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Comparative Efficacy of Dexmedetomidine and Fentanyl for Extubation in Post-Neurosurgical Intensive Care Unit

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Abstract

The process of extubation in post-neurosurgical patients in the intensive care unit (ICU) requires careful management to ensure patient safety and comfort. Dexmedetomidine and fentanyl are two commonly used medications for sedation and analgesia during extubation. This prospective, randomized, single blind trial was conducted in the Department of Anaesthesiology, Community Based Medical College, Mymensingh, Bangladesh, between January and December of 2023, to compare the efficacy and safety of dexmedetomidine and fentanyl in post-neurosurgical ICU. The study was carried out among 50 post-neurosurgical patients requiring extubation after elective ventilation in neurosurgical ICU in a tertiary care hospital in Bangladesh. A total of 50 patients were included in this study. Inclusion criteria involved patients aged between 18 and 40 years, fairly classified as ASA (American Society of Anesthesiologists) physical status I or II, and undergone elective mechanical ventilation for less than 24 hours following any neurosurgical procedure. However, we excluded patients if they had unstable hemodynamic conditions, a Glasgow Coma Score (GCS) of <10 on the day of extubation, no swallowing attempts or visual pursuit, no cough or negative gag reflex, or if they did not meet the weaning criteria for mechanical ventilation. Patients were randomized and before extubation group-I received dexmedetomidine 0.1µg/kg, while group-II received fentanyl 1µg/kg. The degree of sedation, coughing after extubation and haemodynamic parameters were assessed and compared between the groups at the time of extubation. This study observed that single dose of 0.1µg/kg dexmedetomidine given before extubation provides better and smooth extubation as compared to fentanyl (1µg/kg).

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Introduction

Patients on ventilatory support require intravenous sedatives and analgesics to tolerate mechanical ventilation (MV) and the endotracheal tube (ET). These medications help manage anxiety and mitigate excessive hemodynamic and metabolic responses during invasive procedures, physiotherapy, tracheal suctioning, repositioning, and dressing changes.[1] Early extubation for patients in neuro-critical care offers several advantages, such as the early identification of postoperative surgical complications, reduced release of catecholamines, fewer pulmonary

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complications, and lower intensive care unit (ICU) costs. However, a significant drawback is systemic hypertension during the emergence period, which can lead to intracranial issues like bleeding and brain oedema.[2] Extubation often results in adverse effects such as tachycardia, hypertension, coughing, straining, and breath-holding. Aggressive or turbulent extubation not only causes patient discomfort but can also adversely affect surgical outcomes. Straining and coughing can lead to tachycardia and hypertension, elevated intracranial pressure, and increased stress on the surgical site, potentially resulting in surgical site bleeding.[3] Several theories have been proposed to explain the sudden increase in heart rate (HR) and blood pressure (BP) during intubation and extubation, including surges in catecholamines, airway irritation, intense post-surgical pain, and emergence.[4]

While these changes are typically transient, they can pose significant concerns for anaesthesiologists. Various drugs are employed to mitigate the intubation response, such as intravenous lignocaine, short-acting opioids like fentanyl and remifentanil, esmolol, labetalol, intratracheal local anaesthetic instillation, and dexmedetomidine, which can also be used during extubation.[5,6] Each of these drugs has specific advantages and disadvantages. For example, while propofol, opioids, and benzodiazepines can attenuate hemodynamic responses and provide sedation, they can also cause respiratory depression. Recent studies have demonstrated that dexmedetomidine is both safe and effective, as it does not depress respiratory function.[7,8] Despite substantial research aimed at mitigating hemodynamic responses during intubation, comparable attention to detail and precautions are seldom given to the extubation process in ICU. Consequently, the development of a dependable method for swift and seamless extubation remains incomplete. Therefore, this randomized double-blind comparative study sought to assess how dexmedetomidine compares to fentanyl in reducing airway reflexes and hemodynamic responses during tracheal extubation in post-neurosurgical ICU patients.

