Brief Commentary

Initial Experience with IV Ketamine Infusion for Treatment of Post Sternotomy Pain in a Patient with a Total Artificial Heart

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The implantation of total artificial hearts (TAHs) via midline sternotomy for the treatment of severe biventricular cardiac dysfunction is associated with complex postoperative pain management. Ketamaine increases blood pressure by raising sympathetic outflow and cardiac ouput; however, ketamine is a direct vasodilator on isolated arterial tissues. In the setting of a TAH with a mechanically fixed cardiac output, a ketamine infusion for postoperative pain control has the potential to decrease blood pressure due to direct arterial vasodilation. We present the initial experience with a ketamine infusion in a patient with a TAH with minimal observed decreases in blood pressure and significantly improved postoperative pain.

Key words: Ketamine, postoperative pain, poststernotomy pain, total artificial heart, mechanical circulation, hypotension, vasodilation

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Severe pain following an open surgical sternotomy is reported in 60% of patients and can persist as chronic pain in 25% of patients (1). Ketamine is a phencyclidine derived N-methyl-d-aspartate (NMDA) receptor antagonist that is commonly used as an adjunctive analgesic for postoperative pain control, including post sternotomy pain following cardiac surgery and ventricular assist device placement (2,3). In the setting of a preserved baroreceptor reflex and cardiac function, ketamine causes direct arterial smooth muscle relaxation due to blockade of L-type calcium channels in isolated vascular beds (6,7). The hemodynamic response to a ketamine infusion for post sternotomy analgesia in the setting of a TAH has not previously been reported. The purpose of the presented material is to analyze the hemodynamic response of a patient with a TAH to a ketamine infusion. We hypothesized observing a modest decrease in blood pressure due to ketamine's direct vasodilatory properties in the setting of a TAH providing a fixed and uncompensating cardiac output, heart rate, and contractile state.

Case Description

Written consent for this case report was obtained from the patient. The pain service was consulted to evaluate severe chest pain in a 25-year-old 80 kg man following successful implantation of a TAH via a midline sternotomy. The TAH had been implanted 48 hours prior to consultation for a history of a failed prior heart transplantation. The patient did not have a history of opioid use prior to this surgery. The patient did not exhibit signs of opioid tolerance, withdrawal, or opioid-induced hyperalgesia or allodynia. Postoperatively, the patient was taking 900 mg gabapentin twice daily, 12 mg oral hydromorphone twice daily, and had been receiving an intravenous (IV) hydromorphone at 0.2 mg/hour via a patient controlled analgesia (PCA) system for 24 hours. Pain scores were consistently a "10" on an 11-point numerical rating scale (NRS) with zero being no pain and 10 being the worst pain imaginable. The pain team augmented the IV-PCA solution with a ketamine infusion given at a rate of 0.2 mg/hr. Per institutional protocol, the 2 medications were mixed by the pharmacy and infused as a

