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Research Article

Dexmedetomidine and Fentanyl in Endotracheal Intubation: A Comparative Analysis of Hemodynamic and Intubation Responses

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Abstract

Aim: Endotracheal intubation, a critical procedure in anaesthesia, can induce significant hemodynamic fluctuations, posing risks, especially to patients with cardiovascular concerns. This study compares the effects of dexmedetomidine and fentanyl, two agents commonly used to mitigate these responses, on endotracheal intubation conditions and associated hemodynamic changes.
Material and Method: Conducted at tertiary care training and research hospital, this study involved 60 patients aged 40-60, all classified American Society of Anesthesiologists (ASA) I-II, undergoing elective upper and lower extremity surgeries. Excluding patients with contraindicating conditions, the subjects were divided into two groups to receive either dexmedetomidine or fentanyl, along with propofol and vecuronium, for induction. Hemodynamic parameters were continuously monitored, and intubation conditions were assessed using the Cooper scoring system.
Results: The study found that both dexmedetomidine and fentanyl effectively stabilised hemodynamic parameters during intubation. However, the fentanyl group displayed significantly higher total scores on the Cooper intubation conditions scale, indicating more favourable conditions for endotracheal intubation in terms of ease and patient comfort.
Conclusion: While both dexmedetomidine and fentanyl are effective in maintaining hemodynamic stability during endotracheal intubation, fentanyl demonstrates a slight advantage in optimising intubation conditions. This distinction offers valuable insight for anesthesiologists in tailoring anaesthetic strategies and balancing patient safety with procedural efficiency in surgical settings.

Keywords: Dexmedetomidine, fentanyl, endotracheal intubation, hemodynamic responses, surgical anaesthesia

INTRODUCTION

Endotracheal intubation stands as a cornerstone procedure in anesthesiology, pivotal for maintaining patient airway patency during surgical interventions. This procedure, while routine, is not without its complexities and challenges, particularly in the context of hemodynamic stability (1). The act of intubation often triggers a cascade of physiological responses, primarily sympathetic activation, leading to fluctuations in heart rate and arterial pressure. These responses are not merely transient occurrences; they bear significant implications, especially for patients with pre-existing cardiovascular or cerebrovascular conditions (2). Thus, the quest for optimal anaesthetic agents that can mitigate these hemodynamic perturbations while ensuring effective and safe intubation conditions is a topic of ongoing clinical and academic interest.

In this background, dexmedetomidine and fentanyl emerge as two significant pharmacological agents. Dexmedetomidine, a selective α2 adrenoceptor agonist, is esteemed for its sedative, analgesic, and anxiolytic properties, with a notable feature of not depressing respiratory function (3). Its mechanism, centred around the α2 adrenoreceptors, offers a pathway to reducing sympathetic outflow, thus potentially stabilising hemodynamic responses during intubation (4,5). On the other hand, fentanyl, a potent opioid, is renowned for its analgesic efficacy. Beyond pain control, fentanyl's influence on the central nervous system translates into

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blunting of the stress response to intubation, which could yield benefits in terms of hemodynamic management (6). However, the selection between these two agents is not straightforward, as each brings its own profile of benefits and limitations.

Understanding the comparative effects of dexmedetomidine and fentanyl on endotracheal intubation conditions and hemodynamic responses is not just an academic pursuit; it has tangible implications for clinical practice. Anesthesiologists frequently grapple with the choice of these agents, seeking to balance efficacy with safety, particularly in patients with specific vulnerabilities. Therefore, this study aims to dissect and compare the impacts of dexmedetomidine and fentanyl when used in the context of endotracheal intubation. By doing so, it seeks to provide evidence-based insights that can guide clinical decision-making, ultimately enhancing patient outcomes in the diverse landscape of surgical anaesthesia.

MATERIAL AND METHOD

The study protocol was approved by the local ethics committee of Giresun Training and Research Hospital. Informed patient consent was waived due to the retrospective design of the study. This study was guided by the relevant ethical principles of the Declaration of Helsinki, revised in 2013. The study was conducted on 60 patients aged between 40 and 60, all in ASA I-II physical condition, at tertiary care training and research hospital for elective upper and lower extremity surgeries. Excluded from the study were patients with higher ASA classifications, complex intubation criteria, age outside 40-60, uncontrolled hypertension, cardiovascular or pulmonary diseases, hepatic or renal dysfunctions, psychiatric treatments, chronic opioid use, hypersensitivity to opioids or propofol, and liver or kidney failure. Dexmedetomidine and fentanyl groups were created with data obtained from patient file records of anesthesiologists who used only one of these drugs. Each patient was evaluated and consented to a day before surgery. In the operating room, they received a 20 gauge intravenous line with 0.9% NaCl infusion and underwent noninvasive monitoring without premedication. After preoxygenation, patients were divided into two groups for administering either fentanyl or dexmedetomidine, followed by propofol and vecuronium for induction. Anesthesia was maintained with a mix of N2O, oxygen, and sevoflurane. Intubation conditions were assessed using Cooper scoring (Table 1). Vital signs were continuously monitored and recorded at various stages of the procedure. After surgery, intravenous tramadol was administered, and anaesthetic gases were replaced with 100% oxygen. Neostigmine and atropine were used post-operation to reverse the effects of muscle relaxants.

