CASE REPORT

Peripheral Nerve Block for PD Catheter Insertion in a Pediatric Patient with Decompensated Heart Failure: A Case Report

Jeanne Pauline W. Orbe, MD and Lina May C. Osit, MD

Philippine General Hospital, University of the Philippines Manila

ABSTRACT

Peripheral nerve block (PNB) has been successfully used as the sole anesthetic for Peritoneal dialysis (PD) catheter insertion, and has been shown to provide satisfactory anesthesia and analgesia perioperatively, especially among critically–ill patients.

This report describes the anesthetic management of an 18 – year old underweight pediatric patient with End-stage renal disease (ESRD) and decompensated heart failure who was scheduled for PD catheter insertion. He was given a left lateral Transversus abdominis plane (TAP) block and a right Rectus sheath (RS) block as the main anesthetic. Fifteen mL of Isobaric Bupivacaine 0.375% with Epinephrine 1:400,000 dilution was injected for the TAP block, and 10mL for the RS block, for a total volume of 25mL (93.7mg). Sedation was given via a Remifentanil infusion at 0.1mcg/kg/min. Intraoperatively, the patient was awake, conversant, and comfortable, no pressors were used, and no conversion to general anesthesia was done. Post-operatively, he had good pain control, with a pain score of 1/10, and successfully underwent dialysis via the PD catheter on the 2nd hospital day.

This pediatric patient who is critically-ill is not a good candidate for general or neuraxial anesthesia due to the risk of hemodynamic instability and perioperative decompensation. PNB was done to provide satisfactory anesthesia, and ensure good pain control post-operatively, and left TAP and right RS blocks were done instead of a bilateral TAP to lower the LA volume and decrease the risk of LA toxicity.

Unilateral TAP with contralateral RS is a safe anesthetic technique among critically-ill pediatric patients who will undergo PD catheter insertion without the risk of hemodynamic instability with general or neuraxial anesthesia, and to decrease the risk of LA toxicity.

Keywords: Peritoneal Dialysis (PD) catheter insertion, Transversus Abdominis Plane (TAP) block, Rectus Sheath (RS) block, End-stage Renal Disease (ESRD), heart failure

INTRODUCTION

Insertion of peritoneal dialysis (PD) catheter among patients with end-stage renal disease (ESRD) is challenging because of the severe comorbidities of these patients, with increased risk for adverse outcomes.[1] In particular, general and neuraxial anesthesia are usually avoided due to its negative effect on the patient's hemodynamics, cardiovascular, and respiratory functions, while local anesthetic infiltration (LAI) may not provide adequate analgesia and instead require the need to shift to general anesthesia (GA). Peripheral nerve block (PNB) is a safe and effective anesthetic technique in PD catheter insertion since it can provide superior analgesia and a decreased need for anesthetic adjuncts compared with local infiltration, and decreased risk of adverse effects associated with general and neuraxial anesthesia.[2]

Corresponding author: Jeanne Pauline W. Orbe, MD
Philippine General Hospital
University of the Philippines Manila
Taft Avenue, Ermita, Manila 1000, Philippines
Email: Jeanne.orbe@yahoo.com

Multiple case discussions have discussed how a bilateral Transversus abdominis plane (TAP) supplemented with bilateral Rectus Sheath (RS) blocks have been used as the anesthetic of choice in PD catheter insertion for ESRD patients, but this case will discuss how a unilateral TAP with RS block was utilized in an underweight pediatric patient with decompensated heart failure.

CASE PRESENTATION

This is the case of an 18-year-old male weighing 30.1 kg, with a height of 137.5 cm, and a BMI of 16 (z-score -2), with an American Society of Anesthesiologists (ASA) classification of 4 for Chronic kidney disease (CKD), heart failure (HF), hypertension, and anemia, managed as a case of Peritoneal dialysis (PD)–associated peritonitis, Arteriovenous Fistula (AVF) thrombosis, CKD stage 5D secondary to chronic glomerulonephritis since 2017, acute decompensated heart failure from CKD cardiomyopathy, and hypertension stage 2.

