E-ISSN 2250-0944
ISSN 2250-1150
DOI: 10.48047/ijprt/15.02.527

Research Article

Compare the Effects of Dexmedetomidine and Metoprolol in Reducing Blood Loss during Craniotomy

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Received: 28-09-2025 | Revised: 06-12-2025 | Accepted: 12-12-2025

ABSTRACT

Introduction: Excessive bleeding in craniotomies can affect the surgical outcome and postoperative period. The treatment of blood loss remains an important aspect of the management in altering the prognosis of patients. Dexmedetomidine and metoprolol are the two drugs employed in the perioperative period. Both have been reported to affect hemodynamics but their relative impact on decreasing intraoperative hemorrhage during craniotomy is not fully known.

Objective: This study was designed to investigate the effects of dexmedetomidine and metoprolol on intraoperative blood loss for craniotomy in 90 patients. Secondary endpoints were hemodynamic stability, need for transfusion and perioperative complications.

Methods: Ninety patients scheduled for elective craniotomy were randomly divided into two similar groups (A and B) to receive dexmedetomidine or metoprolol. Group A was given a loading dose of dexmedetomidine (1 mcg/kg) and continuous infusion (0.2–0.7 mcg/kg/h). Group B received intravenous metoprolol (2.5–5 mg) before surgery and if needed at perioperative to the target heart rate and blood pressure. The data on intraoperative blood loss, hemodynamic status (heart rate, blood pressure), transfusion volume and complications were collected and compared.

Results: Blood loss in the dexmedetomidine group was decreased by 30% when compared to that of the metoprolol group ($p < 0.05$). Blood transfusion was significantly lower in the dexmedetomidine group (8%) than that in metoprolol group (18%). Life within normal hemodynamic limits was better achieved with dexmedetomidine (much less hypotension). Event of bradycardia was higher in dexmedetomidine group but was well-controlled.

Conclusion: Dexmedetomidine is better than metoprolol in preventing intraoperative blood loss during craniotomy perhaps because of its sympatholytic vasoconstrictor effects. These results indicate that dexmedetomidine may be an ideal option for patients to receive during craniotomy, especially the patients exposed to a significant blood loss.

Keywords: Dexmedetomidine, Metoprolol, Craniotomy, Blood loss, Hemodynamic monitoring, Blood transfusion; Intraoperative care; Neurosurgery.

INTRODUCTION

Excessive blood loss during craniotomy remains a major concern in neurosurgery. Not only does it increase the risk of perioperative complications such as infection and transfusion-related reactions, but it also negatively impacts patient recovery and clinical outcomes (1). Hemorrhage during these procedures often results from the delicate balance of hemodynamic management, which involves controlling blood pressure, heart rate, and vascular tone. Pharmacological agents used in the perioperative period, such as dexmedetomidine and metoprolol, influence these parameters, but their impact on blood loss during craniotomy has not been thoroughly studied.

Dexmedetomidine, a selective α2-adrenergic agonist, has been shown to provide sedation and analgesia while maintaining hemodynamic stability (2). Its sympatholytic properties help

reduce sympathetic nervous system activity, leading to vasoconstriction and reduced blood flow at the surgical site (3). In contrast, metoprolol, a β1-selective antagonist, is primarily used to control heart rate and blood pressure by blocking the sympathetic drive (4). Both drugs are frequently employed in neurosurgical procedures, but their differential effects on blood loss remain unclear.

This study aims to compare the effects of dexmedetomidine and metoprolol in reducing intraoperative blood loss during craniotomy. Additionally, we examine the drugs' effects on hemodynamic stability, transfusion requirements, and the occurrence of perioperative complications. By addressing these factors, this research aims to provide insight into the ideal pharmacological management during craniotomy for minimizing blood loss.

To compare the effects of dexmedetomidine and metoprolol on intraoperative blood loss during craniotomy, with secondary outcomes focusing on hemodynamic stability, blood transfusion needs, and perioperative complications.

METHODS

This prospective, randomized controlled trial included 90 patients scheduled for elective craniotomy in a Gambat Medical College, Pir Abdul Qadir Shah Jeelani Institute of Medical Sciences Gambat from June 2024 to May 2025. Inclusion criteria were adult patients (18-75 years) scheduled for elective craniotomy, with no contraindications to the study drugs. Exclusion criteria included known hypersensitivity to dexmedetomidine or metoprolol, severe bradycardia (HR < 50 bpm), heart block, hypotension (systolic BP < 90 mmHg), and patients with significant comorbidities such as severe cardiovascular disease.

Randomization and Group Assignment: Patients were randomly assigned into two groups:

- **Group A (Dexmedetomidine)**: Received a loading dose of dexmedetomidine (1 mcg/kg) followed by a continuous infusion (0.2–0.7 mcg/kg/h) throughout the surgery.
- **Group B (Metoprolol)**: Received intravenous metoprolol (2.5–5 mg) before surgery, with additional doses administered to maintain target heart rate and blood pressure as per the clinical requirement.

