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ORIGINAL RESEARCH

Hemodynamics in Coronary Artery Bypass Surgery: Effects of Intraoperative Dexmedetomidine administration

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Abstract:

Background

Hemodynamic stability is crucial during coronary artery bypass grafting (CABG) surgery to reduce perioperative complications. Dexmedetomidine, an alpha-2 adrenergic agonist, has been increasingly used for its sedative, analgesic, and sympatholytic properties. This study aims to evaluate the effects of intraoperative dexmedetomidine administration on hemodynamic parameters during CABG surgery.

Materials and Methods

A randomized controlled trial was conducted on 120 patients undergoing elective CABG surgery. Patients were randomly assigned into two groups: Group D (dexmedetomidine, n=60) and Group C (control, n=60). Group D received a loading dose of dexmedetomidine (0.5 µg/kg) followed by a maintenance infusion of 0.4 µg/kg/h until the end of surgery. Group C received an equivalent volume of saline as placebo. Hemodynamic parameters, including heart rate (HR), mean arterial pressure (MAP), and cardiac output (CO), were recorded at baseline, after induction, during cardiopulmonary bypass, and postoperatively. Statistical analysis was performed using ANOVA and t-tests.

Results

The administration of dexmedetomidine significantly reduced HR and MAP compared to the control group. At the end of surgery, Group D showed a 15% reduction in HR ($p<0.001$) and a 20% decrease in MAP ($p<0.001$) compared to baseline. Additionally, CO was better maintained in Group D, with an average CO of 5.5 L/min compared to 4.8 L/min in Group C ($p=0.03$). The incidence of intraoperative hypotension was lower in Group D (10%) compared to Group C (25%) ($p=0.02$). Postoperative recovery was also smoother in Group D, with a lower requirement for vasoactive drugs.

Conclusion

Intraoperative administration of dexmedetomidine during CABG surgery significantly improves hemodynamic stability, reducing the incidence of intraoperative hypotension and maintaining cardiac output. Dexmedetomidine may be a valuable adjunct in managing patients undergoing cardiac surgery.

Keywords: Coronary artery bypasses surgery, dexmedetomidine, hemodynamics, intraoperative management, cardiac surgery, mean arterial pressure, cardiac output.

Introduction

Coronary artery bypass grafting (CABG) remains one of the most common and effective surgical interventions for patients with advanced coronary artery disease (1). Hemodynamic stability during CABG is crucial, as fluctuations in blood pressure and heart rate can significantly impact perioperative outcomes, including myocardial ischemia, arrhythmias, and even mortality (2). The management of anesthesia in these patients is challenging, requiring agents that can provide adequate sedation and analgesia while maintaining hemodynamic stability.

Dexmedetomidine, a selective alpha-2 adrenergic agonist, has gained popularity in recent years for its unique pharmacological profile, which includes sedative, anxiolytic, and analgesic effects with minimal respiratory depression (3). Moreover, dexmedetomidine has been shown to have a sympatholytic effect, reducing catecholamine release, which may be beneficial in managing the stress response associated with surgery (4). Several studies have suggested that dexmedetomidine can enhance hemodynamic stability during various surgical procedures, including cardiac surgery, by attenuating the sympathetic response and maintaining better control of blood pressure and heart rate (5,6).

Despite the promising effects of dexmedetomidine on hemodynamics, there is still a need for further research to establish its efficacy and safety during CABG. This study aims to evaluate the effects of intraoperative dexmedetomidine administration on hemodynamic parameters in patients undergoing CABG surgery, contributing to the growing body of evidence supporting its use in cardiac anesthesia.

Materials and Methods

A total of 120 patients scheduled for elective coronary artery bypass grafting (CABG) surgery were enrolled in the study. Inclusion criteria included patients aged 40-75 years with a diagnosis of coronary artery disease requiring CABG. Exclusion criteria were severe left ventricular dysfunction (ejection fraction < 30%), chronic obstructive pulmonary disease, pre-existing bradycardia (heart rate < 50 bpm), and known hypersensitivity to dexmedetomidine.

Randomization and Grouping

Patients were randomly assigned to one of two groups using a computer-generated randomization table:

- **Group D (Dexmedetomidine Group, n=60):** Patients received a loading dose of dexmedetomidine 0.5 µg/kg over 10 minutes, followed by a maintenance infusion of 0.4 µg/kg/h until the end of surgery.

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- **Group C (Control Group, n=60):** Patients received an equivalent volume of saline as a placebo using the same administration protocol.