He was admitted due to a chief complaint of abdominal pain from an infected PD catheter. During this admission, the catheter was removed, and he was referred to the anesthesia service for PD catheter insertion on the 15th hospital day. Pre-operatively, he had productive cough with whitish sputum, two-pillow orthopnea, with easy fatigability on less than ordinary activities such as activities of self-grooming, but he denied any chest pain at rest. He was last dialyzed six days prior to the procedure. Upon physical examination, he was malnourished, conversed in phrases, and had stable vital signs (BP 120/80, HR 73, RR 20, O_2 sat of 96% with nasal cannula at 2 LPM). He had no periorbital edema, no neck vein engorgement, no pallor, had clear breath sounds and no murmurs on auscultation, a non-distended abdomen with tenderness at the right lower quadrant, with AVF at the right extremity with good bruit and thrill, and no bipedal edema.

On review of laboratories, he was anemic with a Hemoglobin of 84 mg/dL, and Hematocrit of 27. His creatinine was elevated at 376 without other electrolyte abnormalities, and 2D echocardiography revealed the following: hypertensive cardiomyopathy, left ventricular enlargement with concentric hypertrophy, severe tricuspid regurgitation, moderate pulmonic regurgitation, fair but improved left ventricular contractility, with an ejection fraction of 78%.

Given that this patient had productive cough, poor exercise tolerance, oxygen-requiring, and with documented severe tricuspid regurgitation, he was not a good candidate for a spinal or a general anesthesia due to risk of decompensation perioperatively. Moreover, a poorly dialyzed patient is at risk for volume overload, and prolonged effects of sedatives and neuromuscular blockers.[3] The goal for this patient is to minimize myocardial demand, avoid fluid overload, and ensure that there are no residual effects of anesthetics post-operatively. Factors which may contribute to the development of tachycardia such as intubation, hypotension from systemic vasodilation, surgical stimulus, and poor pain control can lead to life-threatening decompensation.[4] Thus, general anesthesia could bring about such risks for this patient. Further, neuraxial anesthesia can provide effective perioperative analgesia, but the sympathetic blockade it brings about can lead to profound hypotension and, as compensation, an increased workload of the heart; whereas local anesthesia infiltration on the surgical site may lead to poor analgesia for the patient and may just bring about pain and anxiety, and the need to convert to general anesthesia. In contrast, peripheral nerve block has less effect on hemodynamics, and can provide superior analgesia for such patients undergoing PD catheter insertion,[5] which is advantageous for this specific patient. Consideration of the patient's undernourished state must also be done since he may also have hypovolemia, multiple electrolyte derangements, hypoalbuminemia, and an increased susceptibility to the sedating effects of anesthetics.[6] Thus, general and neuraxial anesthesia may bring about hemodynamic instability, while peripheral nerve block, specifically a bilateral TAP block, may put the patient at risk for local anesthetic toxicity (LAST) given his weight and condition. An ideal anesthetic technique for this case is one which will confer hemodynamic stability, mitigate the risk of volume overload, ensure effective anesthesia and perioperative analgesia, while minimizing the likelihood of local anesthetic toxicity, thus a PNB – left TAP with right RS block – was chosen as the main anesthetic for this patient.

During induction, the patient was closely monitored, given supplemental oxygen, and an anxiolytic dose of Midazolam 0.5 mg intravenously. A left lateral TAP and right RS block under ultrasound guidance was done (Figure 1). A Pajunk needle (gauge 20, 50 mm) was advanced into the

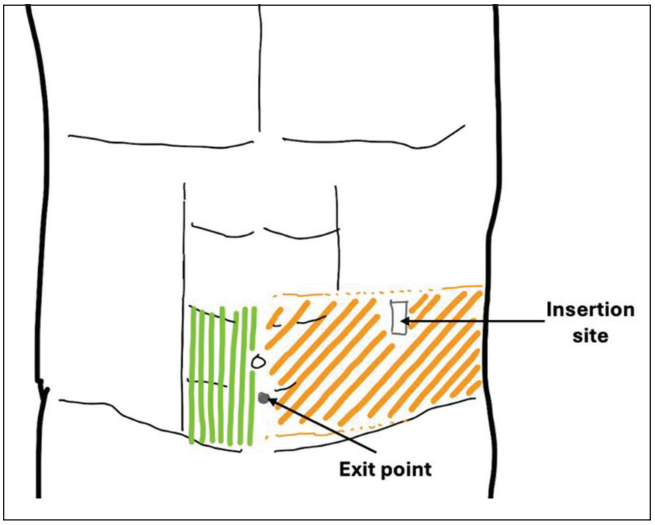

Figure 1. Illustration of the operative site and the blocks performed.