Table 1. Cooper scoring system

Score	Jaw relaxation	Vocal cords	Response to intubation
0	Poor (impossible)	Closed	Severe coughing or bucking
1	Minimal (difficult)	Closing	Mild coughing
2	Moderate (fair)	Moving	Slight diaphragmatic movement
3	Good (easy)	Open	None
Total score: Excellent (8-9), Good (6-7), Fair (3-5), Poor (0-2)			

Statistical Analysis

Number Cruncher Statistical System (NCSS) 2007 & PASS 2008 Statistical Software (Utah, USA) programs were used for statistical analyses. In addition to descriptive statistical methods (Mean, Standard deviation), the Student t-test was used to compare parameters with normal distribution between two groups, and the Whitney U test was used to compare parameters without normal distribution between two groups. Paired sample t-test was used for intra-group comparisons of normally distributed parameters. The chi-square test was used to compare qualitative data. Significance was evaluated at $p<0.05$ level.

RESULTS

The study was conducted with 60 patients, 30 in the Dexmedetomidine group and 30 in the Fentanyl group, who were to undergo upper and lower extremity surgery. The ages of the patients ranged between 40 and 60 years, with a mean age of 50.3±7.4 years. 61.7% (n=37) of the patients were female and 38.3% (n=23) were male. There is no statistically significant difference between age, weight, height, ASA and gender ($p>0.05$) (Table 2).

There was no statistically significant difference between the systolic arterial blood pressure (SABP) levels before induction, before intubation, 1st, 3rd, 5th, 10th, and 15th minutes after intubation ($p>0.05$). In the dexmedetomidine group, statistically significant decreases were observed in SABP levels at the 1st, 3rd, 5th, 10th, and 15th minutes after intubation compared to pre-induction SABP levels ($p<0.05$). In the fentanyl group, statistically significant decreases were observed in SABP levels before intubation, 1st, 3rd, 5th, 10th, and 15th minutes after intubation compared to SABP levels before induction ($p<0.05$) (Table 3).

In the dexmedetomidine group, statistically significant decreases were observed in diastolic arterial blood pressure (DABP) levels before intubation, 1st, 3rd, 5th, 10th, and 15th minutes after intubation compared to pre-induction DABP levels ($p<0.05$). In the fentanyl group, there was no statistically significant change in DABP levels at 1st min after intubation compared to pre-induction DABP levels, and statistically significant decreases were observed in DABP levels at 3rd, 5th, 10th, and 15th minutes after intubation compared to pre-induction DABP levels ($p<0.05$) (Table 4).

Table 2. Comparison of characteristics of patients between two groups

Patients' characteristics		Dexmedetomidine (n: 30)		Fentanyl (n: 30)		p
		Number	%	Number	%	
Gender$^{x^2}$	Female	9	30.0	14	46.7	0.184
	Male	21	70.0	16	53.3	
ASA$^{x^2}$	I	17	56.7	18	60	0.793
	II	13	43.3	12	40	
		Mean±SD		Mean±SD		
Aget		50.4±8.4		50.3±6.4		0.973
Weight^{t}		73.3±10.5		73.1±12.3		0.955
Height^{t}		162±9.6		162.6±23.4		0.897

*p<0.05, **p<0.01, x^2: Chi-square test (Categorical data), t: student T test, Med: median, SD: standart deviation

Table 3. Evaluation of SABP according to groups

SABP (mm Hg)	Dexmedetomidine (n=30)	Fentanyl (n=30)	p
	Mean±SD	Mean±SD	
Before induction	138.1±7.0	135.1±4.9	0.065
Before intubation	121.3±14.2	117.5±8.8	0.211
1st min after intubation	127.6±9.7	131.8±10.7	0.118
3rd min	125.7±10.5	123.0±9.2	0.292
5th min	128.0±6.8	124.5±6.8	0.053
10th min	127.9±7.2	124.4±6.6	0.059
15th min	128.0±6.5	123.5±10.9	0.057
p value	Dexmedetomidine (n=30)	Fentanyl (n=30)	
Before induction – before intubation	**0.001***	**0.001***	
Before induction – 1st min after intubation	**0.001***	**0.048***	
Before induction – 3rd min	**0.001***	**0.001***	
Before induction – 5th min	**0.001***	**0.001***	
Before induction – 10th min	**0.001***	**0.001***	
Before induction – 15th min	**0.001***	**0.001***	

