	8	9	10	11
Pain at extubarion, NRS-P - At rest - In motion	6 6	0 3	0 0	0 0	0 0	0 0	0 0	0 2	0 0	0 0	3 3
Pain at 4 hours, NRS-P - At rest - In motion	2 2	0 2	0 0	0 0	0 0	0 0	0 0	0 0	1 0	0 2	3 3
Pain at 12 hours, NRS-P - At rest - In motion	2 3	0 0	0 1	1 1	2 2	0 0	0 0	2 2	0 0	0 2	2 2
Pain at 24 hours, NRS-P - At rest - In motion	0 0	0 0	0 1	0 2	3 3	0 0	0 0	0 2	0 4	0 4	2 2
Pain at 48 hours, NRS-P - At rest - In motion	0 0	0 2	0 0	0 2	0 1	0 0	0 0	4 7	0 2	0 0	2 2
Pain at 72 hours, NRS-P - At rest - In motion	1 1	0 2	0 0	1 2	0 0	0 0	0 0	2 5	0 0	0 0	1 2

NRS-P: Numerical rate scale pain. **Source:** Authors.

RESULTS

Eleven patients aged between 65 and 89 years were included, of which 9 were males with a mean BMI of 24.9 kg/m2. All patients underwent cardiovascular surgery through sternotomy, 7 of them underwent myocardial revascularization, and 4 valve surgery. The most frequent pre-existing pathologies included hypertension 72.7 %, diabetes 18.1 % and chronic kidney disease 18.1 %.

During the intraoperative period, 9 of 11 patients required extracorporeal circulation and aortic cross-clamping, with an average time for extracorporeal circulation of 68 minutes and of 50 minutes for ischemia. In terms of PCA, an average of 6 boluses per day (3 on each side) of 0.125% bupivacaine were administered. The use of intraoperative fentanyl was in average 2.35 µg/kg, ranging from 0 to 4.35 µg/kg, in addition to an average of 111 minutes of postoperative mechanical ventilation, with subsequent successful extubation in all patients. The average ICU stay was 3 days, with a total hospital stay of 7 days in average. Table 1 summarizes the clinical and demographic characteristics of the study group, as well as the specifics of the surgical intervention and the postoperative period.

Only one patient experienced an episode of psychomotor agitation and delirium. The adverse symptoms included 4 patients with nausea, 2 of which led to emesis. With regards to block-associated complications, only one case of bilateral ecchymosis was identified on the catheter insertion sites, but this event was spontaneously resolved with no further complications. Moreover, a patient died on the fifth day after surgery due to a new acute myocardial infarction (Table 1).

With regards to postoperative pain, all patients reported controlled pain (NRS-P ≤ 3) at the time of extubation, both at rest as in motion, at 4 and 12 hours after extubation. After 24 hours, NRS pain was ≤ 3 in 100 % of the patients assessed at rest and in 63.6 % in motion; the remaining 36.4 % presented NRS pain of 4. At 48 hours, 81 % of the patients reported NRS pain ≤ 3 at rest and in motion. At 72 hours, 100 % of the patients reported NRS pain ≤ 3 at rest and 82 % in motion, the remaining 19 % reported NRS pain between 5 and 7. Table 2 depicts the postoperative pain assessment.

The use of hydromorphone rescue doses (Table 1) was recorded during the first 72 hours, with the following findings: in the first 12-24 hours, 9 of 11 patients required rescue doses with an average of 5.6 mg total dose. In the following 24 h, 7 of 11 patients required rescue doses with an average of 4.1 mg, and in the last 24 hours of follow-up, only 5 patients required rescue doses with an average of 3.3 mg.

DISCUSSION

The acute pain control of patients during the first 72 hours after surgery was satisfactory. Acute pain, both at rest as in motion of the upper limbs during the first 24, 48 and 72 hours was milder, usually NRS-P ≤ 3, which is similar to the reports in other studies (1,14) and case series (20) of patients receiving BC-ESPB, but administered as a local anesthetic infusion with no on demand boluses. Similarly, these results confirm the reports of comparative studies with groups of patients that did not receive regional anesthesia, evidencing that there is a significant postoperative pain improvement and a considerable reduction in opioid use when administering the ESP block, whether as a single dose (18,21) or as a continuous infusion via catheters. (1)

This study showed a very low use of intraoperative fentanyl — average of 2.3 µg/

kg—, which is consistent with the literature indicating that regional analgesia with BC-ESPB reduces the use of opioids during both the intraoperative and postoperative periods (1,10,20); this favors the opioid-sparing strategy recommended by the ERAS guidelines in cardiac surgery. (22,23)

With regards to the postoperative use of opioids, the average consumption recorded was 5.6 mg of IV hydromorphone over the first 24 hours, which is equivalent to 284 µg of intravenous fentanyl; this data is comparable with the study by Athar et al., using in average 225 µg of fentanyl during the first 24 hours postoperatively. However, Macaire et al. (1) and Muñoz-Leyva et al. (20) reported zero use of opioids during the infusion of local anesthetic, which differs from the findings herein described.

Moreover, although Macaire et al. (1) were unable to document a significant difference in the mobility of patients receiving BC-ESPB in contrast with patients receiving the traditional analgesia, this study shows that pain in motion of the upper extremities in patients with BC-ESPB is usually below 3 in the numerical rating pain scale, which may help in the rehabilitation process and early mobility of patients.