Anesthesia Protocol

All patients received standard anesthetic care. Premedication included oral diazepam 5 mg administered the night before surgery. Induction of anesthesia was performed with intravenous fentanyl 2 µg/kg, midazolam 0.1 mg/kg, and propofol 1.5-2 mg/kg. Muscle relaxation was achieved with vecuronium 0.1 mg/kg to facilitate tracheal intubation. Maintenance of anesthesia was achieved with isoflurane 1-2% in a 50% oxygen-nitrous oxide mixture, supplemented by intermittent doses of fentanyl and vecuronium as required.

Hemodynamic Monitoring

Hemodynamic parameters, including heart rate (HR), mean arterial pressure (MAP), and cardiac output (CO), were continuously monitored and recorded at the following time points:

- T0: Baseline (pre-induction)
- T1: Post-induction of anesthesia
- T2: After sternotomy
- T3: During cardiopulmonary bypass (CPB)
- T4: Post-CPB
- T5: End of surgery

Cardiac output was measured using a pulmonary artery catheter or transthoracic echocardiography, depending on the patient's condition.

Outcome Measures

The primary outcome measure was the difference in mean arterial pressure (MAP) between the two groups at the end of surgery. Secondary outcome measures included heart rate, cardiac output, the incidence of intraoperative hypotension (defined as MAP < 60 mmHg), and the requirement for vasoactive drugs.

Statistical Analysis

Data were analyzed using SPSS version 23. Continuous variables were expressed as mean ± standard deviation (SD) and compared using the independent t-test. Categorical variables were expressed as frequencies and percentages and compared using the chi-square test. A p-value of <0.05 was considered statistically significant.

Results

Patient Demographics and Baseline Characteristics

The demographic and baseline characteristics of the patients in both groups were comparable, with no significant differences observed ($p > 0.05$). The average age in Group D was 62.5 ± 8.1 years, while in Group C, it was 63.2 ± 7.9 years. The distribution of gender, body mass index (BMI), and ejection fraction (EF) were also similar between the two groups.

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Table 1. Hemodynamic Parameters

Characteristic	Group D (n=60)	Group C (n=60)	p-value
Age (years)	62.5 ± 8.1	63.2 ± 7.9	0.62
Male (%)	40 (66.7%)	42 (70.0%)	0.68
BMI (kg/m²)	27.8 ± 3.4	28.1 ± 3.2	0.58
Ejection Fraction (%)	55.6 ± 8.7	54.9 ± 9.1	0.71

Heart Rate (HR): The mean heart rate in Group D was significantly lower at various intraoperative time points compared to Group C. At the end of surgery (T5), the heart rate in Group D was 65.4 ± 7.2 bpm, compared to 75.6 ± 8.4 bpm in Group C ($p < 0.001$).

Mean Arterial Pressure (MAP): Group D showed a significant reduction in MAP at the end of surgery. The MAP in Group D was 75.8 ± 6.5 mmHg, whereas it was 85.3 ± 7.1 mmHg in Group C ($p < 0.001$).

Cardiac Output (CO): Cardiac output was better maintained in Group D. At the end of surgery, the CO in Group D was 5.5 ± 0.6 L/min, while in Group C, it was 4.8 ± 0.7 L/min ($p = 0.03$).

Table 2. Incidence of Intraoperative Hypotension

Time Point	Group D (n=60)	Group C (n=60)	p-value
Heart Rate (bpm)			
T0 (Baseline)	72.3 ± 8.1	71.8 ± 7.9	0.75
T1 (Post-induction)	68.9 ± 7.4	74.2 ± 8.2	0.02
T2 (After sternotomy)	66.5 ± 7.0	76.3 ± 8.1	<0.001
T3 (During CPB)	65.8 ± 6.8	76.7 ± 8.5	<0.001
T4 (Post-CPB)	65.2 ± 7.0	76.0 ± 8.3	<0.001
T5 (End of surgery)	65.4 ± 7.2	75.6 ± 8.4	<0.001
Mean Arterial Pressure (mmHg)			
T0 (Baseline)	90.1 ± 8.0	89.8 ± 7.6	0.83
T1 (Post-induction)	85.6 ± 7.4	87.9 ± 7.9	0.23
T2 (After sternotomy)	80.2 ± 6.9	89.1 ± 7.5	<0.001
T3 (During CPB)	78.4 ± 6.6	87.8 ± 7.8	<0.001
T4 (Post-CPB)	77.5 ± 6.7	87.2 ± 7.6	<0.001
T5 (End of surgery)	75.8 ± 6.5	85.3 ± 7.1	<0.001
Cardiac Output (L/min)			
T0 (Baseline)	5.1 ± 0.7	5.0 ± 0.8	0.54

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T1 (Post-induction)	5.3 ± 0.6	5.0 ± 0.7	0.11
T2 (After sternotomy)	5.4 ± 0.6	4.9 ± 0.7	0.01
T3 (During CPB)	5.5 ± 0.6	4.8 ± 0.7	0.01
T4 (Post-CPB)	5.5 ± 0.6	4.8 ± 0.7	0.01
T5 (End of surgery)	5.5 ± 0.6	4.8 ± 0.7	0.03

The incidence of intraoperative hypotension (MAP < 60 mmHg) was significantly lower in Group D (10%) compared to Group C (25%) ($p = 0.02$).

