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Evaluation of Intranasal and Intravenous Dexmedetomidine for Attenuation of Hemodynamic Surge during Laryngoscopy and Endotracheal Intubation in Patients Undergoing Elective Laparoscopic Surgery

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Abstract: ***Laryngoscopy and endotracheal intubation elicit significant hemodynamic stress responses, which can be detrimental, especially in patients with cardiovascular risks. Dexmedetomidine, a selective alpha-2 adrenergic agonist, mitigates these effects through its sedative, anxiolytic, and sympatholytic properties. This study compares the efficacy of intranasal versus intravenous dexmedetomidine in attenuating hemodynamic surges during laryngoscopy and intubation in patients undergoing elective laparoscopic surgery. A prospective, randomized, double-blind controlled trial was conducted on 70 adult patients (35 per group). Patients received either intranasal (1 mcg/kg) or intravenous (1 mcg/kg) dexmedetomidine 45 minutes before induction. Hemodynamic parameters, including heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP), were monitored preoperatively, during intubation, and post-intubation. Sedation was assessed using the Ramsay Sedation Scale (RSS). Dexmedetomidine, a selective alpha-2 adrenergic agonist, is valued in anesthesia for blunting hemodynamic surges during laryngoscopy and intubation. This prospective, randomized, double-blind trial compared intranasal (1 mcg/kg) and intravenous (1 mcg/kg) dexmedetomidine in 70 adults undergoing elective laparoscopic surgery. Administered 45 minutes pre-induction, both routes effectively stabilized heart rate, blood pressure, and mean arterial pressure post-intubation (P > 0.05), though intravenous delivery yielded deeper preoperative sedation (P = 0.014). Intranasal administration proved a non-invasive, well-tolerated alternative, suggesting its potential, especially for pediatric or uncooperative patients. Further research into plasma levels and long-term effects is recommended. These findings suggest that intranasal dexmedetomidine is a viable and patient-friendly alternative to intravenous administration for attenuating hemodynamic stress responses during airway manipulation. Its ease of administration suggests particular advantages for pediatric or uncooperative patients in broader applications. Further studies evaluating plasma concentrations and long-term outcomes are warranted to optimize dosing strategies for diverse clinical scenarios.***

Keywords: Dexmedetomidine, Hemodynamic response, Laryngoscopy, Intranasal administration, Intravenous administration, Anesthesia

1. Introduction

Hemodynamic stability during laryngoscopy and intubation is a critical factor in ensuring safe anesthesia administration. The process of laryngoscopy and endotracheal intubation is associated with significant cardiovascular responses, including tachycardia and hypertension, due to reflex sympathetic stimulation. These responses, though transient, can have detrimental effects, especially in patients with cardiovascular and cerebrovascular comorbidities. Therefore, attenuation of these stress responses is crucial for patient safety and improved perioperative outcomes.

Dexmedetomidine (DEX) is a short acting, highly selective alpha-2 adrenergic agonist known for its sedative, anxiolytic, and analgesic properties while preserving respiratory function. It provides stable hemodynamics by reducing sympathetic outflow and decreasing circulating catecholamine levels. This makes it a preferred agent in modern anaesthesia practice for stress attenuation during airway manipulation.

Dexmedetomidine can be administered via multiple routes, including intravenous (IV), intranasal (IN), intramuscular (IM), and oral. While intravenous (IV) administration is widely used, it has been associated with effects such as reduced heart rate (HR), lowered blood pressure (BP), and, in rare cases, cardiac arrest. The intranasal route has gained interest due to its non-invasiveness, ease of administration, and ability to achieve sufficient bioavailability via nasal mucosal absorption. Prior studies (e. g., Guler et al., 2005) suggest that intranasal dexmedetomidine offers comparable efficacy to intravenous administration for sedation and hemodynamic stability, making it particularly beneficial in paediatric and uncooperative adult patients.

Despite these advantages, limited research directly compares the efficacy of intranasal versus intravenous dexmedetomidine for blunting the hemodynamic response during laryngoscopy and intubation. This study aims to bridge that gap by evaluating and comparing the effects of both administration routes in patients undergoing elective laparoscopic surgery.

Aims and Objectives

To compare the efficacy of intranasal (1 mcg/kg) and intravenous (1 mcg/kg) dexmedetomidine in controlling hemodynamic responses during laryngoscopy and intubation.

Primary objective-

To assess the impact of both routes on:

- Systolic Blood Pressure (SBP)
- Diastolic Blood Pressure (DBP)
- Mean Arterial Pressure (MAP)
- Heart Rate (HR)

Secondary objective

To evaluate ease of administration, safety profile, and sedation levels.

2. Materials and Methods

Study Design:

- A prospective, parallel-group, double-blind, randomized controlled trial.
- Conducted at HI-TECH Medical College and Hospital from 03rd March 2023 to 03rd February 2025.
- Sample Size: 70 adult patients (35 per group) undergoing elective laparoscopic surgery.
- Inclusion criteria: ASA Grade I and II, age 18-60, BMI < 30 kg/m².
- Exclusion criteria: Patient refusal, ASA Grade III and IV, Emergency cases, Cardiovascular, respiratory, metabolic disorders, psychiatric illness, drug allergies and pregnancy cases.

