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Retrospective Analysis of Comorbidities in Patients Receiving Erector Spinae Plane Catheters with Lidocaine Infusions

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Abstract

Background: The Erector Spinae Plane (ESP) block is a safe and effective analgesic adjunct for a variety of surgeries, including the Whipple procedure. The ESP block works by anesthetizing nerves at the site of injection, but also by diffusing into blood vessels to exert a systemic effect. In patients undergoing abdominal surgery, intravenous lidocaine decreases opioid consumption, ileus, and postoperative nausea and vomiting. Although considered safe, complications including local anesthetic toxicity (LAST) have occurred after ESP block, likely because of rapid absorption of local anesthetics that occurs at the ESP. Patient comorbidities including cardiac disease, liver disease, metabolic disease, central nervous system disease, and low plasma protein binding place patients at increased risk of developing LAST. Despite the growing use of the ESP block and risk of LAST, and there are no standard bolus or infusion dosing protocols or recommendations on how much to decrease local anesthetic doses for patients at higher risk of LAST.

Methods: Patients that received ESP block catheters with lidocaine infusions for Whipple procedure and had serum lidocaine levels were included in this retrospective study. Patient demographic information and comorbidities were also recorded. Patient comorbidities and serum lidocaine concentrations were investigated to determine whether the presence of comorbidities is associated with elevated serum lidocaine concentrations.

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Results: Patient age, body mass index, and gender were not significantly related to elevated lidocaine levels. All patients that had elevated serum lidocaine levels had low plasma protein preoperatively. Patients that had symptoms and elevated lidocaine levels did not have levels that were significantly different to the other patients on postoperative day one.

Conclusion: This study suggests that patients with preoperative elevated liver enzymes and hypoalbuminemia are at higher risk of supratherapeutic serum lidocaine levels and symptoms of LAST.

Introduction

The Erector Spinae Plane (ESP) block was first described in 2016 by Forero M et al for its application in treating neuropathic pain [1]. Shortly after, its usefulness in abdominal surgery was introduced in 2017 and it has further been shown to be beneficial in hepatopancreaticobiliary surgery, including the Whipple procedure, by Nair S et al in 2019 [2,3,4].

The ESP block is considered a safe alternative to epidural and paravertebral analgesia. It is a simple technique with superficial landmarks that reduces the risks of pneumothorax, dural puncture, and neuraxial hematoma associated with paravertebral and epidural techniques [5].

Although considered a safe alternative, complications including Local Anesthetic Systemic Toxicity (LAST) have occurred after ESP block [6]. Fascial plane blocks may be considered high risk for LAST due to the increased local anesthetic volumes used and increased uptake of the local anesthetic from vascular tissue planes [7]. Patient comorbidities including cardiac disease, liver disease, metabolic disease, central nervous system (CNS) disease, and low plasma protein binding also place patients at elevated risk of developing LAST [7].

Despite the growing use of the ESP block for a variety of procedures, local anesthetic absorption from the ESP is not yet completely understood and there are no standard bolus or infusion dosing protocols.

At our institution, serum lidocaine levels were collected as part of a quality improvement initiative in patients with ESP catheter infusions after hepatopancreaticobiliary surgery. Several patients were noted to have supratherapeutic levels. We decided to further investigate the elevated levels by evaluating if patients with comorbidities are more likely to have increased serum lidocaine levels. To our knowledge, the association of patient comorbidities and serum local anesthetic levels after ESP block is uninvestigated. The goal of this retrospective study is to evaluate serum lidocaine levels in patients that received ESP catheters with lidocaine infusions for analgesia after hepatopancreaticobiliary surgery. We hypothesize that patients with comorbidities are more likely to have elevated serum lidocaine levels.

Methods

The institutional review board of West Virginia University School of Medicine, Morgantown, West Virginia, USA approved this study and the Health Insurance Portability and Accountability Act waiver. A retrospective analysis was performed of adult patients that received erector spinae plane catheters for hepatopancreaticobiliary surgery and had serum lidocaine levels measured from April 2022 to August 2022.

At our institution, patients scheduled for Whipple procedure receive ESP catheters preoperatively as part of an enhanced recovery after surgery protocol. The ultrasound-guided ESP catheters were placed at the low thoracic level using an 18-gauge Hustead epidural needle to place a 20-gauge polyamide closed tip epidural catheter. A local anesthetic bolus dose is given at the time of catheter placement. Postoperatively, the ESP catheters are connected to infusions of 0.4% lidocaine. Lidocaine is used because of its analgesic and anti-inflammatory effects as well as being less cardiotoxic. The infusions are run at a basal rate of 2 mL/h plus a programmed intermittent bolus of 6 or 8 mL/h to keep the total dose less than 1-1.5 mg/kg/h. Serum lidocaine levels were collected postoperatively in the Post Anesthesia Care Unit (PACU), postoperative day (POD) 1, and POD 2 as part of a quality improvement initiative. The collections were sent to a reference lab for analysis.

