*RESEARCH*

# Effects of Dexmedetomidine Versus Propofol–Fentanyl on QoR-15 Recovery in Cranioplasty

Mhd Fadli✉*, Rr Sinta Irina**, Luwih Bisono**

*Faculty of Medicine, Universitas Sumatera Utara, Medan, Indonesia
**Department of Anesthesiology and Intensive Therapy, Faculty of Medicine, Universitas Sumatera Utara, Medan, Indonesia

✉Correspondence: mhafadly@gmail.com

## ABSTRACT

**Background:** Optimizing postoperative recovery is essential in neurosurgical anesthesia. Dexmedetomidine, a selective α2-adrenergic agonist, may improve sedation and recovery outcomes.

**Objective:** This study compared intraoperative dexmedetomidine versus propofol-fentanyl in cranioplasty patients using the Quality of Recovery-15 (QoR-15) score.

**Methods:** A prospective comparative study was conducted at Adam Malik General Hospital and Haji Medan Hospital from May - August 2025 involving 42 adult patients undergoing elective cranioplasty. Subjects were divided into two groups: dexmedetomidine (n=21) and propofol-fentanyl (n=21). Quality of Recovery-15 (QoR-15), a validated 15-item questionnaire assessing five domains of postoperative recovery (pain, physical comfort, emotional state, psychological support, and physical independence; total score range 0–150), was recorded at 12 and 24 hours postoperatively. Hemodynamic parameters, depth of sedation, and operator satisfaction were assessed. Data were analyzed using t-tests and Fisher's exact test with $p < 0.05$.

**Results:** Patients receiving dexmedetomidine showed higher QoR-15 scores at 12 hours ($p = 0.045$) and 24 hours ($p = 0.003$). Heart rate was significantly lower ($p = 0.02$), while systolic and diastolic pressures showed no significant differences. Sedation depth and operative duration were comparable. Operator satisfaction reached 100% in both groups. Dexmedetomidine improved recovery quality compared to propofol-fentanyl, with better hemodynamic stability and fewer sympathetic responses. These findings align with previous studies supporting its use in enhanced recovery anesthesia. Limitations include a small sample size and a lack of intraoperative sedation monitoring.

**Conclusion:** Intraoperative dexmedetomidine offers superior recovery quality and stable hemodynamics, suggesting its potential for broader use in neurosurgical anesthesia.

**Keywords:** anesthesia recovery; cranioplasty; dexmedetomidine; fentanyl; propofol

## INTRODUCTION

General anesthesia plays a fundamental role in facilitating surgical procedures, including cranioplasty, where safe and effective anesthetic management is essential. Cranioplasty, performed weekly at Adam Malik General Hospital in Medan, presents unique anesthetic challenges due to its neurosurgical nature and the need for rapid yet smooth recovery to minimize postoperative complications and hospitalization length.[1] The selection of anesthetic agents, particularly dexmedetomidine, propofol, and fentanyl, can significantly influence intraoperative stability and postoperative outcomes.[2] Recent studies have shown that anesthetic management affects not only physiological parameters but also the patient's immune response, including modulation of inflammatory pathways and surgical stress.[3] Dexmedetomidine, in particular, has been shown to reduce sympathetic activity and suppress pro-inflammatory cytokines, such as interleukin-6 (IL-6) and tumor necrosis factor-α (TNF-α).[4,5,6] These effects are believed to contribute to improved healing trajectories and decreased postoperative fatigue in surgical patients.[3]

Although various anesthetic protocols have been studied for their impact on recovery time, pain control, and emergence characteristics, few have focused on the patient's overall quality of recovery. The Quality of Recovery-15 (QoR-15) questionnaire, a validated tool comprising five domains: pain, physical comfort, emotional state, psychological support, and physical independence, offers a holistic assessment of postoperative recovery.[7] Recent evidence has demonstrated that QoR-15 scores 24 hours after surgery are significantly associated with long-term quality of life outcomes.[8,9] Comparative studies have evaluated dexmedetomidine and fentanyl in various surgeries, such as laparoscopy,[10] supratentorial neurosurgery,[11] and endoscopic retrograde cholangiopancreatography (ERCP),[12] with findings suggesting faster recovery, more stable hemodynamics, and fewer adverse effects in dexmedetomidine groups. However, specific data on cranioplasty patients and direct comparisons of recovery quality using validated metrics like QoR-15 remain limited, underscoring the need for further investigation in this population.