Methods

This prospective, randomized, single blind study was conducted in the Department of Anaesthesiology, Community Based Medical College, Mymensingh, Bangladesh, between January and December of 2023. Patients were randomly assigned to each study group using a computer-generated random number table in Microsoft Excel. A total of 50 patients were included in this study. Inclusion criteria were: patients aged between 18 and 40 years, classified as ASA (American Society of Anesthesiologists) physical status I or II, and undergone elective mechanical ventilation for less than 24 hours following any neurosurgical procedure. However, we excluded patients if they had unstable hemodynamic conditions, a Glasgow Coma Score (GCS) of <10 on the day of extubation, no swallowing attempts or visual pursuit, no cough or negative gag reflex, or if they did not meet the weaning criteria for mechanical ventilation. Patients were divided into two groups – 25 in each group. All of them All the patients were received standard sedation protocol during mechanical ventilation. Before extubation, group-I received dexmedetomidine 0.1 µg/kg, while group-II received fentanyl 1µg/kg. After extubation following parameters were evaluated. One hour before extubation, sedative agents

were discontinued, and a spontaneous breathing trial (SBT) was initiated for each patient. The ventilator was set to zero continuous positive airway pressure (CPAP) and zero pressure support, with an optional pressure support of 5 to 8 cm of water if needed. Throughout the SBT, patients' vital signs and spontaneous breathing parameters, including respiratory rate (f), tidal volume (VTS), minute volume, and Rapid Shallow Breathing Index (RSBI), were continuously monitored. If signs of SBT failure persisted, the patient was returned to mechanical ventilation support and excluded from the study. Indicators of SBT failure included a respiratory rate over 35 breaths per minute, oxygen saturation below 90%, significant changes in vital signs such as heart rate or blood pressure, agitation, sweating, or severe anxiety. If no signs of intolerance appeared, the SBT was continued for 30 to 120 minutes. Following this period, the patient was returned to the previous mechanical ventilation support, and extubation was considered. Coughing after extubation was assessed with a 4-point scale [1- no coughing,2- minimal coughing (once or twice),3- moderate coughing (3-4 times), 4- Severe coughing (5-10 times).5- Poor extubation, very uncomfortable and forced breathing (laryngospasm and coughing >10 times)].Ramsay sedation score was used to assess the degree of sedation [1- anxious and agitated or restless or both,2- co-operative,oriented and tranquil, 3- responding to commands only, 4- brisk response to light glabellar tap or loud auditory stimulus, 5- sluggish response to light glabellar tap or loud auditory stimulus,6- no response to stimulus]. During the extubation period, patients' vital parameters, including systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR), were monitored. If the mean arterial blood pressure (BP) dropped by more than 10% from the baseline value, a 200 ml fluid bolus was administered. If there was no improvement, intravenous injection of ephedrine was given. If heart rate decreased more than 20% from the baseline, the patient was treated with an intravenous injection of 0.6 mg atropine.

The parameters were recorded, and data were entered into Microsoft Excel 2016. Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) version 19.0 for Windows. A paired-samples t-test was used for comparisons between groups. Chi-square test was used to analyze extubation quality, sedation scores, and adverse events. A p-value <0.05 was considered statistically significant. The study was approved by the Ethical Review Committee of Community Based Medical College, Mymensingh, Bangladesh.

Results

There are no statistically significant differences between group-I and group-II in terms of age, gender distribution, BMI, or duration of mechanical ventilation (p>0.05 (Table-I). There are no statistically significant differences between two groups regarding the types of surgeries (craniotomy, brain tumours, spine tumours, and spine fixation) (p>0.05), which indicates that the distribution of different types of surgeries is similar between the two groups (Table-II). Comparing the heart rate (HR) (Fig-1), systolic blood pressure (SBP) (Fig-2) and diastolic blood pressure (DBP) (Fig-3) during extubation, no statistically significant differences were observed between the groups (p>0.05). Group-I had significantly more participants with no coughing

after extubation as compared to group-II, while group-II had significantly more participants with moderate and severe coughing as compared to group-I. Minimal coughing showed no significant difference between the groups (Table-III). Group-I generally exhibited a better sedation profile post-extubation compared to group-II, with more patients being cooperative, oriented, tranquil, or responding to commands only. Group-II had a higher proportion of patients who were anxious, agitated, or restless. The statistical significance in three out of four categories (anxious and agitated, cooperative, oriented and tranquil, responding to commands only) supports the conclusion that sedation levels differed between the two groups (Table-IV). Higher incidence of bradycardia was observed in group-I, while group-II has significantly higher incidences of tachycardia and itching. However, no significant differences were observed in hypotension between the two groups (Table-V).