The primary outcome was to describe postoperative total serum lidocaine concentrations in patients with intermittent bolus ESP catheters after hepatopancreaticobiliary surgery. The secondary outcome was to determine whether the presence of comorbidities is associated with elevated serum lidocaine concentrations.

Patient age, weight, Body Mass Index (BMI), sex, surgical procedure, American Society of Anesthesiologists (ASA) physical status, comorbidities, and serum lidocaine levels were collected via review of the electronic medical record. Comorbidities recorded included cardiac disease, liver disease, metabolic disease, CNS disease, kidney disease, and low plasma protein binding. Serum lidocaine levels were collected PACU, POD 1, and POD 2.

Statistical evaluation was performed using RStudio® (Version 1.4). Statistical significance was determined as $p < .05$. Patient subsets were compared using nonparametric statistical tests including unpaired Wilcox rank sum analysis for continuous variables and Fisher exact test for categorical variables.

Results

A total of 12 patients were included in the study. Eight (66.7%) patients were female and four (33.3%) patients were male. Patient ages ranged from 39 years to 86 years. The mean BMI was 28.9 ± 8.3 kg/m^2. Patient age, BMI, and gender were not significantly related to elevated lidocaine levels.

The majority of patients had a Whipple procedure, and one patient had a bile duct excision with Roux-en-Y hepaticojejunostomy. The most common comorbidity was low plasma protein (66.7%), and the remaining comorbidities can be found in **Table 1.** All patients that had elevated lidocaine levels had low plasma protein preoperatively.

Most patients received an initial bolus dose of 0.5% ropivacaine 30mL prior to catheter placement. ESP lidocaine infusion rates ranged from 0.7 to 1.7 mg/kg/h. Three of the twelve patients had elevated lidocaine levels and they all occurred on POD 2. Symptoms of LAST occurred in two patients, and both of those patients had elevated lidocaine levels. Patients that had LAST symptoms and elevated lidocaine levels had no significantly different levels compared to the other patients on POD 1. Serum lidocaine levels measured on POD 1 and POD 2 and are shown in **Figure 1 and Table 2**. The lidocaine levels obtained in PACU were not included in analysis since several patients were missing values and all values measured were subtherapeutic.

Table 1: Patient Clinical Characteristics. This table includes clinical characteristics of included patients and the surgeries patients underwent. Kruskal-Wallis rank sum test was used for direct comparison analysis for numeric data and Fisher's Exact Test was used for categorical data.

	All patients	No elevated lidocaine levels	Elevated lidocaine levels	p-value
Patient characteristics	(n = 12)	(n = 9)	(n = 3)	
Mean age (years) ± SD (range)	64.6 ± 14.5 (39-86)	65.7 ± 13.7 (43-86)	61.3 ± 19.5 (39-75)	.782
Age > 60 years (n, %)	8 (66.7%)	6 (66.7%)	2 (66.7%)	>.999
Mean BMI ± SD (range)	28.9 ± 8.3 (18.6-42.6)	29.4 ± 9.4 (18.6-42.6)	27.3 ± 4.6 (22-30.5)	.926
BMI ≥ 30	5 (41.7%)	4 (44.4%)	1 (33.3%)	>.999
Mean weight (kg) ± SD (range)	79.3 ± 22.6 (46-112)	80.2 ± 26.3 (46-112)	76.5 ± 5.9 (71.4-83)	.926
Mean LBW	51 ± 9.8 (33-70.3)	51.4 ± 11 (33-70.3)	49.7 ± 7.4 (43.7-57.9)	.838
Gender (n, %)				>.999
Male	4 (33.3%)	3 (33.3%)	1 (33.3%)	
Female	8 (66.7%)	6 (66.7%)	2 (66.7%)	
ASA class (n, %)				>.999
ASA class I	0 (0.0%)	0 (0.0%)	0 (0.0%)	
ASA class II	0 (0.0%)	0 (0.0%)	0 (0.0%)	
ASA class III	12 (100.0%)	9 (100.0%)	3 (100.0%)	
ASA class IV	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Comorbid Conditions				
cardiac disease	4 (33.3%)	4 (44.4%)	0 (0.0%)	.491
Kidney disease	3 (25.0%)	3 (33.3%)	0 (0.0%)	.509
Liver disease	3 (25.0%)	3 (33.3%)	0 (0.0%)	.509
CNS disease	1 (8.3%)	1 (11.1%)	0 (0.0%)	>.999
Diabetes	3 (25.0%)	2 (22.2%)	1 (33.3%)	>.999
Low plasma protein	8 (66.7%)	5 (55.6%)	3 (100.0%)	.491
Surgery (n, %)				.236
Robotic Whipple	8 (66.7%)	7 (77.8%)	1 (33.3%)	
Open Whipple	3 (25.0%)	1 (11.1%)	2 (66.7%)	
Robotic bile duct excision	1 (8.3%)	1 (11.1%)	0 (0.0%)	

