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CASE REPORT

Sedation for central venous access in a non-cooperative child with complex heart disease: case report on the effectiveness of adjusted-dose Ketodex

Sedação para acesso venoso central em criança não colaborativa com cardiopatia complexa: relato de caso sobre a efetividade de Ketodex em dose ajustada

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ABSTRACT

Introduction: Sedation of non-cooperative children with complex congenital heart disease and severe systolic dysfunction for invasive procedures requires agents that ensure immobility and comfort without compromising cardiorespiratory stability. The combination of ketamine and dexmedetomidine (Ketodex) has emerged as a promising alternative, providing effective sedation with a lower risk of respiratory depression and hemodynamic instability. **Objective:** To evaluate the efficacy and safety of Ketodex at an adjusted dose (ketamine 0.15 mg/kg + dexmedetomidine 0.3 mcg/kg) for sedation during central venous access puncture in a child with complex heart disease, emphasizing the maintenance of hemodynamic and respiratory stability. **Methods:** Case report with retrospective analysis of the patient's medical records and anesthesia chart, including administered drugs, routes of administration, and hemodynamic parameters. Statistical analysis of hemodynamic data was performed, including the coefficient of variation (CV) and Wilcoxon and Friedman tests to assess intraoperative variations. **Case Report:** A 9-year-old girl with complex congenital heart disease (single ventricle, double inlet to the left ventricle, ventriculo-arterial discordance) and severe systolic dysfunction (ejection fraction 24.5%) underwent sedation with Ketodex (ketamine 0.15 mg/kg, dexmedetomidine 0.3 mcg/kg, 1:2 ratio), preceded by fentanyl (0.5 mcg/kg). Vital signs remained stable, without adverse events. **Discussion:** Statistical analysis showed CV <5% for hemodynamic variables, with no significant differences between baseline and final values (p>0.05). Reduced doses and titration guided by clinical response provided effective, well-tolerated sedation without compromising spontaneous ventilation or hemodynamic stability. **Conclusion:** Adjusted-dose Ketodex proved to be a safe and effective alternative to general anesthesia in a high-risk pediatric patient, ensuring cardiorespiratory stability during the invasive procedure.

Keywords: Deep sedation; Central venous catheterization; Heart failure; Pediatric anesthesia; Ketamine; Dexmedetomidine; Case report.

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None.

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None.

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RESUMO

Introdução: A sedação de crianças não colaborativas com cardiopatia congênita complexa e disfunção sistólica grave para procedimentos invasivos requer agentes que garantam imobilidade e conforto sem comprometer a estabilidade cardiorrespiratória. A combinação de cetamina e dexmedetomidina (Ketodex) tem se mostrado uma alternativa promissora, proporcionando sedação eficaz com menor risco de depressão respiratória e instabilidade hemodinâmica. **Objetivo:** Avaliar a eficácia e segurança do Ketodex em dose ajustada (cetamina 0,15 mg/kg + dexmedetomidina 0,3 mcg/kg) para sedação durante punção para acesso venoso central em uma criança com cardiopatia complexa, enfatizando a manutenção da estabilidade hemodinâmica e respiratória. **Métodos:** Relato de Caso com análise retrospectiva de prontuário e ficha anestésica, contemplando dados clínicos, farmacológicos e hemodinâmicos. Foi realizada análise estatística dos parâmetros hemodinâmicos (pressão arterial sistólica e diastólica, frequência cardíaca e saturação periférica de oxigênio) por meio do coeficiente de variação (CV) e dos testes de Wilcoxon e Friedman para avaliar variações intraoperatórias. **Relato de Caso:** Paciente do sexo feminino, 9 anos, portadora de cardiopatia congênita complexa (ventrículo único, dupla via de entrada para o ventrículo esquerdo e discordância ventrículo-arterial) e disfunção sistólica grave (fração de ejeção de 24,5%), foi submetida à sedação com Ketodex (cetamina 0,15 mg/kg e dexmedetomidina 0,3 mcg/kg, proporção 1:2), precedida de fentanil (0,5 mcg/kg). Os sinais vitais permaneceram estáveis, sem eventos adversos. **Discussão:** A análise estatística mostrou CV <5% para variáveis hemodinâmicas, sem diferenças significativas entre valores basais e finais (p>0,05). Doses reduzidas e titulação guiada pela resposta clínica proporcionaram sedação eficaz, bem tolerada e sem comprometer a ventilação espontânea. **Conclusão:** O Ketodex em dose ajustada demonstrou ser uma alternativa segura e eficaz à anestesia geral em uma paciente pediátrica de alto risco, garantindo estabilidade cardiorrespiratória durante o procedimento invasivo.