Table-I: Demographic profile of the patients (N=50)

Variables		Group-I (n=25)	Group-II (n=25)	p-value
Age (years)		37.5±10.8	34.7±9.4	0.352
Gender	Male	16(64%)	14(56%)	0.437
	Female	9 (36%)	11(44%)	0.462
BMI (Kg/m^2)		25.1±3.8	24.8±3.6	0.617
Duration of MV		16.3±6.2	14.8±5.7	0.642

Table-II: Indication of neurosurgery (N=50)

Type of surgery	Group-I (n=25)	Group-II (n=25)	p-value
Craniotomy	15(60%)	13(52%)	0.583
Brain Tumors	4(16%)	6(24%)	0.518
Spine Tumors	1(4%)	2(8%)	0.764
Spine Fixation	5(20%)	4(16%)	0.752

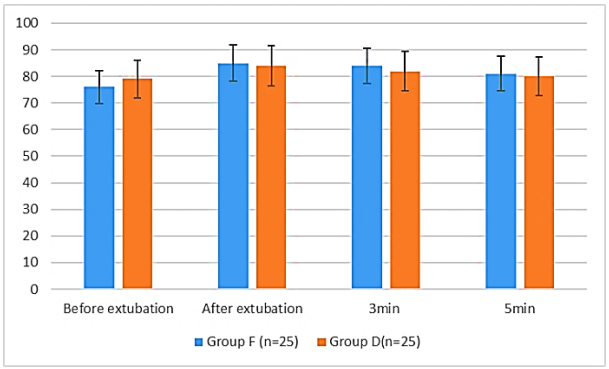

Fig. 1: Comparison of heart rate between the groups

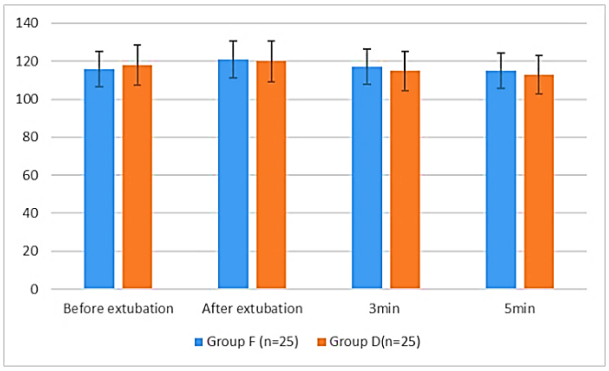

Fig. 2: Comparison of SBP between the groups

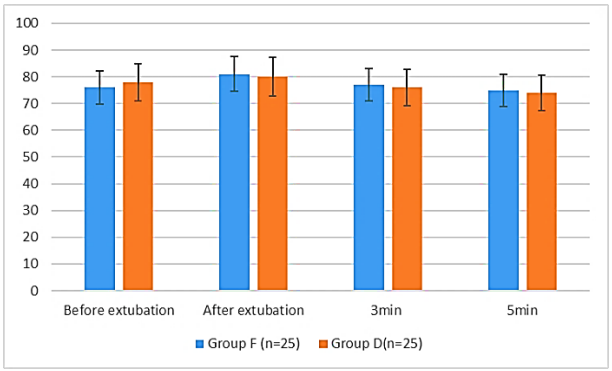

Fig. 3: Comparison of DBP between the groups

Table-III: Coughing after extubation

Coughing	Group-I (n=25)	Group-II (n=25)	p-value
1. no coughing	17(68%)	8(32%)	0.001
2. minimal coughing	4(16%)	6(24%)	0.269
3. moderate coughing	3(12%)	7(28%)	0.007
4. Severe coughing	1(4%)	4(16%)	0.014

Table-IV: Ramsay sedation score after extubation

Coughing	Group-I (n=25)	Group-II (n=25)	p-value
1. Anxious and agitated or restless or both	5(20%)	12(48%)	0.001
2. Co-operative, oriented and tranquil,	13(52%)	8(32%)	0.009
3. Responding to commands only	6(24%)	3(12%)	0.012
4. Brisk response to light glabellar tap or loud auditory stimulus	1(4%)	2(8%)	0.438