Abbreviations: SD: Standard Deviation; BMI: Body Mass Index; LBW: Lean Body Weight; ABW: Actual Body Weight; CNS: Central Nervous System.

Table 2: ESP Bolus Dose, ESP Infusion, Dose, LAST Symptoms. This table describes the ESP local anesthetic bolus and infusion. Kruskal-Wallis rank sum test was used for direct comparison analysis for numeric data and Fisher's Exact Test was used for categorical data. Abbreviations: LAST, Local Anesthetic Systemic Toxicity, POD, postoperative day.

	All patients	No elevated lidocaine levels	Elevated lidocaine levels	p-value
Patient characteristics	(n = 12)	(n = 9)	(n = 3)	
Initial Bolus				
Initial Bolus type				>.999
Bupivicane 0.25% 15mL	2 (16.7%)	2 (22.2%)	0 (0.0%)	
Bupivicane 0.5% 15 mL	1 (8.3%)	1 (11.1%)	3 (100.0%	
Ropivicane 0.5% 15 mL	9 (75.0%)	6 (66.7%)	0 (0.0%)	
Infusion dose				
Maximum rate (mg/hr)	80 ± 11.8 (64-96)	78.2 ± 12.5 (64-96)	85.3 ± 9.2 (80-96)	.367
Maximum rate (mg/kg/hr)	1.1 ± 0.3 (0.7-1.7)	1.1 ± 0.3 (0.7-1.7)	1.1 ± 0.2 (1-1.3)	.457
LAST symptoms	2 (16.7%)	0 (0.0%)	2 (66.7%)	.045
Lidocaine levels				
POD1	2.3 ± 0.8 (1.4-4.2)	2.1 ± 0.6 (1.4-2.9)	2.9 ± 1.2 (2.1-4.2)	.354
POD2	4.2 ± 1.4 (2.3-6.9)	3.6 ± 0.9 (2.3-4.8)	5.9 ± 0.9 (5.2-6.9)	.012
POD infusion discontinued	2.8 ± 0.8 (2-4)	2.7 ± 0.7 (2-4)	3 ± 1 (2-4)	.549

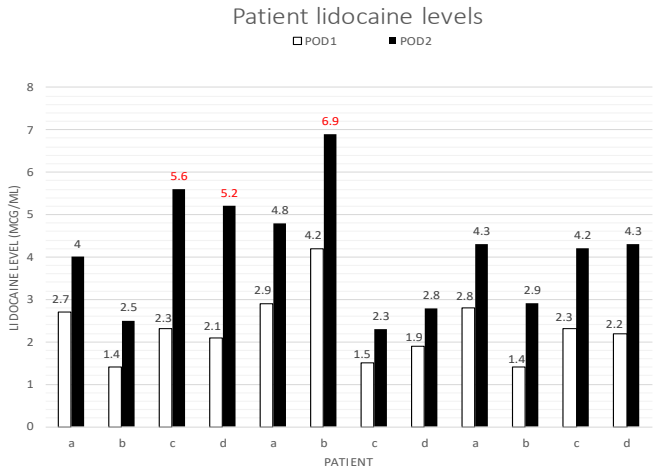

Figure 1: Serum Lidocaine Levels. This graph depicts patient lidocaine levels measured on POD 1 and 2. Elevated lidocaine levels are shown in red. Individual patients are represented as letters a-d. Abbreviations: POD; Postoperative Day.

Discussion

This study demonstrates that patients with preoperative elevated liver enzymes and hypoalbuminemia are more likely to have supratherapeutic serum lidocaine levels. Even though the ESP catheter infusion doses used were appropriate for intravenous infusion, some patients were found to have supratherapeutic levels and developed prodromal symptoms of LAST.