Palavras-chave: Sedação profunda; Cateter venoso central; Insuficiência cardíaca; Anestesia pediátrica; Cetamina; Dexmedetomidina; Relato de caso.

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Introduction

Sedating non-cooperative children with complex heart disease for invasive procedures, such as central venous access, represents a significant anesthetic challenge due to the high risk of cardiorespiratory complications[1].

Choosing the ideal sedative agent is crucial to ensure immobility and comfort during the procedure while preserving hemodynamic and respiratory stability, especially in patients with compromised cardiovascular function. Recent studies suggest that combining ketamine and dexmetomidine (Ketodex) shows relevant advantages, including effective sedation with lower risks of respiratory depression and cardiovascular instability[1].

Inserting a central venous catheter is a widely used procedure in pediatric practice. It is essential for advanced hemodynamic monitoring, administering vasoactive medications, chemotherapy, and parenteral nutrition, while also serving as an indispensable alternative when peripheral venous access is difficult[2]. Children who require prolonged intravenous antibiotic therapy or who experience exhaustion of the peripheral venous network due to multiple

hospitalizations often require the insertion of central venous catheters to ensure safe and continuous treatment[2].

Traditionally, central venous access in pediatric patients is performed under general anesthesia, since neurocognitive immaturity may hinder collaboration during the procedure[3]. However, general anesthesia in patients with heart disease implies considerable risks, such as bronchospasm, laryngospasm, hypoxia, and hemodynamic instability, especially in the context of tracheal intubation[4]. Sevoflurane, for instance, though widely used, is associated with a higher incidence of laryngospasm and postoperative delirium when compared to propofol, an intravenous agent[4].

Inhalational induction in children with congenital heart disease can be particularly risky, as factors such as hemodynamic instability, myocardial depression, circulatory compromise, and sensitivity to hypoxia increase the likelihood of cardiorespiratory arrest. Moreover, intense crying can exacerbate this vulnerability by elevating intrathoracic pressure and pulmonary vascular resistance, increasing oxygen demand, reducing venous return, and compromising cardiac output, especially in patients with a single ventricle. Intravenous anesthetics are not without risk either; propofol, for instance, commonly used for IV induction, may induce hypotension and myocardial depression, particularly in patients with impaired ventricular function. Therefore, minimizing stress and maintaining a controlled environment are essential to prevent hemodynamic complications in these cases. Given these challenges, the search for consistent alternatives to general anesthesia has become essential.

Ketamine emerges as a valuable option for pediatric sedation due to its anesthetic, sedative, analgesic, and amnestic properties. Its dissociative mechanism of action maintains an altered state of consciousness while preserving spontaneous breathing—a particularly relevant characteristic in children with congenital, especially cyanotic, heart disease. To optimize the sedative effect, ketamine may be combined with α_2-agonists such as dexmedetomidine, resulting in synergistic sedation with controlled hemodynamic responses[3]. Thus, the combination of ketamine and dexmedetomidine (Ketodex) represents a promising strategy, providing adequate sedation while maintaining cardiorespiratory balance.

This case report aims to evaluate the efficacy and safety of adjusted-dose Ketodex for central venous access puncture in an uncooperative child with complex heart disease, emphasizing hemodynamic stability and absence of perioperative complications.

Methods

This is a descriptive single-case study reporting a 9-year-old female patient diagnosed with complex congenital heart disease and severe ventricular dysfunction, treated at a teaching hospital in the Federal District, Brazil, who required central venous access due to exhausted peripheral veins and continuous dobutamine support. The procedure was performed under sedation with adjusted-dose Ketodex combined with fentanyl.

The study was approved by the Research Ethics Committee of FEPESCS/SES-DF (CAAE 85795424.0.0000.5553, February 9, 2025). Data were retrospectively collected from the electronic medical record and anesthesia chart, including pharmacologic interventions, monitoring, and laboratory results. All information was anonymized to ensure confidentiality. The study was authorized by the child through the signing of the Informed Assent Form (TALE) and by her legal guardian through the Informed Consent Form (ICF).