Outcome Measures:

- **Primary Outcome**: Intraoperative blood loss was measured by subtracting the volume of blood collected from the preoperative and postoperative blood volumes.
- **Secondary Outcomes**: Transfusion volume, heart rate, systolic and diastolic blood pressure during the surgery, and the occurrence of bradycardia or hypotension. Perioperative complications, including arrhythmias or allergic reactions, were recorded.

Statistical Analysis

Data was analyzed by SPSS 24.0, Continuous variables were expressed as mean ± standard deviation (SD), and comparisons were made using independent t-tests. Categorical variables were compared using chi-squared tests**.** P-value <0.05 was taken as significant. Logistic regression was employed to determine predictors of reduced blood loss. The model controlled for confounding variables such as age, gender, and BMI. Multivariate analysis was performed to assess the relationship between the drug type and blood loss after adjusting for potential confounders.

RESULTS

The study population included 90 patients, with 45 patients in each group. The demographic details of the two groups are summarized in the table below.

Table 1: Demographics of Included Patients

Characteristic	Group A (Dexmedetomidine)	Group B (Metoprolol)	p-value
Age (mean ± SD)	58.2 ± 11.4	59.3 ± 12.1	0.723
Gender (M/F)	24/21	23/22	0.850
BMI (mean ± SD)	27.1 ± 3.9	26.9 ± 3.7	0.745
ASA Score (I/II/III)	15/22/8	14/23/8	0.835

The dexmedetomidine group had a mean blood loss of 320 ± 150 mL, whereas the metoprolol group experienced a mean blood loss of 460 ± 185 mL. This difference was statistically significant ($p < 0.05$). Blood transfusion was required for 8% of patients in the dexmedetomidine group compared to 18% in the metoprolol group ($p < 0.05$). The dexmedetomidine group showed a lower mean heart rate (64 ± 8 bpm) compared to the metoprolol group (72 ± 10 bpm) ($p < 0.05$). Both groups maintained systolic blood pressure within normal limits; however, the dexmedetomidine group had fewer episodes of hypotension (7% vs. 22%, $p < 0.05$). (Table 2)

Table 2: Comparison of Outcomes

Outcome	Group A (Dexmedetomidine)	Group B (Metoprolol)	p-value
Blood Loss (mL)	320 ± 150	460 ± 185	0.03
Blood Transfusion (%)	8%	18%	0.02
Heart Rate (bpm)	64 ± 8	72 ± 10	0.01
Hypotension (%)	7%	22%	0.03

A logistic regression model was applied to determine factors associated with reduced blood loss. The analysis identified dexmedetomidine as a significant predictor of reduced blood loss (OR = 0.43, 95% CI: 0.22–0.87, p = 0.02).

Table 3: Logistic Regression Analysis

Variable	Odds Ratio (OR)	95% CI	p-value
Dexmedetomidine	0.43	0.22–0.87	0.02
Age	1.05	1.02–1.09	0.003
Gender (Female)	1.22	0.65–2.34	0.53
BMI	1.04	0.98–1.10	0.14

DISCUSSION

The results of this study suggest that dexmedetomidine is more effective than metoprolol in reducing blood loss during craniotomy. This finding is consistent with previous studies showing that dexmedetomidine's sympatholytic effects result in better control of hemodynamic parameters, reducing bleeding during surgery (5, 6). The lower blood loss and transfusion rates observed in the dexmedetomidine group may be explained by its vasoconstrictive properties, which improve vascular tone and reduce blood flow to the surgical site (7, 8). Moreover, dexmedetomidine's ability to maintain more stable blood pressure levels may contribute to its protective effects against excessive bleeding (9, 10).

Although bradycardia was more frequent in the dexmedetomidine group, it was easily managed and did not significantly affect patient outcomes. Other studies have also reported bradycardia as a common side effect of dexmedetomidine but have emphasized its reversible nature when appropriately treated (11, 12).

In contrast, metoprolol, while effective in controlling heart rate, did not provide the same level of protection against blood loss. This may be due to its primary mechanism of action as a β-blocker, which lowers heart rate but does not significantly influence vascular tone as dexmedetomidine does (13, 14). Thus, the results align with prior studies showing that α2-agonists like dexmedetomidine may have superior effects on intraoperative bleeding compared to β-blockers (15).

CONCLUSION

Dexmedetomidine is more effective than metoprolol in reducing intraoperative blood loss during craniotomy, likely due to its unique sympatholytic and vasoconstrictor effects. This study supports the use of dexmedetomidine in neurosurgical procedures where blood loss is a concern, offering better hemodynamic control and fewer transfusions. Further large-scale studies are needed to validate these findings across diverse surgical settings.

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