This study aims to compare the effects of dexmedetomidine-propofol versus fentanyl-propofol combinations on the quality of recovery from general anesthesia, assessed by QoR-15 scores in patients undergoing cranioplasty at Adam Malik General Hospital. While previous research has highlighted intraoperative stability and emergence profiles, this study uniquely focuses on multidimensional recovery from the patient's perspective, integrating subjective and clinical outcomes. The novelty lies in evaluating the contribution of dexmedetomidine to enhanced recovery quality and hemodynamic stability in the context of neurosurgery, an area still underrepresented in current literature. The findings are expected to inform better anesthetic strategies tailored to improve both short- and long-term postoperative outcomes in neurosurgical settings.

## METHOD

This is a prospective comparative study conducted at Adam Malik General Hospital and Haji Medan Hospital from May - August 2025, following approval from the Health Research Ethics Committee, Faculty of Medicine,

Universitas Sumatera Utara (Approval No: 345/KEPK/FKUSU/2025). The study aimed to compare the effects of intraoperative dexmedetomidine versus fentanyl–propofol infusion on the quality of recovery following general anesthesia in cranioplasty patients, assessed using the QoR-15 questionnaire.

Participants were adults aged 18–65 years undergoing elective cranioplasty under general anesthesia with endotracheal intubation. Inclusion criteria included glasgow coma scale (GCS) of 15, no motor neurological deficits, and surgery duration under 3 hours. Exclusion criteria were allergy to anesthetic agents, chronic pain, or psychiatric history. Informed consent was obtained from all patients. Sample size was calculated to require 19 subjects per group, increased to 42 to account for potential dropouts. Subjects were selected via simple random sampling and allocated into two groups using randomizer.org.

Both groups received standard general anesthesia induction with fentanyl 2 mcg/kg, propofol 2 mg/kg, and rocuronium 0.6 mg/kg, followed by maintenance with sevoflurane 1 vol%. The fentanyl group received fentanyl 0.5 mcg/kg plus propofol 50 mcg/kg/h via syringe pump, while the dose of dexmedetomidine 0.5 mcg/kg was selected based on previous clinical studies demonstrating that this dose provides adequate sedation and hemodynamic stability while minimizing the risk of bradycardia and hypotension in neurosurgical patients. This moderate loading dose has been widely used in intraoperative settings to achieve sympatholytic and analgesic effects without excessive sedation, both in identical covered syringes to maintain blinding. Postoperative analgesia included IV paracetamol 1 g and ibuprofen 400 mg every 6 hours. Rescue fentanyl (1 mcg/kg) was administered if NRS ≥ 7. Recovery quality was assessed 24 hours post-extubation using the QoR-15 instrument. Hemodynamic parameters, pain scores, adverse effects, and surgeon satisfaction were also recorded.

Data were analyzed using SPSS version 26. Continuous variables were tested with the t-test or Mann–Whitney U test, and categorical data with the chi-square or Fisher's exact test. A p-value of $\leq 0.05$ was considered statistically significant.

## RESULTS

This study included 42 patients undergoing cranioplasty, randomized equally into two groups: 21 received intraoperative fentanyl combined with propofol, and 21 received dexmedetomidine. All participants fulfilled the inclusion and exclusion criteria, and there were no dropouts during the study. The baseline characteristics of both groups were comparable. The mean age in the fentanyl + propofol group was 61.28 ± 8.12 years, while in the dexmedetomidine group it was 55.04 ± 8.32 years, with no statistically significant difference ($p = 0.180$). Gender distribution and the American Society of Anesthesiologists' (ASA) physical status were also similar between groups ($p > 0.05$). However, the mean duration of surgery was significantly shorter in the dexmedetomidine group (148.9 minutes) compared to the fentanyl + propofol group (155 minutes) ($p = 0.034$). (Table 1)

Intraoperative hemodynamic monitoring revealed no significant differences in systolic or diastolic blood pressure between groups. The mean systolic

pressure in the fentanyl + propofol group was 99.52 mmHg, compared to 98.67 mmHg in the dexmedetomidine group, while diastolic pressures were 57.67 mmHg and 64.04 mmHg, respectively. However, a significantly lower heart rate was observed in the dexmedetomidine group (65.90 bpm) compared to the fentanyl + propofol group (81.38 bpm), indicating better heart rate stability ($p = 0.02$). (Table 2)