Orange – Left lateral TAP block, Green – Right RS block

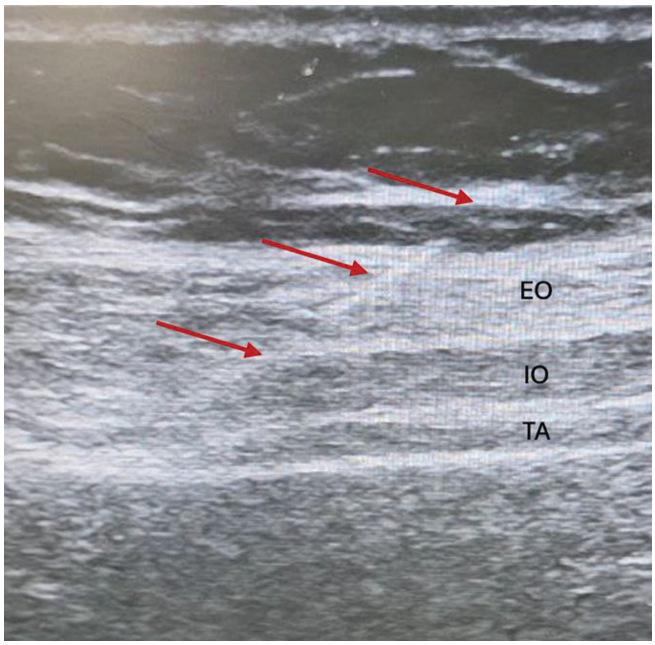

Figure 2. Ultrasound image showing the TAP block.

Red arrows – needle, EO – External oblique, IO – Internal Oblique, TA – Transversus abdominis.

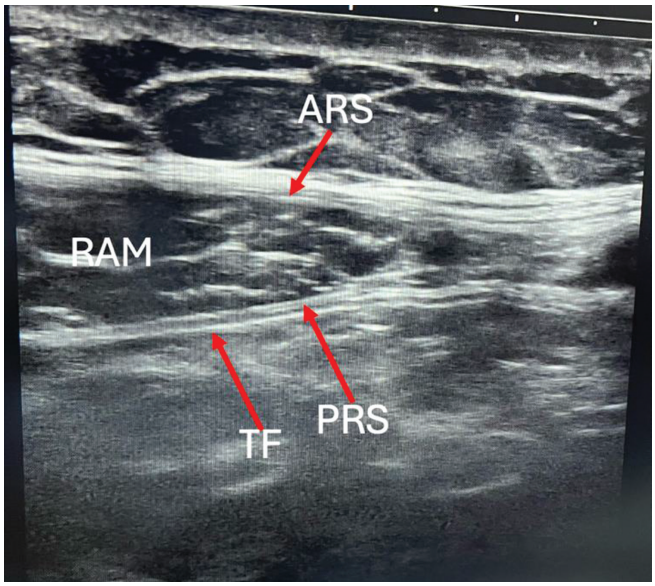

Figure 3. Ultrasound image showing the RS block.

ARS – Anterior Rectus Sheath, RAM - Rectus Abdominis Muscle, PRS – Posterior Rectus Sheath, TF – Transversalis Fascia

target planes (Figures 2 and 3), and local anesthetic was infiltrated using Isobaric Bupivacaine 0.375% with an adjunct of Epinephrine 1:400,000 dilution. Fifteen mL of LA was injected for the TAP block, and 10 mL for the RS block, yielding a total volume of 25 ml (93.7 mg) of LA, which is close to the toxic dose of 24.1 – 28.1 mL (90.3 – 105.4 mg) for the said LA.[7]

Adequacy of the block was tested with temperature and pinprick sensation. A 45-minute interval was permitted from block performance to the initiation of the surgery. Intraoperatively, sedation was provided with low-dose Remifentanil at 0.1 mcg/kg/min which was discontinued 20 mins after cutting, and the patient was closely monitored for any signs of pain (verbal complaints, elevations in blood pressure and heart rate). He remained awake and comfortable for the whole procedure which lasted for 35 minutes, without the need for conversion to general anesthesia. He also exhibited no signs of LAST.

