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A COMPARATIVE EVALUATION OF INDUCED HYPOTENSION USING NITROGLYCERINE, ESMOLOL, AND DEXMEDETOMIDINE DURING FUNCTIONAL ENDOSCOPIC SINUS SURGERY

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ABSTRACT **Background:** Functional endoscopic sinus surgery (FESS) provides superior visualisation for sinus disease management, but operative bleeding can obscure the surgical field. Controlled hypotension reduces blood loss and improves visibility. We compared three agents for induced hypotension: nitroglycerine, esmolol, and dexmedetomidine. **Methods:** Ninety adult patients (ASA I–II) scheduled for FESS were randomized into three groups (n=30 each). Group N received nitroglycerine infusion (0.5–2 µg/kg/min), Group E received esmolol (1 mg/kg IV bolus + 0.5–1 mg/kg/h infusion), and Group D received dexmedetomidine (1 µg/kg IV loading over 10 min + 0.5–1 µg/kg/h infusion). Hypotension was targeted at mean arterial pressure (MAP) 60–70 mmHg. We recorded heart rate (HR) and MAP at defined intervals, total fentanyl use, time to first postoperative analgesic, Ramsay sedation scores, nausea/vomiting, and side effects. Data were analysed with significance set at $p<0.05$. **Results:** Baseline demographics and surgical times were comparable among groups. Group D had significantly lower intraoperative HR and MAP values than groups N and E at all measured times ($p<0.05$). Total fentanyl consumption (µg/kg) was lowest in group D (mean±SD: 1.62±3.18) versus N (3.26±7.34) and E (3.13±0.28) ($p<0.05$). The time to first analgesic request was significantly longer in group D (61.5±10.2 min) than in N (32.7±6.5) and E (31.4±5.6) ($p<0.05$). Postoperative Ramsay scores were higher in group D (48% of patients scored 3) compared to groups N and E (most patients scored 2). No serious hemodynamic complications occurred. Dry mouth (36%) was noted in group D as the most frequent side effect; nausea/vomiting incidence was similar across groups. **Conclusion:** Dexmedetomidine provided superior hemodynamic stability and clearer surgical field conditions compared to nitroglycerine and esmolol during FESS, with the added benefits of reduced analgesic requirement and sedation. However, it caused more bradycardia and dry mouth, and its cost should be considered.

KEYWORDS : Induced hypotension, nitro glycerine, esmolol, dexmedetomidine, functional endoscopic sinus surgery, hemodynamic stability.

INTRODUCTION

Functional endoscopic sinus surgery (FESS) is indicated [1] for the surgical management of acute and chronic sinus diseases. FESS allows better illumination and visualization of the sinus anatomy, but even minimal bleeding can obscure the endoscopic view and complicate surgery. Bleeding during FESS has been correlated with nasal mucosal vascularity. Impaired visibility due to severe bleeding is a major obstacle with FESS under general anesthesia (GA)[2]. Techniques such as head elevation (reverse Trendelenburg), local vasoconstrictors, careful surgical technique, and cautery are used to minimize bleeding.

Controlled hypotension is an effective anaesthetic strategy to reduce blood loss in FESS. By lowering the patient's baseline mean arterial pressure (MAP) by about 30% (target MAP ~60–70 mmHg)[3,4] blood loss and transfusion needs decrease, surgical visibility improves, and operative time may be shortened. Various pharmacologic agents can induce hypotension: for example, vasodilators like nitroglycerine[5] or sodium nitroprusside[7,8], high-dose inhaled anesthetics[6], and β-blockers [5?7]like esmolol. Each agent has drawbacks: nitroglycerine can cause tachyphylaxis, nitroprusside risks cyanide toxicity, and high-dose inhaled agents delay emergence. Therefore, an ideal agent for inducing hypotension is needed. The ideal agent used for controlled hypotension must have certain properties such as a short onset time, rapid elimination without toxic metabolites, easy to administer, and dose-dependent predictable effects[9]