There are no standard dosing protocols for ESP catheter infusions, and many different local anesthetic concentrations, infusion rates, and regimens have been described in the literature. Local anesthetics that are used for ESP catheter infusions include 0.2% ropivacaine [8], 0.25% and 0.15% bupivacaine [4], 0.125% and 0.2% levobupivacaine [9, 10], 0.3% ropivacaine [11], 0.25% lidocaine at various infusion rates and programmed intermittent bolus doses [12].

To further complicate infusion dosing, patients with cardiac, renal, and hepatic dysfunction are at higher risk developing LAST [7, 13]. Lidocaine is metabolized by the liver to monoethylglycinexylidide and then glycinexylidide, which is then excreted by the kidney [14]. Accumulation of local anesthetic in plasma and therefore increased risk of LAST is expected in patients with hepatic and renal disease, but there are no guidelines on how to adjust local anesthetic doses for these patients [7]. However, the risk of toxicity is reduced postoperatively by an increase in plasma proteins [13]. Amide local anesthetics bind to alpha-1-acid glycoprotein, which prevents buildup of free local anesthetic and reduces risk of toxicity [13]. Surgery stimulates an increase in hepatic production of alpha-1-acid glycoprotein levels, resulting in reduced free local anesthetic levels and decreased risk of toxicity [13].

De Cassai et al evaluated the pharmacokinetics of lidocaine injected in the ESP and found a rapid absorption rate of lidocaine [11]. The findings are concerning for an increased risk of developing LAST from the rapid absorption of local anesthetics from the ESP [11]. A retrospective study by Caruso et al compared serum lidocaine levels in pediatric patients with ESP catheters undergoing cardiac surgery with and without cardiopulmonary bypass [15]. No patients in either group had supratherapeutic serum lidocaine levels, and the average levels increased for the first 48 hours postoperatively, then decreased [15]. When local anesthetic is injected into the erector spinae plane, the local anesthetic has an effect on nerves within the fascial plane, but also diffuses into blood vessels to exert a systemic effect [16]. Fascial plane blocks may produce transient elevations in plasma concentrations similar to intravenous lidocaine infusions [16]. In patients undergoing abdominal surgery, intravenous lidocaine has benefits of decreased opioid consumption, ileus, and postoperative nausea and vomiting [17].

The therapeutic range for lidocaine is 1.5-5 ug/mL [18]. When serum levels exceed the therapeutic range, patients may first experience paresthesias and drowsiness, followed by confusion, seizures, coma, and cardiovascular collapse [18]. Fortunately, toxicity is rare and intravenous lidocaine is considered safe [17]. In a study by Miller et al, only one patient out of 4483 that received postoperative lidocaine infusion required lipid emulsion administration [19]. In the study, lidocaine infusions were continued for only 24 hours, but a systemic review by Masic et al stated that infusions up to 48 hours are safe and recommended a 1mg/kg/hr infusion dose [19,20]. If infusions are to be continued for greater than 24 hours, Foo et al recommend reducing the lidocaine infusion rate by approximately 50%, because lidocaine pharmacokinetics are linear and predictable only up to 12 hours [14]. Because of the rapid rate of absorption of local anesthetics from the ESP, infusions may need to be decreased if continued longer than one day, especially in patients with hepatic disease.

There are limitations to this study. The study had a sample size of 12 patients, so additional prospective studies need to be completed in order to provide conclusive evidence. The study was also retrospective and lidocaine doses were not standardized.

Conclusion

This study suggests that patients with preoperative elevated liver enzymes and hypoalbuminemia are at higher risk of supratherapeutic serum lidocaine levels and symptoms of LAST. Further studies are needed to provide guidance on dosing of ESP catheter infusions. Individualized dosing is probably safer than standardized dosing. Based on pharmacokinetic studies of lidocaine administered intravenously or in the ESP, we recommend decreasing the infusion rate in patients with low albumin and elevated liver enzymes and consider reducing the infusion rate after 24 hours.

References

1. Forero M, Adhikary SD, Lopez H, Tsui C, Chin KJ. The Erector Spinae Plane Block: A Novel Analgesic Technique in Thoracic Neuropathic Pain. Reg Anesth Pain Med. 2016; 41: 621-627.

2. Chin KJ, Malhas L, Perlas A. The Erector Spinae Plane Block Provides Visceral Abdominal Analgesia in Bariatric Surgery: A Report of 3 Cases. Reg Anesth Pain Med. 2017; 42: 372-376.