*p<0.05, t: student T test, SD: standart deviation, min: minute

Table 4. Evaluation of DABP according to groups

DABP (mm Hg)	Dexmedetomidine (n=30)	Fentanyl (n=30)	p
	Mean±SD	Mean±SD	
Before induction	86.3±8.4	82.7±7.4	0.065
Before intubation	73.6±9.5	72.2±7.8	0.547
1st min after intubation	79.0±7.0	82.7±7.4	0.055
3rd min	74.5±7.6	75.6±7.5	0.588
5th min	77.6±7.9	74.0±8.3	0.093
10th min	77.8±7.5	74.2±7.9	0.080
15th min	78.4±6.0	75.1±7.7	0.071
p value	Dexmedetomidine (n=30)	Fentanyl (n=30)	
Before induction – before intubation	**0.001***	**0.001***	
Before induction – 1st min after intubation	**0.001***	0.754	
Before induction – 3rd min	**0.001***	**0.001***	
Before induction – 5th min	**0.001***	**0.001***	
Before induction – 10th min	**0.001***	**0.001***	
Before induction – 15th min	**0.001***	**0.001***	

*p<0.05, t: student T test, SD: standart deviation, min: minute

There was no statistically significant difference between the pre-induction, pre-intubation, and post-intubation 1st, 3rd, 5th, 10th, and 15th minutes mean arterial blood pressure (MABP) levels between the groups (p>0.05). In the dexmedetomidine group, statistically significant decreases were observed in the pre-intubation, post-intubation 1st, 3rd, 5th, 10th and 15th minutes MABP levels compared to the pre-induction MABP levels (p<0.05) (Table 6). In the fentanyl group, no statistically significant change was observed in the MABP levels at the 1st minute after intubation compared to the pre-induction MABP levels. Statistically, significant decreases were observed in the MABP levels at the 3rd, 5th, 10th and 15th minutes after intubation compared to the pre-induction MABP levels (p<0.05) (Table 5).

There was no statistically significant difference between the groups in pre-induction, pre-intubation, and post-intubation 1st, 3rd, 5th, 10th, and 15th minutes peak heart rate (PHR) levels (p>0.05). In the dexmedetomidine group, statistically significant decreases were observed in pre-intubation, post-intubation 1st, 3rd, 5th, 10th, and 15th minutes PHR levels compared to pre-induction PHR levels (p<0.05). In the fentanyl group, statistically significant decreases were observed in PHR levels at 1st, 3rd, 5th, 10th, and 15th minutes after intubation compared to pre-induction PHR levels (p<0.05) (Table 6).

Table 5. Evaluation of MABP according to groups

DABP (mm Hg)	Dexmedetomidine (n=30)	Fentanyl (n=30)	p
	Mean±SD	Mean±SD	
Before induction	86.3±8.4	82.7±7.4	0.065
Before intubation	73.6±9.5	72.2±7.8	0.547
1st min after intubation	79.0±7.0	82.7±7.4	0.055
3rd min	74.5±7.6	75.6±7.5	0.588
5th min	77.6±7.9	74.0±8.3	0.093
10th min	77.8±7.5	74.2±7.9	0.080
15th min	78.4±6.0	75.1±7.7	0.071
p value	Dexmedetomidine (n=30)	Fentanyl (n=30)	
Before induction – Before intubation	**0.001***	**0.001***	
Before induction – 1st min after intubation	**0.001***	0.754	
Before induction – 3rd min	**0.001***	**0.001***	
Before induction – 5th min	**0.001***	**0.001***	
Before induction – 10th min	**0.001***	**0.001***	
Before induction – 15th min	**0.001***	**0.001***	