He was then transferred to the post-anesthesia care unit (PACU) with the following vital signs: BP 140/80, HR 72, RR 18, O_2 sat 100%. At the PACU, he was comfortable and had a post-operative pain score of 1/10, he had no complaints of dyspnea, nausea, vomiting, and did not show any signs of hemodynamic instability. He was then transferred to the ward subsequently. On the first post-operative day, he had good pain control (pain score of 1/10) at the ward.

Dialysis was done via PD catheter two days post-operatively, and he was discharged after 24 hospital days.

DISCUSSION

The goals for a pediatric patient with decompensated heart failure, hypertrophic cardiomyopathy, and severe tricuspid regurgitation are to address any imbalances between myocardial oxygen supply and demand to prevent myocardial ischemia, avoid tachycardia to ensure diastolic filling of the ventricles and maintain preload,[8] and avoid decreases in systemic vascular resistance and maintain afterload[9]. General anesthesia can lead to sympathetic stimulation and systemic vasodilation, both of which may lead to perioperative decompensation of the patient. In contrast, neuraxial anesthesia leads to sympathetic blockade and decrease in afterload, which may also be debilitating to a patient without cardiac reserves. Moreover, due to the poorly dialyzed state of this patient, there may be a preexisting fluid overload contributing to his baseline dyspnea, increasing the work of breathing and oxygen requirements, and a risk of prolonged sedation and residual neuromuscular blockade for a patient not on dialysis.

Peripheral nerve block is a safe alternative to neuraxial and general anesthesia especially among pediatric patients with end-stage renal disease requiring regular dialysis, specifically for this patient who has preexisting heart failure. It confers the advantage of less hemodynamic instability and vasoactive use, and better analgesia perioperatively as compared with general anesthesia and subarachnoid block. Another option for this is a LAI, but this has a higher chance of conversion to GA due to failure to provide analgesia during peritoneal dissection and manipulation,[10] has low patient satisfaction, and has increased risk for local anesthetic systemic toxicity due to increased requirements for analgesia.

The surgical insertion of PD catheter in this case involved a paramedian incision at the left to expose the rectus abdominis muscle and posterior rectus sheath. The catheter is introduced into the peritoneal cavity, sutured onto the posterior border of the rectus abdominis muscle, tunneled through the subcutaneous tissue, and exteriorized through the abdominal wall.[11] Given this, a lateral TAP block can provide somatic anesthesia to the anterolateral abdominal walls from T10 to L1 dermatomal levels, including the parietal peritoneum. Since this is a neurofascial plane block, a large volume of LA (at least 15 mL for each side) is required to anesthetize the thoracolumbar nerves that innervate the abdominal walls.[12] However, a bilateral TAP block in this patient may lead to systemic toxicity due to the large LA volume needed to bring about the desired analgesia in an underweight patient. Moreover, a unilateral TAP is inadequate in providing analgesia at the catheter exit site which lies at the rectus abdominis area. In contrast, an RS block can only provide analgesia proximal to the midline, and it is inadequate as the sole anesthetic for PD catheter insertion. In this case, a left lateral TAP was done to cover for the insertion site of the PD catheter, while a right RS block covered the areas of possible sparing at the exit site of the catheter proximal to the midline. This technique, instead of a bilateral TAP, or a bilateral TAP with RS, was done to decrease the local anesthetic volume requirements during PD catheter insertion in an underweight patient.

During the procedure, minimal to moderate sedation[13] was provided via a Remifentanil infusion at 0.1mcg/kg/min, where the patient remained responsive with tapping, and had no episodes of dyspnea or desaturation requiring invasive airway intervention. Thus, a peripheral nerve block with TAP + RS in this case did not warrant the use of any pressors, did not lead to any form of hemodynamic instability, and any form of LAST. He had good perioperative pain control as shown by discontinuation of Remifentanil intraoperatively, and good pain control post-operatively.

CONCLUSION

To the best of the authors' knowledge, there are still no clinical trials done for PD catheter insertion using a unilateral TAP with RS block in this subgroup of patients. This case shows how a peripheral nerve block achieves the desired effects of analgesia, anesthesia, and safety for this patient. However, there is a need to explore other nerve blocks with visceral coverage for these kinds of procedures.