Table-V: Adverse events

Adverse events	Group-I (n=25)	Group-II (n=25)	p-value
Bradycardia	7(28%)	2(8%)	0.017
Tachycardia	1(4%)	5(20%)	0.029
Hypotension	5(20%)	3(12%)	0.189
itching	2(8%)	8(32%)	0.008

Discussion

In this study, we tried to identify the most effective drug for extubation from mechanical ventilation. The ideal medication should provide adequate sedation, have a rapid onset, maintain haemodynamic stability, have a short elimination time, show minimal accumulation in the body, and preferably be excreted independently of the liver and kidneys. Additionally, it should result in a shorter extubation time when given as a bolus before extubation. We compared the effects of dexmedetomidine and fentanyl in attenuating hemodynamic responses and extubation reflexes during weaning from mechanical ventilation. Comparing the heart rate (HR), systolic blood pressure (SBP) and diastolic blood pressure (DBP) during extubation, no statistically significant differences were observed between dexmedetomidine and fentanyl groups (p>0.05). Similarly, no statistical or clinically significant differences in hemodynamic parameters (HR, SBP and DBP) or oxygen saturation (SpO2) between the two groups were observed after extubation in previous studies done by Aksu *et al.* and Saleh.[9,10] However, another study done by Sabir & Baig reported that after extubation, HR, SBP and DBP were found significantly lower in the dexmedetomidine group compared to the fentanyl group.[11]

Our study found that most of the patients having dexmedetomidine experienced no coughing after extubation, while patients having fentanyl experienced moderate and severe coughing (p<0.05). Minimal coughing did not differ significantly between the groups (p>0.05). Dexmedetomidine ranked highest (81%) among various agents in reducing the incidence of moderate to severe peri-extubation coughing, followed by remifentanil (67.2%), fentanyl (66.2%), lidocaine intracuff (59.5%), topical lidocaine (59.2%), and intravenous lidocaine (52.4%).[12] Similar findings were report by Aksu *et al.* that dexmedetomidine group had better outcomes in terms of no coughing (85% vs. 30%), and severe coughing (0% vs. 20%), compared to fentanyl group.[9] The results of our study are also in congruence with that of studies done by Rani *et al*., Guler *et al*., and Fan *et al*.[13-15]

In our study, patients having dexmedetomidine generally exhibited a better sedation profile post-extubation (as more patients were cooperative, oriented, tranquil, or responding to commands) compared to fentanyl group (which had a higher proportion of anxious, agitated, or restless patients). Our results are aligned with the findings

of Sabir & Baig, Chrysostomou *et al*., and Tobias & Berkenbosch.[11,16,17] In contrast, Aksu *et al*. reported no significant differences in post-extubation sedation scores between dexmedetomidine and fentanyl groups. They also found that extubation, awakening, and orientation times did not significantly differ between these two medications.[9]

In our study, dexmedetomidine group exhibited a significantly higher incidence of bradycardia, whereas fentanyl group had significantly higher incidences of tachycardia and itching. Our findings are in congruence with that of Aksu *et al.,* Tervonen *et al.* and Bindu *et al.*[9,18,19] Hence, our study findings highlight the importance of monitoring and managing cardiovascular parameters closely when using dexmedetomidine as well as fentanyl, especially in patients predisposed to cardiovascular complications.

Conclusion

It can be concluded that dexmedetomidine offers clinically relevant benefits compared to fentanyl in facilitating extubation due to its hemodynamic stability, reduction in coughing, and ease of arousability. Therefore, it can be considered an effective and safe agent for facilitating extubation in post-neurosurgical ICU patients.