The quality of postoperative recovery was assessed using the QoR-15 questionnaire at two time points: 12 hours (T1) and 24 hours (T2) after surgery. The dexmedetomidine group demonstrated higher median QoR-15 scores at both time points. At T1, the median score was 140 (IQR: 130–148) in the dexmedetomidine group and 135 (IQR: 125–147) in the fentanyl + propofol group. At T2, the median scores were 138 (IQR: 125–140) and 130 (IQR: 120–145), respectively. Both differences were statistically significant ($p = 0.045$ and $p = 0.003$). (Figure 1)

Further analysis of QoR-15 scores based on recovery quality classification revealed that at 12 hours postoperatively, 90.5% of patients in the dexmedetomidine group were categorized as having "good" recovery, compared to 66.7% in the fentanyl + propofol group. At 24 hours, this increased to 95% in the dexmedetomidine group, whereas it declined to 52% in the fentanyl + propofol group. These statistically significant findings ($p = 0.045$ and $p = 0.003$, respectively). (Table 3)

Regarding surgical diagnosis, traumatic brain injury was the most common indication for cranioplasty in both groups, followed by brain tumors, stroke or hemorrhage, and infection or decompression. There were no significant differences in diagnosis distribution between the two groups, as summarized in Table 1.

Operator satisfaction was evaluated to assess the perceived quality of sedation, analgesia, and intraoperative stability. All operators (100%) in both groups reported high satisfaction with the anesthetic technique used. This was based on criteria such as hemodynamic stability, ease of the surgical procedure, and smooth emergence from anesthesia.

Finally, the depth of sedation was measured using the Ramsay sedation scale (RSS) in the recovery room (RR). Most patients scored RSS 2 or 3 in both groups. In the fentanyl + propofol group, 90.5% of patients scored RSS 2 or 3, while in the dexmedetomidine group, this figure was 95.2%. No patients in either group reached RSS scores of 5 or 6. The distribution of sedation scores and the absence of significant differences ($p = 0.65$). (Table 4)

**Table 1.** Characteristics of patients undergoing cranioplasty

| Characteristics | Propofol + Fentanyl group | Dexmedetomidine group | p-value |
|---|---|---|---|
| Sex | | | 0.758[b] |
| Male | 11 (52.4%) | 10 (47.6%) | |
| Female | 10 (47.6%) | 11 (52.4%) | |
| Age | 61.28 ± 8.12 years (95% CI: 57.7–64.9) | 55.04 ± 8.32 years (95% CI: 51.4–58.7) | 0.180[a] |
| ASA Physical Status | | | |
| I | 2 (9%) | 4 (20%) | 0.67 |
| II | 14 (67%) | 15 (71%) | 0.70 |
| III | 5 (24%) | 2 (9%) | 0.90 |
| Duration of Surgery | 155 minutes (95% CI: 149–161) | 148.9 minutes (95% CI: 144–153) | 0.034[a] |
| QoR-15 Score | | | |
| 12 Hours Post-op | 135 (125–147) (95% CI: 130–140) | 140 (130–148) (95% CI: 137–143) | 0.045 |
| 24 Hours Post-op | 130 (120–145) (95% CI: 126–134) | 138 (125–140) (95% CI: 135–140) | 0.003 |
| Diagnosis | | | |
| Head Trauma | 10 (47.6%) | 9 (42.9%) | |
| Brain Tumor | 6 (28.6%) | 5 (23.8%) | |
| Stroke | 3 (14.3%) | 4 (19%) | |
| Infection/Decompression | 2 (9.5%) | 3 (14.3%) | |

[a]T-test Independent
[b]Chi-Square

**Table 2**. Hemodynamic characteristics of patients undergoing cranioplasty

| Characteristics | Propofol + Fentanyl group | Dexmedetomidine group | p-value |
|---|---|---|---|
| Blood Pressure | | | |
| Systolic (mmHg) | 99.52 | 98.67 | 0.68 |
| Diastolic (mmHg) | 57.67 | 64.04 | 0.52 |
| Heart Rate (bpm) | 81.38 | 65.90 | 0.02 |