Informed Consent

Informed consent was obtained from the patient's father, both for the procedure, and for this report.

Statement of Authorship

Both authors certified fulfillment of ICMJE authorship criteria.

Author Disclosure

Both authors declared no conflicts of interest.

Funding Source

None.

REFERENCES

1. Jaksic A, Vujicic B, Desa D, Grskovic A, Vukelic I, Spanjol J, et al. Case report: synchronous removal and implantation of peritoneal dialysis catheter using bilateral transversus abdominis plane block. Front Med. 2022 Mar;9 (828930). doi: 10.3389/fmed.2022.828930. PMID: 35299839; PMCI PMC8921767.
2. Qi Q, Zhou Z, Qiao Y, Ren T, Yang B. Transversus abdominis plane block versus local anesthetic infiltration for anesthetic effect in peritoneal dialysis catheter insertion: A systematic review and meta-analysis. Medicine. 2023;102(31):p e34517. doi: 10.1097/MD.0000000000034517. PMID: 37543799; PMCID: PMC10403017.
3. Guruswamy V, Barbour R. Anesthesia for children with renal disease. BJA Education 15. 2015;(6):294–8. doi: 10.1093/bjaceaccp/mku064.
4. Baldock A. Anesthesia and Heart Failure. World Federation of Societies of Anesthesiologists [Internet]. 2008 [cited 2024 May 7]. Available from: https://resources.wfsahq.org/atotw/anaesthesia-and-heart-failure-anaesthesia-tutorial-of-the-week-86/.
5. Li J, Guo W, Zhao W, Wang X, Hu W, Zhou J, et al. Ultrasound-guided unilateral transversus abdominis plane combined with rectus sheath block versus subarachnoid anesthesia in patients undergoing peritoneal dialysis catheter surgery: a randomized prospective controlled trial. J Pain Res. 2020;13:2279–87. doi: 10.2147/JPR.S264255. PMCID: PMC7500835; PMID: 32982391.
6. Edwards S. Anesthetising the malnourished patient. World Federation of Societies of Anesthesiologists [Internet]. 2016 [cited 2024 May 7]. Available from: www.wfsahq.org/resources/update-in-anaesthesia.
7. Shafiei F, McAllister R, Lopez J. Bupivacaine. National Library of Medicine [Internet]. 2023. [cited 2024 Sep 16]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK532883/.
8. Magner J, Royston D. Heart failure. BJA, 2004;93 (1):74 – 85. doi: 10.1093/bja/aeh167.
9. Antunes MJ, Rodríguez-Palomares J, Prendergast B, De Bonis M, Rosenhek R, Al-Attar N, et al. Management of tricuspid valve regurgitation: Position statement of the European Society of Cardiology Working Groups of Cardiovascular Surgery and Valvular Heart Disease. Eur J Cardiothorac Surg. 2017;52(6):1022-30. doi: 10.1093/ejcts/ezx279. PMID: 28950325.
10. Jiang X, Li Z, Li Q, Zhang H, Tang X, Zhu T. Comparison of single-injection ultrasound-guided thoracic paravertebral block with transversus abdominis plane block in peritoneal dialysis catheter implantation: a randomized controlled trial. Trials. 2021;22(266): 1-9. doi: 10.1186/s13063-021-05223-7.
11. Henshaz D, Baker M, Reynolds J, Jaffe J. Transversus abdominis plane block as the primary anesthetic for peritoneal dialysis catheter surgery. J Clin Anesth. 2016;31:182–8. doi: 10.1016/j.jclinane.2016.01.028.
12. Elsharkawy H, Bendtsen T. Ultrasound-Guided Transversus Abdominis Plane and Quadratus Lumborum Nerve Blocks. Nysora [Internet]. [cited 2024 Jun 2]. Available from: https://www.nysora.com/topics/regional-anesthesia-for-specific-surgical-procedures/abdomen/ultrasound-guided-transversus-abdominis-plane-quadratus-lumborum-blocks/.
13. American Society of Anesthesiologists. Position on Monitored Anesthesia Care. Last amended on October 17, 2018.