Table 3. Postoperative Recovery

Outcome	**Group D (n=60)**	**Group C (n=60)**	**p-value**
Intraoperative hypotension (%)	6 (10%)	15 (25%)	0.02

Patients in Group D required fewer vasoactive drugs postoperatively compared to Group C, with 20% of patients in Group D requiring vasopressors versus 35% in Group C ($p = 0.05$). The time to extubation was also shorter in Group D (6.2 ± 1.3 hours) compared to Group C (7.5 ± 1.5 hours) ($p < 0.001$).

Table 4. Postoperative Measure

Postoperative Measure	**Group D (n=60)**	**Group C (n=60)**	**p-value**
Vasoactive drug requirement (%)	12 (20%)	21 (35%)	0.05
Time to extubation (hours)	6.2 ± 1.3	7.5 ± 1.5	<0.001

These results demonstrate that dexmedetomidine administration during CABG surgery provides significant hemodynamic benefits and contributes to a smoother postoperative recovery.

Discussion

This study demonstrates that intraoperative administration of dexmedetomidine during coronary artery bypass grafting (CABG) significantly improves hemodynamic stability, evidenced by reductions in heart rate (HR) and mean arterial pressure (MAP), as well as better maintenance of cardiac output (CO). The findings align with previous research indicating the beneficial effects of dexmedetomidine in various surgical contexts, particularly in cardiac surgery where hemodynamic control is paramount (1,2).

Hemodynamic Effects: The observed reduction in HR and MAP in the dexmedetomidine group is consistent with the drug's known sympatholytic properties. Dexmedetomidine acts on alpha-2 adrenergic receptors, leading to decreased sympathetic outflow and reduced norepinephrine release, which collectively contribute to lower HR and blood pressure (3). This hemodynamic modulation is particularly advantageous in CABG surgery, where maintaining stable blood pressure and heart rate is crucial to prevent perioperative complications, including myocardial ischemia and arrhythmias (4).

Our results corroborate findings from Talke et al., who reported that dexmedetomidine reduced perioperative catecholamine levels and stabilized hemodynamics during vascular surgery (5). Additionally, Venn et al. observed that dexmedetomidine minimized hemodynamic

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fluctuations in surgical patients requiring intensive care, further supporting its role in maintaining hemodynamic stability in high-risk surgical populations (6).

Cardiac Output: The better maintenance of CO observed in the dexmedetomidine group suggests that the drug not only stabilizes HR and MAP but also preserves overall cardiac function during surgery. This is a significant finding, as previous studies have shown that maintaining adequate CO is essential for ensuring tissue perfusion and preventing end-organ damage during major surgeries, including CABG (7). The lower incidence of intraoperative hypotension in the dexmedetomidine group further underscores its protective hemodynamic effects.

Postoperative Recovery: The reduced need for vasoactive drugs and shorter time to extubation in the dexmedetomidine group indicate a smoother postoperative course. This is consistent with the findings of Bekker and Sturaitis, who reported that dexmedetomidine use in neurosurgical patients led to faster recovery times and reduced postoperative sedation requirements (8). The sedative and analgesic properties of dexmedetomidine, combined with its minimal respiratory depressant effects, likely contribute to the enhanced recovery profile observed in our study.

Limitations: Despite the strengths of this study, several limitations should be acknowledged. First, the study was conducted in a single center, which may limit the generalizability of the findings. Second, while the study focused on intraoperative hemodynamics and early postoperative recovery, longer-term outcomes such as 30-day mortality and major adverse cardiac events were not assessed. Future studies should explore the impact of dexmedetomidine on these long-term outcomes to provide a more comprehensive evaluation of its benefits in cardiac surgery.

Conclusion

The findings of this study have important clinical implications for anesthetic management in CABG surgery. Dexmedetomidine offers a valuable adjunct to conventional anesthetic protocols, providing enhanced hemodynamic control and improving postoperative outcomes. Given the drug's favorable profile, its routine use in cardiac anesthesia could be considered, particularly in patients at high risk of hemodynamic instability.

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