The current scientific literature in cardiac surgery is quite diverse in terms of the local anesthetic and its ESP block administration regimens: use of ropivacaine or bupivacaine, whether as a single intraoperative dose or via catheters for intra and post-operative continuous infusion administration, automatic or on demand boluses. Macaire et al. (1) described their technique using 0.5% ropivacaine, but this drug is not available in Colombia. Moreover, Nagaraja et al. (14) and Muñoz-Leyva et al. (20) used 0.125% bupivacaine, which is the medication used in this study.

With regards to the administration regimens of the local anesthetic agent via catheters in cardiac surgery through sternotomy, Nagaraja et al. (14) implanted two bilateral catheters at the level of T6, administering an initial bolus of 15 mL of 0.5% bupivacaine on each side, and continued with 0.125% bupivacaine infusion at 0.1 mg/kg/h up to 48 hours post-extubation. Similarly, Munoz-Leyva et al. (20) placed their catheters at the level of T4, administering initial boluses of 20 mL of 0.25% bupivacaine with epinephrine 2.5 µg/mL, and continued with 0.125% bupivacaine infusion at 8 mL/h per catheter. In the cases herein described, the catheters were placed at the level of T5-T6, and 0.375% levobupivacaine boluses of 40 mL were administered, 20 mL on each side; subsequently, PCA with 0.125% bupivacaine was initiated on each side with 8 mL/h infusion if the body weight was between 40 and 80 kg or 10 mL/h if the body weight was over 80 kg, with on demand boluses of 5 mL, with a minimum safety interval of 1 hour between boluses. This anesthesia regimen was selected by the anesthesiologists participating in the study, based on the fact that both the patient's body weight and the possibility of using regional anesthesia as rescue analgesia were considered; hence, not only is the infusion adapted to the patient's needs, but there is also a reduction in the use of rescue doses of opioids, preventing a potential catheter obstruction by maintaining patency.

The average duration of mechanical ventilation in these patients was 111 minutes; early extubation was probably facilitated by the opioid-sparing strategy and by an adequate pain control at awakening provided by the BC-ESPB which enabled ultra-fast-track or fast-track (24) extubations in the 11 patients involved. These events made it possible to leverage the benefits of these types of early extubation protocols in cardiac surgery, in terms of reduced ICU stay (25), reduced hospital length of stay (26), lower cardiovascular morbidity (27) and improved cost-effectiveness of care. (28)

With regards to complications, no major adverse events were recorded among the study patients, such as local anesthetic toxicity, spinal hematoma, pneumothorax, inter alia. There was only one case of bilateral ecchymosis at the catheter insertion site, with no impact on the patient's evolution; this is consistent with reports in the available literature, evidencing a very low incidence of BC-ESPB-associated complications. (1,14,18,20,21)

Finally, the limitations of this study include the limited number of patients, the absence of a control group, failure to assess chronic pain, failure to assess pain sensation related to dermatomes using a Pinprick test, and the variability in the types of catheters used for continuous regional analgesia; i.e., Pajunk's E-Cath® and Contiplex® S Ultra 360 B. Braun. On one hand, the E-Cath® catheter, classified as catheter over needle, in which the tip of the catheter is at the same site as the tip of the needle, limits the catheter insertion to a very small space inside the block plane and hence increases the likelihood of catheter migration and complications such as intramuscular administration of the local anesthetic agent or outside the block plane. In contrast, the Contiplex® S Ultra 360 catheter is classified as a catheter-through-needle system in which the tip of the catheter advances beyond the tip of the needle, placing the distal end of the catheter inside a pocket created by hydro-dissection, which reduced the potential of catheter migration and associated complications.

CONCLUSION

Intraoperative and postoperative analgesia in cardiac surgery through sternotomy, using a thoracic BC-ESPB with administration of 0.125% bupivacaine in PCA as continuous infusion and on demand boluses, facilitates acute pain control, reduces opioid use, facilitates extubation and early mobilization, with no significant adverse effects. Considering the significance of the benefits derived from this analgesic technique, it is possible that its implementation in patients undergoing cardiac surgery, particularly those programmed for accelerated recovery, may be extremely helpful and safe.

ETHICAL RESPONSIBILITIES

Ethical Committee Endorsement

The study has been endorsed by the Ethics in Biomedical Research Committee of Fundación Valle del Lili, pursuant to Minutes N.° 09, dated April 25, 2022.

Protection of persons and animals

The authors declare that no experiments in human beings or in animals were conducted for this research project. The authors declare that the procedures followed were consistent with the ethical standards of the responsible human experimentation committee and pursuant with the World Medical Association and the Declaration of Helsinki.

Confidentiality of the data

The authors declare that they have followed the protocols of their work center on the publication of patient data.

Right to privacy and informed consent

The authors declare that this article does not disclose any patient data. The authors have obtained the informed consent of all patients and/or subjects mentioned in the article. This document is in the possession of the corresponding author.

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Contribution by the authors

IFQC: study planning and design; patient care and administration of the anesthetic technique described; data collection and interpretation; literature search; initial correction of the manuscript; final draft of the manuscript.
JCC, AHN and MAVE: collection, organization and interpretation of the data; literature search; initial draft of the manuscript.
GACS and KCM: patient care and administration of the anesthetic technique described; final draft of the manuscript.

Assistance for the study

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Disclosures

None declared.

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