Cardiology in the Young

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Caudal Anaesthesia: clonidine and morphine dosing and outcomes in paediatric cardiac surgery

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Brief Report

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Abstract

We describe caudal analgesia agent, dose, reported adverse events, and outcomes in a single-centre, retrospective cohort study of 200 patients undergoing cardiac surgery from October 2020 to April 2023. Median (interquartile range) doses of clonidine and morphine were 2.7 (2.1–3) mCg/kg and 0.12 (0.1–1.12) mg/kg, respectively. Our findings suggest that a clonidine/morphine caudal was tolerated in cardiac surgical patients.

Introduction

Caudal anaesthesia for paediatric cardiac surgical procedures is a described technique for improving analgesia, allowing for potential early extubation, decreasing hospital length of stay, avoiding positive pressure ventilation, and minimising exposure to opioids.[1–6] Studies to date differ in the combination of medications utilised, all with diverse spinal pharmacokinetics, study numbers, patient age, and underlying pathophysiology.[3–4] Furthermore, concerns related to potential complications from dural puncture and the risk of bleeding, haemodynamic instability, risk of airway compromise, and the need for reintubation have limited the use of caudal anaesthesia in paediatric cardiac surgery.[2–6] Given the lack of data on morphine and clonidine caudals, we sought to describe a regimen for analgesia in paediatric cardiac surgery.

Methods

This study was approved by the Johns Hopkins Medicine Institutional Review Board (IRB00389283), and the requirement for informed consent was waived.

Study design

We reviewed all paediatric patients less than 6 years of age who underwent cardiac surgery requiring cardiopulmonary bypass and received caudal analgesia according to an institutional clinical care algorithm from October 2020 through April 2023 were included (Supplemental Figure 1). Patients with any of the following were excluded: documented allergy, contraindication to neuraxial opioid, cellulitis or infection at sacrum, history of chronic pain syndrome or opioid dependence, previous sacral surgery or violation of epidural space, obscured superficial landmark anatomy, or known deep anatomical variation. Surgical case complexity was stratified using the Society of Thoracic Surgeons-European Association for Cardiothoracic Surgery Congenital Heart Surgery Mortality (STAT) Categories.[7]

Outcomes

Outcomes of interest included the morphine and clonidine caudal dose, reported adverse outcomes, extubated in the operating room after the cardiac surgery case, rate of patients reintubated in the first 48 hours, and length of stay.

Statistical analysis

Continuous variables were reported using medians and interquartile range; categorical variables were described using frequencies and percentages.

Table 1. Patient characteristics, intraoperative medications, and caudal medications

	Neonate (n = 54)	Infant (n = 101)	Child (n = 45)	All Patients (n = 200)
Weight, kg median (IQR)	3.2 (2.9-3.5)	5.8 (4.8-7.1)	14.2 (10.9-16.5)	5.7 (3.7-8.4)
STAT Category n (%)				
1	6 (11)	48 (48)	30 (67)	84 (42)
2	7 (13)	43 (43)	8 (18)	58 (29)
3	19 (35)	8 (8)	7 (16)	34 (17)
4	9 (17)	2 (2)	0 (0)	11 (6)
5	13 (24)	0 (0)	0 (0)	13 (7)
CPB, min median (IQR)	156 (132-187)	122 (93-145)	122 (80-157)	132 (100-171)
Cross clamp time, min median (IQR)	74 (56-98)	74 (42-100)	44 (27-73)	68 (49-92)
Circulatory arrest n (%)	14 (26)	4 (4)	4 (9)	22 (11)
Modified ultrafiltration n (%)	54 (100)	101 (100)	45 (100)	200 (100)
Caudal, clonidine, morphine n (%)	54 (100)	100 (99)	44 (98)	198 (99)[a]
Caudal - clonidine, mCg/kg median (IQR)	2.1 (2.0-2.8)	2.7 (2.3-3.0)	2.9 (2.8-3.1)	2.7 (2.1-3.0)
Caudal - morphine, mg/kg median (IQR)	0.1 (0.0-0.11)	0.12 (0.11-0.12)	0.12 (0.12-0.13)	0.12 (0.1-0.12)
Intraoperative intravenous acetaminophen n (%)	34 (63)	72 (71)	32 (71)	137 (69)
Intraoperative intravenous acetaminophen, mg/kg median (IQR)	10 (9.8-12.5)	14.5 (12.6-15)	15 (12.5-15)	14.4 (12.4-15)
Intraoperative intravenous dexmedetomidine n (%)	53 (98)	97 (96)	45 (100)	198 (99)
Intraoperative intravenous dexmedetomidine, mcg/kg median (IQR)	2.3 (1.9-2.7)	1.9 (1.5-2.5)	2.1 (1.7-2.6)	2.1 (1.7-2.6)
Intraoperative intravenous fentanyl n (%)	2 (4)	9 (9)	4 (9)	15 (8)
Intraoperative intravenous fentanyl, mCg/kg median (IQR)	2.8 (2.8-2.9)	2.1 (1.6-2.2)	0.7 (0.6-2.6)	2.1 (1.3-2.7)
Intraoperative intravenous morphine n (%)	43 (80)	82 (81)	35 (78)	160 (80)
Intraoperative intravenous morphine, mg/kg[1] median (IQR)	0.23 (0.17-0.37)	0.25 (0.16-0.37)	0.2 (0.13-0.26)	0.23 (0.16-0.34)
Intraoperative intravenous hydromorphone n (%)	0 (0)	0 (0)	2 (4)	2 (1)
Intraoperative intravenous hydromorphone, mg/kg median (IQR)	–	–	0.06 (0.06-0.06)	0.06 (0.06-0.06)
Intraoperative intravenous ketamine n (%)	12 (22)	12 (12)	5 (11)	30 (15)
Intraoperative intravenous ketamine, mg/kg median (IQR)	2.7 (2.2-2.9)	2.1 (1.2-2.9)	1.4 (1.1-2.1)	2.3 (1.4-2.9)