Hemodynamic data (systolic and diastolic blood pressure, heart rate, and peripheral oxygen saturation) were analyzed for cardiovascular stability. The coefficient of variation (CV) was calculated; values below 5% indicate low variability and, therefore, clinical stability. The Wilcoxon test compared baseline and final measurements, while the Friedman test evaluated intraoperative fluctuations. Statistical significance was set at $p<0.05$.

The reduced-dose combination of ketamine 0.15 mg/kg and dexmedetomidine 0.3 mcg/kg (1:2 ratio) was chosen based on physiologic considerations of severe cardiac dysfunction, aiming to minimize sympathetic stimulation while maintaining adequate analgesia and ventilation. Fentanyl (0.5 mcg/kg) was administered five minutes before the injection of the mixture to attenuate the adrenergic response to venipuncture.

Although ketamine and dexmedetomidine sedation are considered safe, potential adverse effects, such as bradycardia, transient hypertension, or prolonged sedation, were anticipated and continuously monitored. No complications occurred during the procedure. This study contributes to clinical practice by illustrating an evidence-based, individualized anesthetic approach that ensured hemodynamic and respiratory stability in a high-risk pediatric patient undergoing central venous catheterization.

Case Report

We present the case of a 9-year-old female patient with severe congestive heart failure and complex congenital heart disease. The patient was classified as NYHA Functional Class IV. The complex congenital heart defect is characterized by a single ventricle with double inlet to the left ventricle and ventriculo-arterial discordance. The patient had been followed by a specialized pediatric cardiology team and was listed for cardiac transplantation since 2020 (Table 1).

Echocardiography revealed severe systolic dysfunction, with an ejection fraction of 24.5 % (Simpson's method) and myocardial fiber shortening of 17%. She presented chronic hypoxemia (Figure 1) (baseline Peripheral oxygen saturation 81–84%) and recurrent episodes of decompensated heart failure (Table 2).

The patient was admitted to the Pediatric Intensive Care Unit (PICT) following one of these decompensated episodes, requiring continuous dobutamine infusion.

Peripheral venous access was no longer viable due to vein fragility, generalized edema, and multiple prior punctures, warranting a central venous puncture under controlled sedation to maintain continuous vasoactive support and secure a stable venous line.

This complex hemodynamic configuration, characteristic of univentricular physiology, led to elevated pulmonary vascular resistance, limited cardiac output reserve, and a high susceptibility to preload and afterload fluctuations. These conditions significantly increased the anesthetic risk, demanding an approach that avoided abrupt sympathetic changes, maintained spontaneous ventilation, and preserved systemic-pulmonary flow balance.

Anesthetic intervention

Given the patient's critical condition and absence of sustainable peripheral access, right internal jugular vein puncture was chosen for catheterization (Figure 2). The decision was supported by ultrasound, which confirmed its straight trajectory to the superior vena cava and a lower risk of mechanical complications compared with other possible access sites.

Initially, fentanyl (0.5 mcg/kg) was administered for anxiolysis and attenuation of the sympathetic response to venipuncture. After five minutes, sedation was deepened with ketamine (0.15 mg/kg) and dexmedetomidine (0.3 mcg/kg), diluted in 5 mL of Ringer's lactate and infused at

Figure 1. Presence of digital whitening

Table 1. Timeline of main clinical events.

Year	Event	Description
2014	Diagnosis	Single ventricle; pulmonary trunk banding
2016	Glenn surgery	Second pulmonary banding
2020	Transplant listing	Pediatric cardiac transplant waiting list
2024	Decompensated heart failure	Required central venous access
2025	Current case	Central venous access under Ketodex sedation

Source: Primary research data (2024).

Table 2. Baseline anthropometric and hemodynamic parameters.

Parameter	Value	Comment
Age	9 years	—
Weight	28 kg	Slightly below average
Height	121 cm	Below the expected percentile
Body surface area	1.02 m^2	—
Ejection fraction	24.5%	Severe dysfunction
Fractional shortening	17%	—
Baseline Peripheral oxygen saturation	81-84%	Chronic hypoxemia
HR*	92-96 bpm	Stable
SBP*/DBP*	96/55-57 mmHg	Mildly low normal

Caption: *HR = Heart rate; SBP = Systolic blood pressure; DBP = Diastolic blood pressure.
Source: Primary research data (2024).