*p<0.05, t: student T test, SD: standart deviation, min: minute

Table 6. Evaluation of PHR according to groups

PHR (beats/min)	Dexmedetomidine (n=30)	Fentanyl (n=30)	p
	Mean±SD	Mean±SD	
Before induction	80.9±10.1	80.4±6.8	0.824
Before intubation	68.3±9.8	72.8±8.2	0.077
1st min after intubation	70.8±5.7	74.0±8.7	0.105
3rd min	68.8±8.3	72.8±8.9	0.077
5th min	69.5±9.0	72.5 ±8.3	0.182
10th min	72.5±8.4	73.5±6.6	0.612
15th min	72.3±8.7	73.2±6.8	0.658
p value	Dexmedetomidine (n=30)	Fentanyl (n=30)	
Before induction – before intubation	**0.001***	**0.001***	
Before induction – 1st min after intubation	**0.001***	**0.001***	
Before induction – 3rd min	**0.001***	**0.001***	
Before induction – 5th min	**0.001***	**0.001***	
Before induction – 10th min	**0.001***	**0.001***	
Before induction – 15th min	**0.001***	**0.001***	

*p<0.05, t: student T test, SD: standart deviation, min: minute

Oxygen saturation (SPO2) levels maintained stability throughout the operation in both groups, with no significant changes observed across different time intervals (p>0.05). Additionally, end-tidal carbon dioxide (etCO2) levels remained consistent and did not show statistically significant differences in either group at any observed time intervals (p>0.05).

One notable finding was in the assessment of intubation conditions using Cooper scoring. The Fentanyl group displayed statistically significantly higher total intubation conditions scores compared to the Dexmedetomidine group (p<0.05). This suggested a higher proportion of patients in the Fentanyl group experienced excellent intubation conditions, while the Dexmedetomidine group predominantly had good intubation conditions.

DISCUSSION

The intricate relationship between anaesthetic agents and their physiological impact during endotracheal intubation is a focal area in anesthesiology, underscored by our study's findings. Though a routine procedure, endotracheal intubation often elicits a sympathoadrenergic response, leading to cardiovascular stress (7). This phenomenon, particularly critical in patients with cardiac ischemia or cerebrovascular conditions, has been well-documented, as in studies by Saitoh et al., highlighting the imperative for effectively managing these hemodynamic changes (8).

Our research, focusing on dexmedetomidine and fentanyl, contributes to this area by providing a comparative analysis of their effects on hemodynamic responses during intubation. Dexmedetomidine's efficacy, as evidenced in our study, aligns with the growing body of literature advocating for its use in anaesthetic practice due to its minimal respiratory depression and stabilising influence on hemodynamics, as supported by findings from Özköse et al., Dyck et al., and Başar et al. (9-11). Meanwhile, fentanyl's effective suppression of hemodynamic responses without significant side effects, resonating with the work of Salihoğlu et al. and Myless et al., underlines its utility in surgical anaesthesia (12,13).

Methodologically, our study faced limitations such as a confined demographic range and a specific surgical context, which may influence the generalizability of the findings. Future research could expand on these aspects, exploring varied patient populations and surgical settings to validate and extend our results.

Clinically, the insights from this study have profound implications. The nuanced understanding of how dexmedetomidine and fentanyl modulate cardiovascular responses could guide anesthesiologists in selecting the most appropriate agent, particularly in patients with pre-existing cardiovascular conditions (14). The preference for fentanyl in scenarios demanding smoother intubation processes, as suggested by our findings, could enhance patient comfort and procedural efficiency.

The field would benefit from further research exploring the long-term outcomes of using these agents, their interactions with other medications, and their effects in more diverse patient cohorts. Such studies would enrich our understanding and help develop more refined anaesthetic protocols.

Study Limitations

This research, while insightful, has its limitations. The study's sample size and demographic concentration may limit the extrapolation of results to a broader population, as it was conducted within a single medical centre and possibly lacked diversity in patient profiles. The focus on short-term hemodynamic and intubation responses also means that the longer-term effects of the anaesthetic agents were not explored. Additionally, the study design did not incorporate blinding, potentially introducing bias in assessing outcomes. High-risk patients and those with complex medical histories were excluded, which might restrict the applicability of our findings to these patient groups. The reliance on specific drugs for induction and maintenance alongside dexmedetomidine and fentanyl could have influenced the results, and variability in intubation techniques may have introduced additional outcome variability. Lastly, the absence of a comparative analysis with other anaesthetic agents limits the scope of understanding the relative efficacy of dexmedetomidine and fentanyl in a wider anaesthetic context.

CONCLUSION

This study demonstrates that both dexmedetomidine and fentanyl effectively manage hemodynamic and intubation conditions during endotracheal intubation, with fentanyl slightly outperforming in terms of intubation conditions. These findings guide anesthesiologists in choosing suitable agents, highlighting the need for tailored approaches in anaesthesia to optimise patient safety and outcomes within the study's limitations.

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Ethical approval: *The study was conducted in accordance with the Helsinki Declaration principles and was approved by our Corporate Ethics Committee, Giresun Training and Research Hospital (2023/KAEK-164).*

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