[a]1 patient had only clonidine, and 1 patient had only morphine for caudal. IQR = interquartile range; STAT = Society of Thoracic Surgeons-European Association for Cardiothoracic Surgery Congenital Heart Surgery Mortality.

Results

Among the 200 patients included in the final sample, 101 (51%) were infants, and most cases were STAT 1 ($n = 84$, 42%) (Table 1). Types of cardiac operations included: Norwood ($n = 7$, 3.5%), ventricular septal defect ($n = 32$, 16%), truncus ($n = 5$, 2.5%), aorta/arch repair ($n = 18$, 9%), cortriatriatum ($n = 2$, 1%), Fontan ($n = 7$, 3.5%), Glenn ($n = 16$, 8%), tetrology/pulmonary artery plasty ($n = 30$, 15%), atrioventricular canal ($n = 20$, 10%), arterial switch ($n = 8$, 4%), interrupted aortic arch ± ventricular septal defect ($n = 5$, 2.5%), total anomalous pulmonary venous return ($n = 5$, 2.5%), unifocalization of major ortopulmonary collateral arteries ($n = 4$, 2%), atrial septal defect ($n = 9$, 4.5%), valvuloplasty

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Table 2. Outcomes

Variable	Neonate (n = 54)	Infant (n = 101)	Child (n = 45)	All Patients (n = 200)
Extubation at the end of the case, n (%)	29 (54)	89 (88)	44 (98)	162 (81)
Reintubation (respiratory distress) ≤ 48 hrs. n (%)	2 (4)	6 (6)	3 (7)	11 (6)
Unplanned cardiac operation n (%)	3 (6)	1 (1)	1 (2)	5 (3)
Time to first opioid, hrs. median (IQR)	3.9 (1.1-8.1)	1.8 (1.1-4.2)	2.9 (1.2-7.8)	2.8 (1.2-6.1)
Opioids 0 to<24 hrs. post-op, MME/kg/day median (IQR)	0.2 (0.14-0.35)	0.2 (0.1-0.35)	0.2 (0.1-0.38)	0.2 (0.1-0.35)
Length of stay, days median (IQR)	20 (12-30)	6 (5-10)	4 (3-8)	8 (8-17)
Mortality n (%)	0 (0)	2 (2)	3 (7)	5 (3)

IQR = interquartile range; MME = morphine milligram equivalents.

(n = 19, 9.5%), myomectomies (n = 4, 2%), anomalous left coronary artery from the pulmonary artery (n = 1, 0.5%), and other cardiac procedures (n = 8, 4%).

The median (interquartile range) doses of caudal clonidine and morphine used were 2.7 (2.1–3) mcg/kg and 0.12 (0.1-0.12) mg/kg (Table 1). Most patients received other analgesic agents during the case, with morphine being administered to 80% of patients (Table 1).

There were no reports of neurological injury, infection, or neuraxial haematoma in patients who received caudal morphine and clonidine. Of the 200 patients, 162 (81%) underwent extubation at the end of the case in the OR, including 5/13 (38%) STAT 5 cases and 29/54 (54%) neonatal cases (Table 2). Within 48 hours of extubation, 10/165 (6 %) patients were re-intubated (Supplemental Table 2). The median (interquartile range) opioid requirements in intravenous morphine milligramme equivalents within the first 24 hours following ICU were 0.2 (0.1–0.35) mg/kg/day. The median (interquartile range) length of stay for the cohort was 8 (8–17) days (Table 2).