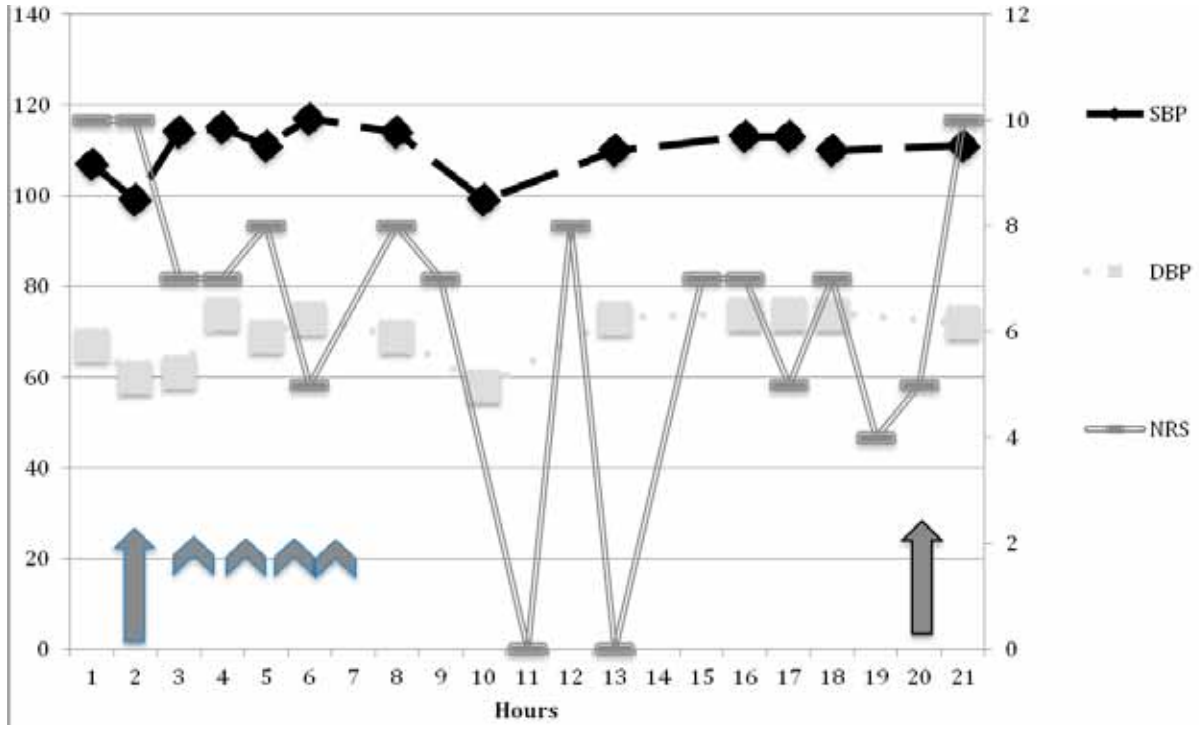

Fig. 1. *TAH Function, Physiologic Parameters, and Numerical Rating Scale Pain Score. SBP = systolic blood pressure, DBP = diastolic blood pressure, NRS = numerical rating scale. SBP and DBP use the left vertical axis for scale. NRS uses the right vertical axis for scale. The long arrows indicate when the mixed ketamine and hydromorphone infusion was initiated and subsequently discontinued. The chevrons indicate patient controlled boluses of the mixed ketamine and hydromorphone infusion. Two hours prior to the initiation of the mixed infusion and 2 hours after the discontinuation of the mixed infusion are shown to demonstrate the patient's response to hydromorphone PCA infusion. Initial TAH settings included heart rate of 130 beats per minutes, 50% systolic time, left drive pressure 180 mmHg, right drive pressure 90 mmHg, and a biventricular vacuum of -10 mmHg. Initial right fill volumes (RFV) were 50 mL, right cardiac output (RCO) was 6.6 L/minute, left fill volumes (LFV) were 54 mL, and left cardiac output (LCO) was 7.3 L/minute.*

single PCA solution. While receiving the PCA solution, TAH settings remained constant. The patient's systolic and diastolic blood pressures and NRS pain scores are presented (Fig. 1). In addition to the basal PCA rate, the patient received 4 additional boluses of the mixed solution. Each bolus contained 0.5 mg of hydromorphone and 0.5 mg of ketamine. The patient remained on gabapentin but did not require any additional opioids while on the infusion. While receiving the mixed ketamine and hydromorphone PCA solution, the patient's blood pressure remained stable. Pre-infusion blood pressure was 107/67 mmHg. While receiving the mixed infusion, the highest recorded blood pressure was 2 hours after initiation and was 117/73 mmHg. The lowest recorded blood pressure was 99/58 mmHg and occurred 6 hours after initiation. The infusion was switched to a hydromorphone infusion after 18 hours at the request of the attending surgeon. At the time of discontinuation, the patient reported no signs of altered mental status or dysphoria and no adverse psychologic effects were observed.

Discussion

Ketamine causes direct relaxation of arterial smooth muscle (6). In patients with preserved cardiac physiology, a catecholamine-induced rise in cardiac output is sufficient to overcome this direct vasodilation and instead causes an observed rise in blood pressure secondary to increased cardiac output (4). In the setting of a fixed mechanical cardiac output, such as a TAH, a patient's physiologic response to a ketamine infusion has not previously been reported. This initial

report of the use of a ketamine infusion in a patient with a TAH was associated with both effective treatment of post sternotomy pain and a lack of significant changes in the patient's measured stystolic or diastolic arterial blood pressures. While receiving the mixed ketamine and hydromorphone, the patient was able to achieve subjectively adequate comfort and lower NRS scores compared to intermittent opioid boluses or a hydromorphone PCA (Fig. 1). Twice the patient was able to achieve a NRS score of zero. These findings highlight the relatively minor contribution that ketamine-induced vasodilation has on systemic blood pressure while emphasizing ketamine's safety and usefulness as an analgesic. In conclusion, the initial experience with ketamine infusions in the setting of a TAH demonstrates safe and effective perioperative pain control with minimal effects on the both the TAH function and patient physiologic measurements.

References

1. Lahtinen P, Kokki H, Hynynen M. Pain after cardiac surgery: A prospective cohort study of 1-year incidence and intensity. *Anesthesiology* 2006; 105:794-800.
2. Lahtinen P, Kokki H, Hakala T, Hynynen M. S(+)-ketamine as an analgesic adjunct reduces opioid consumption after cardiac surgery. *Anesth Analg* 2004; 99:1295-1301; table of contents.
3. Kocabas S, Askar FZ, Yagdi T, Engin C, Ozbaran M. Anesthesia for ventricular assist device placement in pediatric patients: Experience from a single center. *Transplant Proc* 2013; 45:1009-1012.
4. Gelissen HP, Epema AH, Henning RH, Krijnen HJ, Hennis PJ, den Hertog A. Inotropic effects of propofol, thiopental, midazolam, etomidate, and ketamine on isolated human atrial muscle. *Anesthesiology* 1996; 84:397-403.
5. Adams HA. [S-(+)-ketamine. Circulatory interactions during total intravenous anesthesia and analgesia-sedation]. *Anaesthesist* 1997; 46:1081-1087.
6. Akata T, Izumi K, Nakashima M. Mechanisms of direct inhibitory action of ketamine on vascular smooth muscle in mesenteric resistance arteries. *Anesthesiology* 2001; 95:452-462.
7. Jung I, Jung SH. Vasorelaxant mechanisms of ketamine in rabbit renal artery. *Korean J Anesthesiol* 2012; 63:533-539.