1 mL/min (1:2 ratio). The regimen was designed to ensure adequate sedation, maintenance of spontaneous ventilation, and cardiovascular stability, particularly in view of the patient's reduced ejection fraction and chronic hypoxemia.

Monitoring

During the 50-minute procedure, hemodynamic and respiratory parameters remained stable, with no episodes of desaturation or arrhythmia. Systolic blood pressure ranged from 93 to 99 mmHg, diastolic pressure from 55 to 57 mmHg, heart rate from 92 to 97 bpm, and peripheral oxygen saturation (SpO_2) remained between 82% and 83% with oxygen supplementation via nasal catheter at 2.5 L/min (Table 3).

Results

Statistical analysis confirmed hemodynamic stability, with a coefficient of variation below 5% for all monitored parameters and no significant differences between the initial and final values ($p>0.05$). The patient tolerated the procedure well, with no adverse events or discomfort reported. She awoke promptly, remained alert and cooperative, and maintained stable vital signs throughout recovery. The reduced doses and titration guided by clinical response allowed adequate sedation without compromising spontaneous ventilation or hemodynamic stability.

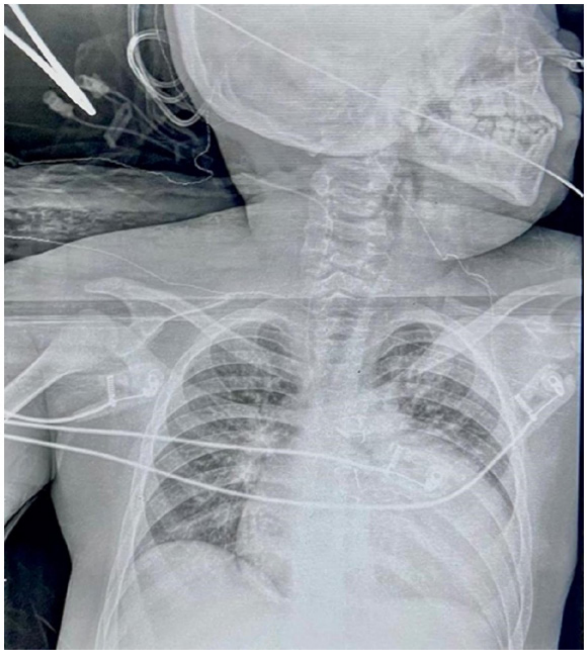

Figure 2. Central Venous Access Positioned

Table 3. Intraoperative monitoring.

Time	NIBPs (mmHg)*	NIBPd (mmHg)*	Peripheral oxygen saturation (%)-	HR (bpm)*
09:35	96	57	83	92
09:40	96	57	83	92
09:45	96	57	83	92
09:50	96	57	83	93
09:55	96	57	83	93
10:00	96	57	83	96
10:05	97	57	83	96
10:10	96	56	83	97
10:15	93	55	83	97
10:20	99	56	83	96
10:25	96	55	83	96

Caption: *NIBPs = Non-invasive blood pressure – systolic; NIBPd = Non-invasive blood pressure – diastolic; HR = Heart rate.
Source: Primary research data (2024).

Patient's legal guardian perspective

The patient's mother expressed relief and satisfaction with the outcome, emphasizing that the child remained calm throughout the procedure and recovered quickly without distress or prolonged drowsiness. The patient's legal guardian signed the informed consent form (ICF) for publication.

Discussion

Patients with complex congenital heart disease, such as double-inlet left ventricle with ventriculo-arterial discordance, often present conduction abnormalities secondary to surgical scarring, myocardial remodeling, and anatomical alterations related to the underlying condition[5]. This complex hemodynamic configuration increases pulmonary vascular resistance and reduces cardiac output reserve, heightening the risk of perioperative instability. Any abrupt changes in sympathetic tone or intrathoracic pressure can compromise venous return and the systemic–pulmonary flow balance, predisposing the patient to arrhythmias and low-output events. Therefore, individualized anesthetic management is essential and should prioritize hemodynamic stability, attenuation of autonomic fluctuations, and preservation of spontaneous ventilation to avoid adverse outcomes.

The right internal jugular vein was chosen for central venous catheterization based on clinical findings and literature support. The attending surgeon used ultrasound to assess potential puncture sites and determined that the internal jugular vein provided a straighter trajectory to the superior vena cava, thereby reducing the risk of mechanical complications such as inadvertent arterial puncture, hematoma, and pneumothorax[6].