References

1. *Arroliga A, Frutos-Vivar F, Hall J, Esteban A, Apezteguía C, Anzueto A, et al. Use of sedatives and neuromuscular blockers in a cohort of patients receiving mechanical ventilation. Chest. 2005;128(2):496-506.*
2. *Tanwar G, Singh U, Kundra S, Chaudhary AK, Kaytal S, Grewal A. Evaluation of airway care score as a criterion for extubation in patients admitted in neurosurgery intensive care unit. J Anaesthesiol Clin Pharmacol. 2019;35(1):85-91.*
3. *Luthra A, Prabhakar H, Rath GP. Alleviating stress response to tracheal extubation in neurosurgical patients: a comparative study of two infusion doses of dexmedetomidine. J Neurosci Rural Pract. 2017;8(Suppl 1):S49-56.*
4. *Lowrie A, Johnston PL, Fell D, Robinson SL. Cardiovascular and plasma catecholamine responses at tracheal extubation. Br J Anaesth. 1992;68:261-3.*
5. *Mohsin S, Ahmad Ganaie Z, Kundi H, Ahmed MB, Riaz B, Khurshid Ahmed N, et al. Comparison of fentanyl and dexmedetomidine in preventing an increase in heart rate during intubation among patients undergoing general anesthesia: a meta-analysis. Cureus. 2022;14(6):e26194.*
6. *Zhou WJ, Liu M, Fan XP. Differences in efficacy and safety of midazolam vs. dexmedetomidine in critically ill patients: A meta-analysis of randomized controlled trial. Exp Ther Med. 2021;21(2):1.*
7. *Menda F, Köner Ö, Sayin M, Türe H, Imer P, Aykaç B. Dexmedetomidine as an adjunct to anesthetic induction to attenuate hemodynamic response to endotracheal intubation in patients undergoing fast-track CABG. Ann Cardiac Anaesth. 2010;13(1):16-21.*
8. *Liu HH, Zhou T, Wei JQ, Ma WH. Comparison between remifentanil and dexmedetomidine for sedation during modified awake fiberoptic intubation. Exp Ther Med. 2015;9(4):1259-64.*
9. *Aksu R, Akin A, Biçer C, Esmaoğlu A, Tosun Z, Boyaci A. Comparison of the effects of dexmedetomidine versus fentanyl on airway reflexes and hemodynamic responses to tracheal extubation during rhinoplasty: a double-blind, randomized, controlled study. Curr Ther Res. 2009;70(3):209-20.*
10. *Saleh RH. Randomized controlled comparative trial between low dose dexmedetomidine sedation and that of fentanyl in children after surgical procedures in surgical pediatric intensive care unit. Egypt J Anaesth. 2016;32(1):137-42.*
11. *Sabir M, Baig MN. A better drug for extubation-dexmedetomidine or fentanyl. Int J Adv Med. 2023;10:352-7.*
12. *Ahmed NA, Yehia AM, Mohamed AH, Abdulwahhab A. Attenuation of the airway and cardiovascular responses to extubation in*

chronic smokers by prior treatment with dexmedetomidine, fentanyl, and their combination. Open Access Macedonian J Med Sci. 2021;9(B):1290-5.

13. *Rani P, Kumar VH, Ravishankar M, Sivashanmugam T, Sripriya R, Trilogasundary M. Rapid and reliable smooth extubation – comparison of fentanyl with dexmedetomidine: A randomized, double-blind clinical trial. Anesth Essays Res. 2016;10(3):597-601.*
14. *Guler GÜ, Akin AY, Tosun ZE, Eskitascoglu E, Mizrak A, Boyaci A. Single-dose dexmedetomidine attenuates airway and circulatory reflexes during extubation. Acta Anaesthesiol Scand. 2005;49(8):1088-91.*
15. *Fan Q, Hu C, Ye M, Shen X. Dexmedetomidine for tracheal extubation in deeply anesthetized adult patients after otologic surgery: A comparison with remifentanil. BMC Anesthesiol. 2015;15:106.*
16. *Chrysostomou C, Di Filippo S, Manrique AM, Schmitt CG, Orr RA, Casta A, et al. Use of dexmedetomidine in children after cardiac and thoracic surgery. Pediatr Crit Care Med. 2006;7:126-31.*
17. *Tobias JD, Berkenbosch JW. Sedation during mechanical ventilation in infants and children: Dexmedetomidine versus midazolam. South Med J. 2004;97:451-5.*
18. *Tervonen M, Cajanus J, Kallio M, Huhtamäki H, Pokka T, Peltoniemi O. Adverse cardiovascular events are common during dexmedetomidine administration in neonates and infants during intensive care. Acta Paediatrica. 2023;112(11):2338-45.*
19. *Bindu B, Pasupuleti S, Gowd UP, Gorre V, Murthy RR, Laxmi MB. A double blind, randomized, controlled trial to study the effect of dexmedetomidine on hemodynamic and recovery responses during tracheal extubation. J Anaesthesiol Clin Pharmacol. 2013;29:162-7.*