Discussion

We report 200 paediatric patients undergoing cardiac surgery employing a morphine and clonidine caudal at higher doses than previously reported. Nguyen et al described in a retrospective study the use of clonidine up to 2 mcg/kg with morphine up to 0.04 mg/kg.[5] Reported complications include epidural haematoma, neurological sequalae, epidural abscess, and cutaneous infections.[5] In our study, we did not note any of the above complications or any concerns related to bleeding from anticoagulation.

Beamer et al in a retrospective cohort study reported that a caudal consisting of 0.05–0.1 mg/kg morphine if < 5 years of age or 0.005–0.01 mg/kg morphine and 1–2 mcg/kg clonidine facilitated early extubation and shorter length of stay in patients undergoing STAT 1, 2, 3, and 4 cardiac operations.[5] While there is not a comparison group in our study, we report a rate of extubation to be 81% in all patients, including 38% of STAT 5 cases and 54% of neonatal cases, with 6% of the 162 extubated patients requiring re-intubation (Supplemental Table 1).

Leyvi et al reported that paediatric patients randomised to receive caudal epidural morphine 0.07 mg/kg and 0.25% bupivacaine at 1 mL/kg resulted in a 24-hour postoperative opioid requirement of 0.3 ± 0.1 mg/kg.[1] We report a low median opioid requirement of 0.2 mg/kg/day IV morphine in the first 24 hours following surgery compared to other published studies.[8–10] Beamer et al. reported a mean hospital length of stay of 6 days in patients who underwent early extubation.[4] We report a similar overall length of stay of 8 days (Table 2).

Limitations of this study include its single-centre, retrospective study design and outcomes that are not patient-centric. Because any effort to construct a concomitant or historical control group would engender substantial selection bias, we have contextualised our findings regarding published literature in similar or relevant paediatric populations. Also, most patients in this study were either STAT 1 or 2 cases, which may limit generalisability to more complex cardiac cases. Patients also received intraoperative opioids before extubation, which could impact overall postoperative opioid requirements. While we collected reasons for re-intubation, it is difficult to know for certain to what extent the caudal morphine and clonidine may have impacted re-intubation. Despite these limitations, there is an opportunity to prospectively measure specific outcome metrics in a programme confident in an early extubation strategy, perhaps identifying specific criteria to determine a patient population that truly benefits from this strategy.

This study demonstrates that the use of high-dose caudal analgesia consisting of clonidine and morphine was tolerated in paediatric cardiac surgical patients. Prospective studies of this approach are needed to evaluate the use of caudal analgesia in this patient population.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/S1047951125100620

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Ethical standard. The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national guidelines on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008, and have been approved by the institutional committees (Johns Hopkins).

References

1. Leyvi G, Taylor DG, Reith E, Stock A, Crooke G, Wasnick JD. Caudal anesthesia in pediatric cardiac surgery: does it affect outcome? J Cardiothorac Vasc Anesth 2005; 19: 734–738.
2. Preisman S, Lembersky H, Yusim Y, et al. A randomized trial of outcomes of anesthetic management directed to very early extubation after cardiac surgery in children. J Cardiothorac Vasc Anesth 2009; 23 : 348–357.
3. Maharramova M, Taylor K. A systematic review of caudal anesthesia and postoperative outcomes in pediatric cardiac surgery patients. Semin Cardiothorac Vasc Anesth 2019; 23: 237–247.
4. Beamer S, Ferns S, Edwards L, Gunther G, Nelson J. Early extubation in pediatric heart surgery across a spectrum of case complexity: impact on hospital length of stay and chest tube days. Prog Pediatr Cardiol 2017; 45: 63–68.
5. Nguyen KN, Byrd HS, Tan JM. Caudal Analgesia and cardiothoracic surgery: a look at postoperative pain scores in a pediatric population. Paediatr Anaesth 2016; 26: 1060–1063.
6. Gaies M, Tabbutt S, Schwartz SM, et al. Clinical epidemiology of extubation failure in the pediatric cardiac ICU: a report from the pediatric cardiac critical care consortium. Pediatr Crit Care Med 2015; 16: 837–845.
7. Jacobs ML, Jacobs JP, Thibault D, et al. Updating an empirically based tool for analyzing congenital heart surgery mortality. World J Pediatr Congenit Heart Surg 2021; 12: 246–281.
8. Amula V, Vener DF, Pribble CG, et al. Changes in anesthetic and postoperative sedation-Analgesia practice associated with early extubation following infant cardiac surgery: experience from the pediatric heart network collaborative learning study. Pediatr Crit Care Med 2019; 20: 931–939.
9. Roy N, Parra MF, Brown ML, et al. Initial experience introducing an enhanced recovery program in congenital cardiac surgery. J Thorac Cardiovasc Surg 2020; 160: 1313–1321.e5.
10. Walker BJ, Long JB, Sathyamoorthy M, et al. Complications in pediatric regional Anesthesia: an analysis of more than 100,000 blocks from the pediatric regional Anesthesia network. Anesthesiology 2018; 129: 721–732.

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