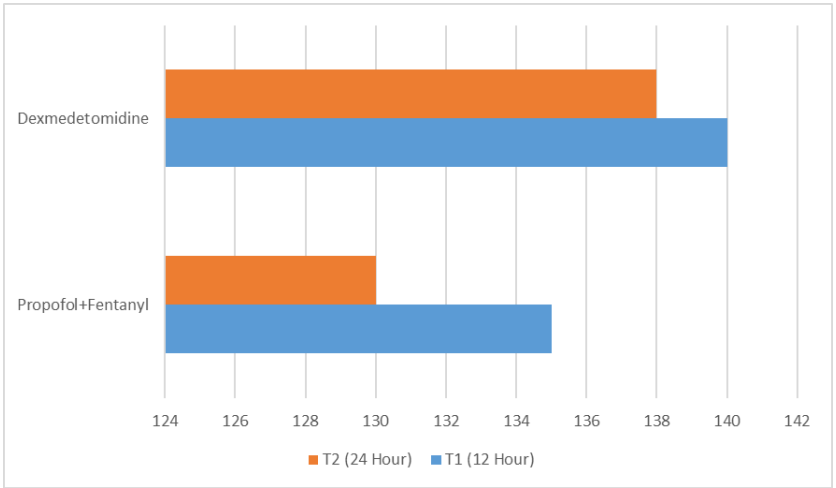



**Figure 1.** Comparison of median quality of recovery-15 (QoR-15) scores between propofol + fentanyl and dexmedetomidine groups in cranioplasty patients

**Table 3**. Association between propofol + fentanyl and dexmedetomidine administration with postoperative recovery quality

| Variables | Propofol + Fentanyl group | Dexmedetomidine group | p-value |
|---|---|---|---|
| T1 (12 Hours) | | | 0.045[a] |
| Good (130–135) | 14 (66.7%) | 19 (90.5%) | |
| Moderate (100–129) | 7 (33.3%) | 2 (9.5%) | |
| T2 (24 Hours) | | | 0.003[a] |
| Good (130–135) | 12 (52%) | 20 (95%) | |
| Moderate (100–129) | 9 (48%) | 1 (5%) | |

[a]fischer exact

**Table 4.** Distribution of Ramsay sedation scale (RSS) Scores in the recovery room (RR)

| RSS Score | Propofol + Fentanyl (n=21) | Dexmedetomidine (n=21) | p-value |
|---|---|---|---|
| RSS 2 (calm, cooperative) | 8 (38.1%) | 10 (47.6%) | |
| RSS 3 (responsive to commands) | 11 (52.4%) | 10 (47.6%) | |
| RSS 4 (responsive to light stimuli) | 2 (9.5%) | 1 (4.8%) | |
| RSS 5–6 (deep sedation, difficult to arouse) | 0 (0%) | 0 (0%) | – |
| Total | 21 (100%) | 21 (100%) | 0.65[a] |

## DISCUSSION

This study aimed to compare the quality of postoperative recovery between patients who received dexmedetomidine and those who received a combination of propofol and fentanyl during cranioplasty procedures, as assessed using the QoR-15 questionnaire. The results indicate that patients in the dexmedetomidine group experienced significantly better recovery outcomes at both 12 and 24 hours postoperatively. These findings underscore the clinical relevance of choosing anesthetic agents that not only ensure intraoperative stability but also optimize recovery profiles.

No statistically significant differences were observed in demographic characteristics, such as sex and age, between the two groups. This indicates that both groups were well-matched and comparable, strengthening the internal validity of the findings. These results align with a study by Fallatah et al., which found no significant difference in the incidence of cranioplasty based on sex, although trauma-related cases tend to involve more males due to occupational and traffic-related risks.[13] Additionally, the mean age of patients in this study (55–61 years) corresponds with the population typically undergoing cranioplasty, as noted by Sepviyanti et al., who reported that younger adults generally experience better recovery outcomes than older individuals, who may face greater surgical risks and slower healing.[14]

Although there was a slight difference in mean surgery duration between the groups, this was not statistically significant, consistent with the literature indicating that cranioplasty duration is influenced more by the complexity of the defect, surgical technique, and intraoperative conditions than by anesthetic regimen alone. These observations reinforce the reliability of recovery outcomes being attributed primarily to the pharmacologic effects of the sedative agents rather than surgical duration or baseline differences.