The combination of ketamine and dexmedetomidine (Ketodex) produces synergistic sedation and analgesia with minimal cardiorespiratory impact. The 1:2 ratio (ketamine 0.15 mg/kg: dexmedetomidine 0.3 mcg/kg) was selected to balance sympathetic and parasympathetic tone while maintaining autonomic stability. A 1:1 ratio would enhance sympathetic tone and afterload, whereas 1:3 or higher ratios would favor bradycardia and hypotension due to α_2-adrenergic predominance[7].

The doses were intentionally subanesthetic, consistent with Miller (2020)[8] and Coté et al. (2022)[9], who describe ranges of 0.2-0.5 mg/kg for ketamine and 0.5-1 mcg/kg for dexmedetomidine. Within a multimodal context, the synergistic effect allows proportional dose reduction without loss of efficacy.

Even at 0.15 mg/kg, ketamine maintains dissociative analgesia and partial amnesia with minimal interference in myocardial contractility. In patients with low catecholaminergic reserve, its sympathetic stimulation may reverse, leading to direct myocardial depression, reinforcing the rationale for a conservative dose. Dexmedetomidine, a central α_2A agonist, promotes cooperative sedation, anxiolysis, and sympathetic modulation without compromising ventilation. Higher doses were avoided due to the risk of bradycardia and vasoconstriction, particularly in cardiac patients with partial denervation[1,10].

Fentanyl (0.5 mcg/kg) was administered at the beginning of the procedure to attenuate the adrenergic response to puncture and catheter manipulation. Although a commonly used dose, its selection was guided by pharmacokinetic and safety criteria: onset within 2-3 minutes and peak at 5-7 minutes coincide with the early phase of Ketodex action, ensuring predictable nociceptive control without prolonging sedation. Lower doses might fail to blunt acute nociceptive stimulation, whereas higher doses would increase the risk of respiratory depression, especially in stable cardiac patients under spontaneous ventilation.

The Ketodex mixture was titrated gradually, with incremental infusions of 1 mL/min up to a total of 5 mL, respecting the average onset times of ketamine (~2 min) and dexmedetomidine (~5 min). This pacing avoided overlapping plasma peaks, ensured stable sedation, preserved spontaneous ventilation, and maintained hemodynamic stability. The dosage selection also accounted for the patient's anthropometric profile (28 kg, 121 cm at 9 years old), below the expected percentile for age, reflecting chronic hypoxemia and hypercatabolic metabolism.

Continuous intraoperative monitoring confirmed cardiorespiratory stability, with a coefficient of variation <5% across all vital parameters and no statistically significant differences between baseline and final values (p>0.05). No episodes of arrhythmia or desaturation were recorded.

These findings demonstrate the feasibility of using adjusted-dose Ketodex for invasive procedures in pediatric patients with complex congenital heart disease. They reinforce that individualized titration, a multimodal approach, and meticulous monitoring allow for effective, safe, and hemodynamically stable sedation, minimizing perioperative risks.

Conclusion

Ketodex has emerged as a promising alternative for safe pediatric sedation, particularly in cases of complex congenital heart disease, by providing cardiorespiratory stability and preserving spontaneous ventilation. The adjusted-dose combination evaluated in this study (ketamine 0.15 mg/kg: dexmedetomidine 0.3 mcg/kg, 1:2 ratio), associated with a microdose of fentanyl within a multimodal strategy, proved to be effective, well-tolerated, and reproducible during a short invasive procedure such as central venous catheter insertion. It ensured hemodynamic stability, the absence of adverse events, and a rapid, smooth recovery.

These findings reinforce the importance of individualized titration, rational use of synergistic drug combinations, and a humanized anesthetic approach focused on the comfort and safety of the pediatric patient. As this is a single case report, further studies are needed to validate these findings across different clinical contexts and expand their application in pediatric anesthesia. Finally, conducting this

case in a teaching hospital highlights the role of academic environments in fostering practical medical training, applied scientific research, and the promotion of safer, more compassionate anesthesia practices.

Author's contributions

We describe contributions to the papers using the taxonomy (CRediT) provide above:

Conceptualization, Investigation, Methodology, Visualization & Writing – analysis and editing: JS Contaifer. *Project Administration, Supervision & Writing – original draft*: LA Baldiotti; JCD Arboés. *Data Curation & Formal Analysis*: JS Contaifer; LA Baldiotti; JCD Arboés.

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