Intervention:

- Group DIN (n=35): Intranasal dexmedetomidine (1 mcg/kg) administered 45 minutes pre-induction.
- Group DIV (n=35): Intravenous dexmedetomidine (1 mcg/kg) infused over 45 minutes before induction.
- Standard monitoring included HR, SBP, DBP, MAP, SpO2, and Ramsay Sedation Score (RSS).

Outcome Measures:

- Primary: Hemodynamic stability during and post-intubation.
- Secondary: Sedation level, safety, and side effects.

3. Results

1) Demographic Data
- Both groups were comparable in age, gender, BMI, and baseline vitals (P > 0.05).

2) Preoperative Findings:
- Reduction in HR, SBP, DBP, and MAP was observed in both groups from 20 minutes onward.
- Intravenous dexmedetomidine caused greater reductions at 40 minutes (P < 0.05). (Tables are in the Figure section)
- Preoperative sedation was significantly higher in the intravenous group (P = 0.014).

3) Intraoperative Hemodynamics:
- Peak hemodynamic response occurred at laryngoscopy and intubation.
- Intranasal DEX group showed slightly higher values for SBP, DBP, and MAP, but the difference was not statistically significant.

4) Safety and Side Effects:
- No significant adverse effects such as hypotension, bradycardia, or respiratory depression.

4. Discussion

Laryngoscopy and intubation provoke a sympathetic response leading to hemodynamic instability. Dexmedetomidine effectively attenuates these responses by reducing sympathetic outflow and stress-induced catecholamine release.

Intranasal administration provides a painless, non-invasive alternative with comparable efficacy to intravenous administration, making it a viable option in pediatric and non-cooperative patients.

The hemodynamic stability observed in both groups aligns with previous research indicating that dexmedetomidine, irrespective of the route of administration, contributes to smoother induction and reduced intraoperative fluctuations.

Although intravenous dexmedetomidine achieved significantly deeper sedation (P = 0.014) than the intranasal route, both approaches achieved adequate preoperative sedation without significant adverse effects.

Further pharmacokinetic studies could assess the absorption rates and bioavailability differences between intranasal and intravenous administration to refine dosing strategies for optimal patient outcomes.

Limitations

- Plasma drug concentrations were not measured.
- Stress hormone levels were not assessed.
- A larger sample size could enhance statistical significance.

5. Conclusion

Both intravenous and intranasal dexmedetomidine are effective in attenuating hemodynamic surges during laryngoscopy and intubation. Intranasal administration presents a convenient, painless, and non-invasive alternative, reducing procedural discomfort and eliminating the need for IV access before induction.

Clinical application of intranasal dexmedetomidine extends beyond surgical settings, as its ease of use makes it a suitable option for sedation in pediatric imaging, dental procedures, and minor outpatient interventions. Its efficacy in maintaining stable hemodynamics while minimizing risks of profound sedation and hypotension makes it a promising choice for future anesthesia protocols.

Further research with larger patient cohorts and plasma drug concentration analysis is recommended to establish

definitive dosing guidelines and to explore additional benefits of intranasal dexmedetomidine in various clinical settings.

6. Future Recommendations

- Larger-scale studies for broader applicability.
- Plasma concentration studies for pharmacokinetic insights.
- Exploration of intranasal dexmedetomidine in paediatric and high-risk patients.

Tables:

Table 1: Demographic characters of the patients in two groups

Demography and other parameters of patients	GroupD_{IN} (n=35) Mean±SD	GroupD_{IV} (n=35) Mean±SD	P – value
Age in year	40.71±10.91	42.03±12.50	0.641
Sex (M/F)	22/13	19/16	0.642
Weight in kgs	60±6.894	61.03±7.350	0.548
Height in meter	1.623±0.075	1.625±0.065	0.892
BMI in kg/m^2	22.75±1.7	23.10±2.388	0.980

Baseline Haemodynamic Parameters

Table 2: Baseline parameters of patients in Group DIN and Group DIV

Parameter	Group D_{IN} Mean±SD	Group D_{IV} Mean±SD	P – value
SBP in mm of Hg	128.20±11.749	126.94±10.519	0.639
DBP in mm of Hg	79.74±7.590	78.74±8.965	0.616
MAP in mm of Hg	94.63±8.128	93.06±9.365	0.456
Heart Rate in beats/min	87.06±11.337	82.43±8.462	0.057

Table3: Baseline Saturation

Parameter	Rank Sum Group D_{IN}	Rank Sum Group D_{IV}	P-value
Sp02	1174.500	1310.500	0.424

Parameters Recorded During Preoperative Study Period
Comparison of preoperative Heart Rate variation