3. Chin KJ, Adhikary S, Sarwani N, Forero M. The Analgesic Efficacy of Pre-Operative Bilateral Erector Spinae Plane (ESP) Blocks in Patients having Ventral Hernia Repair. Anaesthesia. 2017; 72: 452-460.

4. Nair S, McGuinness S, Masood F, Boylan JF, Conlon NP. Erector Spinae Plane Blocks in Major Hepatopancreaticobiliary Surgery: A Case Series. A A Pract. 2019; 13: 332-334.

5. Tsui BCH, Fonseca A, Munshey F, McFadyen G, Caruso TJ. The Erector Spinae Plane (ESP) Block: A Pooled Review of 242 Cases. J Clin Anesth. 2019; 53: 29-34.

6. Yawata S, Imamachi N, Sakura S, Yamamoto H, Saito Y. Local Anesthetic Systemic Toxicity of Levobupivacaine in Erector Spinae Plane Block. Korean J Anesthesiol. 2021; 74: 271-272.

7. Neal JM, Barrington MJ, Fettiplace MR, Gitman M, Memtsoudis SG, et al. The Third American Society of Regional Anesthesia and Pain Medicine Practice Advisory on Local Anesthetic Systemic Toxicity: Executive Summary 2017. Reg Anesth Pain Med. 2018; 43: 113-123.

8. Forero M, Rajarathinam M, Adhikary S, Chin KJ. Continuous Erector Spinae Plane Block for Rescue Analgesia in Thoracotomy After Epidural Failure: A Case Report. A A Case Rep. 2017; 8: 254-256.

9. Kupeli I, Bosinci E, Simić D. Continuous Erector Spinae Plane Block Infusion in Children: A Case Series. J Clin Anesth. 2021; 71: 110251.

10. Taketa Y, Irisawa Y, Fujitani T. Comparison of Ultrasound-Guided Erector Spinae Plane Block and Thoracic Paravertebral Block for Postoperative Analgesia after Video-Assisted Thoracic Surgery: A Randomized Controlled Non-Inferiority Clinical Trial. Reg Anesth Pain Med. 2019; 100827.

11. De Cassai A, Bonanno C, Padrini R, Geraldini F, Boscolo A, et al. Pharmacokinetics of Lidocaine after Bilateral ESP Block. Reg Anesth Pain Med. 2021; 46: 86-89.

12. Pan S, Lee CK, Caruso TJ, Vorhies JS, Tsui BCH. Systemic Lidocaine Absorption from Continuous Erector Spinae Plane Catheters after Paediatric Posterior Spine Fusion Surgery. Reg Anesth Pain Med. 2022; 47: 251-252.

13. Rosenberg PH, Veering BT, Urmey WF. Maximum Recommended Doses of Local Anesthetics: A Multifactorial Concept. Reg Anesth Pain Med. 2004; 29: 564-524.

14. Foo I, Macfarlane AJR, Srivastava D, Bhaskar A, Barker H, et al. The Use of Intravenous Lidocaine for Postoperative Pain and Recovery: International Consensus Statement on Efficacy and Safety. Anaesthesia. 2021; 76: 238-250.

15. Caruso TJ, Lin C, O'Connell C, Weiss D, Boltz Md G, et al. Systemic Absorption of Lidocaine from Continuous Erector Spinae Plane Catheters After Congenital Cardiac Surgery: A Retrospective Study. J Cardiothorac Vasc Anesth. 2020; 34: 2986-2993.

16. Chin KJ, Lirk P, Hollmann MW, Schwarz SKW. Mechanisms of Action of Fascial Plane Blocks: A Narrative Review. Reg Anesth Pain Med. 2021; 46: 618-628.

17. Dunn LK, Durieux ME. Perioperative Use of Intravenous Lidocaine. Anesthesiology. 2017; 126: 729-737.

18. Bauer LA. Chapter 7. Lidocaine. In: Bauer LA. eds. Applied Clinical Pharmacokinetics, 2e. McGraw Hill; 2008.

19. Miller M, Jayaram J, Allen BFS, Freundlich RE, Wanderer JP, et al. Safety of Postoperative Lidocaine Infusions on General Care Wards without Continuous Cardiac Monitoring in an Established Enhanced Recovery Program. Reg Anesth Pain Med. 2022; 47: 320-321.

20. Masic D, Liang E, Long C, Sterk EJ, Barbas B, Rech MA. Intravenous Lidocaine for Acute Pain: A Systematic Review. Pharmacotherapy. 2018; 38: 1250-1259.