The most important finding in this study is the statistically significant improvement in QoR-15 scores among patients in the dexmedetomidine group, both at 12 and 24 hours postoperatively. This finding is consistent with results from Parikh et al., who reported better sedation quality and surgical field conditions with dexmedetomidine compared to midazolam-fentanyl.[15] Similarly, Yuan et al. demonstrated that dexmedetomidine-fentanyl combinations provide greater hemodynamic stability and fewer adverse effects than propofol-fentanyl regimens.[16] Kim et al. further noted that dexmedetomidine enhanced both patient and clinician satisfaction, particularly due to smoother awakening and more controlled postoperative conditions.[17]

Pharmacologically, dexmedetomidine is a highly selective α2-adrenergic receptor agonist that induces sedative and analgesic effects without significant respiratory depression. Its relatively short distribution half-life (~2 hours) enables rapid offset of sedation, which may explain the higher recovery scores in this study. Patients receiving dexmedetomidine generally awakened sooner and were more responsive, likely due to the drug's minimal impact on the respiratory centers and sympathetic nervous system, allowing for stable hemodynamics and faster return to baseline consciousness. These properties are supported by findings from Lee et al., who showed that dexmedetomidine improved QoR-40 scores significantly, particularly in physical comfort and pain dimensions.[18] Miao et al. also reported a reduction in postoperative nausea and vomiting (PONV) and faster functional recovery in patients given intravenous dexmedetomidine during elective surgery.[19]

This study also found that operator satisfaction was uniformly high in both groups, although clinical observations suggested greater ease in patient management with dexmedetomidine, likely due to reduced intraoperative bleeding, faster awakening, and better hemodynamic control. These findings align with Parikh et al., who highlighted improved surgical workflow and lower complication rates with dexmedetomidine, and with Yuan et al., who reported superior surgical satisfaction in the dexmedetomidine group.[15,16]

Regarding sedation depth in RR, most patients in both groups had RSS scores of 2–3, suggesting a calm, cooperative, and responsive state. Importantly, no patients exhibited deep sedation (RSS 5–6), indicating that both anesthetic regimens were well-tolerated and safe for use in neurosurgical contexts. This observation is in line with Bekker et al., who described dexmedetomidine-induced sedation as mimicking natural sleep, allowing for easy arousal and minimal respiratory compromise, and with Hall et al., who emphasized the synergistic depressant effects of propofol and opioids on the central nervous system, which may lead to deeper sedation in some cases.[20,21]

Despite the promising findings, this study has several limitations. First, the sample size was relatively small (n=42), which may limit statistical power and generalizability. Second, the study was conducted at only two medical centers, possibly introducing site-specific biases. Third, postoperative recovery was only evaluated within the first 24 hours; longer-term outcomes such as return to baseline function, complication rates, and patient-reported quality of life were not assessed. Additionally, subjective

measures of comfort and satisfaction were not captured from the patient perspective, which may offer valuable insights in future research.

Future studies should assess the depth of sedation during the intraoperative period in both the dexmedetomidine and propofol-fentanyl groups to better evaluate the comparative sedative potency of each regimen. Additionally, a systematic evaluation of adverse effects, both intraoperative and postoperative, is recommended to determine the safety profiles of these agents more comprehensively. Expanding the sample size, involving multiple centers, and including extended follow-up periods would enhance the generalizability of the findings. Furthermore, integrating qualitative assessments of patient experiences and cost-effectiveness analyses may offer deeper insights into the practical value of dexmedetomidine in neurosurgical anesthesia. Considering its role in promoting better postoperative recovery, especially within enhanced recovery after surgery (ERAS) protocols, dexmedetomidine warrants further investigation for potential incorporation into standardized anesthetic practices.

## CONCLUSION

Intraoperative administration of dexmedetomidine was associated with better quality of recovery in patients undergoing cranioplasty, demonstrating superior outcomes compared to the fentanyl and propofol combination. While both anesthetic regimens were comparable in terms of baseline characteristics and overall safety, dexmedetomidine provided more stable intraoperative conditions and enhanced postoperative recovery experience. These findings highlight the potential of dexmedetomidine as an effective anesthetic adjunct in neurosurgical procedures.

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