Table 4: Comparison of heart rate between two groups

Time in mins	Group D_{IN} Mean±SD	Group D_{IV} Mean±SD	P-value
Basal	87.06±11.337	82.43±8.462	0.057
10min	82.31±10.715	78.80±8.213	0.128
20min	76.80±10.238	73.09±7.358	0.086
30min	73.86±9.372	69.86±6.722	**0.044**
40min	71.23±9.481	66.60±5.553	**0.015**

Table 5: Comparison of Preoperative Oxygen saturation

Time in min	Rank Sum Group DIN	Rank Sum Group DIV	P-value
Basal	1174.500	1310.500	0.424
10min	1123.500	1361.500	0.162
20min	1274.500	1210.500	0.707
30min	1315.000	1170.000	0.394
40min	1467.000	1017.500	0.008

Pre-operative SpO2 from time of intranasal & intravenous drug administration till 40 min

Table 6: Pre operative SBP, DBP and MAP variation in mm of Hg (mean±SD) from time of intranasal and intravenous drug administration till 40 mins

	Group	Basal	10min	20min	30min	40min
SBP	D_{IN}	128.20±11.749	125.03±11.449	120.20±11.483	117.26±12.793	113.54±12.181
	D_{IV}	126.94±10.519	123.71±9.057	118.89±10.417	116.23±10.672	111.80±9.710
	p-value	0.639	0.596	0.618	0.716	0.51
DBP	D_{IN}	79.74±7.590	75.29±7.458	71.89±7.940	68.91±8.424	66.00±6.962
	D_{IV}	78.74±8.965	75.97±9.596	72.91±9.441	70.60±8.247	66.77±7.628
	P-value	0.616	0.74	0.623	0.401	0.66
MAP	D_{IN}	94.63±8.128	90.83±8.624	87.00±8.888	84.20±9.333	81.06±7.673
	D_{IV}	93.06±9.365	90.37±9.340	86.94±9.175	84.57±7.868	80.74±7.913
	P-value	0.456	0.832	0.979	0.858	0.867

Table 7: Comparison of preoperative sedation

Time in min	Rank Sum Group DIN	Rank SUM Group DIV	P –value
40min	1032.500	1452.500	0.014.

Parameters Recorded During Intraoperative Study Period

Comparison between intraoperative HR, SBP, DBP, MAP

Table 8: Intraoperative Heart Rate (beats per mins) from time of induction to 10 mins after intubation

Time in min	Group D_{IN} Mean±SD	Group D_{IV} Mean±SD	P-value
Induction	68.23±9.162	65.40±5.771	0.127
L&I	84.40±9.435	79.03±5.874	0.006
1min	82.06±8.734	80.54±6.487	0.413
2min	79.74±9.082	77.94±6.063	0.333
3min	78.54±9.936	76.29±5.453	0.243
4min	77.94±10.833	75.60±5.325	0.256
5min	76.46±9.669	74.63±5.325	0.331
7min	76.09±9.633	75.09±5.883	0.602
10min	76.71±9.164	76.09±5.404	0.728

Table 9: Intraoperative SBP (mm of Hg) from time of induction to 10 mins after Intubation

Time in min	Group D_{IN} Mean±SD	GroupD_{IV} Mean±SD	P-value
Induction	108.46±9.201	108.63±8.951	0.937
L&I	125.83±8.743	121.83±9.205	0.067
1min	124.97±11.333	122.43±8.994	0.302
2min	121.03±11.155	119.66±9.759	0.586
3min	118.51±11.044	117.46±9.407	0.668
4min	116.63±10.949	116.40±9.211	0.925
5min	116.09±10.285	114.51±8.803	0.495
7min	115.66±9.819	114.60±8.806	0.637
10min	115.29±9.106	115.83±8.827	0.801

Table 10: Intraoperative DBP (mm of Hg) from time of induction to 10 mins after Intubation

Time in min	Group D_{IN} Mean±SD	Group D_{IV} Mean±SD	P-value
Induction	63.49±6.428	66.03±7.991	0.147
L&I	77.09±7.489	75.03±8.237	0.278
1min	75.43±6.810	74.74±7.759	0.696
2min	72.29±6.134	72.00±7.452	0.861
3min	70.60±6.683	69.54±7.473	0.535
4min	70.34±6.683	68.71±7.160	0.321
5min	69.66±6.202	68.20±6.202	0.329
7min	69.26±6.568	67.71±5.849	0.303
10min	67.54±5.700	68.14±7.105	0.698

Table 11: Intraoperative MAP (mm of Hg) from time of induction to 10 mins after Intubation

Time in min	Group D_{IN} Mean±SD	Group D_{IV} Mean±SD	P-value
Induction	78.74±6.418	80.80±8.141	0.245
L&I	93.63±7.080	90.91±8.336	0.147
1min	91.97±7.833	91.26±6.853	0.682
2min	88.83±6.853	88.17±7.812	0.709
3min	86.89±7.696	86.40±7.531	0.790
4min	86.23±6.787	85.20±7.304	0.544
5min	85.49±7.089	83.97±6.640	0.360
7min	85.54±6.630	83.71±6.090	0.234
10min	83.26±5.617	84.66±7.557	0.382

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