Dexmedetomidine is a selective α2-adrenergic agonist that provides sedation, analgesia, and some hypotensive effect, without significant respiratory depression. It reduces sympathetic outflow and norepinephrine release, thereby lowering heart rate and blood pressure. Its desirable properties (slow and controlled onset, easy titration, minimal accumulation) make dexmedetomidine a candidate for induced hypotension. Previous studies showed dexmedetomidine can decrease bleeding and anaesthetic requirements in various surgeries. Comparing Esmolol and Nitroglycerine for Controlled Hypotension in Functional Endoscopic Sinus Surgery by SRIVASTAVA et al in 2013 [5] reported that Both Esmolol and Nitroglycerine are effective and safe drugs for this purpose with only mild reduction in blood pressure and proved that esmolol provided optimum surgical condition. Supporting the above study, Guney Aet al.[11] done a study comparison of Esmolol to Nitroglycerine in controlling hypotension during nasal surgery and found that Esmolol provides hemodynamic stability and good surgical field visibility and be considered as an alternative to nitroglycerine.

Dexmedetomidine which is a selective α2 adrenoceptor agonist causes reduction in blood pressure, slowing of HR, sedation and analgesia. Inhibition of central sympathetic outflow and stimulation of presynaptic α2 adrenoceptors decreases norepinephrine release and causes decrease in blood pressure . An important advantage is its potent sedative and analgesic effects with minimal respiratory depressant effect compared with opioids and other sedatives. Within the framework of hemodynamic stability [8,12][11,13,14] few studies have shown that dexmedetomidine decreases the bleeding in surgeries.

In light of these considerations, this study was designed to compare the efficacy of nitroglycerine, esmolol, and dexmedetomidine for achieving controlled hypotension in FESS. We hypothesized that dexmedetomidine, due to its sedative and analgesic effects, might provide better surgical conditions. The specific objectives were to compare among the three groups:

1. Intraoperative hemodynamics: heart rate and mean arterial pressure at baseline and at intervals
2. Total opioid (fentanyl) consumption during surgery
3. Time to first postoperative analgesic request
4. Postoperative sedation: measured by Ramsay Sedation Score
5. Postoperative nausea and vomiting incidence
6. Adverse effects: such as shivering and dry mouth

By evaluating these parameters, we aimed to determine which agent offers the most favourable profile of hypotension control, surgical field quality, and patient outcomes during FESS.

MATERIALS AND METHODS

This study was approved by the Institutional Ethics Committee of Andhra medical college -King George Hospital (Approval No. 94/IEC AMC-KGH/DEC/2018) and conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants. This study was conducted between June 2017 to October 2018. Ninety patients of age group between 18-55 yrs. coming for management of sinus diseases admitted in Government E.N.T hospital, Visakhapatnam were taken into this prospective randomized controlled study belonging to ASA grade I & II scheduled for functional endoscopic sinus surgery. Exclusion criteria included significant cardiac disease, uncontrolled hypertension, or pregnancy. Patients were randomised by computer-generated numbers into three equal groups (n=30 each):

- Group D (Dexmedetomidine): IV dexmedetomidine 1 µg/kg over 10 minutes before induction, then infusion 0.5–1 µg/kg/h after intubation.
- Group N (Nitroglycerine): IV nitroglycerine infusion 0.5–2 µg/kg/min starting before induction.
- Group E (esmolol): IV esmolol 1 mg/kg bolus over 1 min before induction, then infusion 0.5–1 mg/kg/h after intubation.

Standard anesthesia monitors (ECG, pulse oximetry, invasive arterial blood pressure) were applied. All patients were preloaded with lactated Ringer's solution (5 ml/kg) and received a standard induction (e.g. fentanyl, propofol, and succinylcholine) and maintenance (oxygen–air or N2O–oxygen, volatile anaesthetics). Controlled hypotension was targeted by adjusting the study drug infusions to maintain MAP 60–70 mmHg.Heart rate (HR) and mean arterial pressure (MAP) were recorded at baseline (pre-induction), post-loading dose, after induction, after intubation, and then every 5 minutes intraoperatively, as well as after reversal and extubation. Total fentanyl dose (µg/kg) used during the case was noted. Duration of surgery and anesthesia, and time from end of surgery to eye opening (emergence time) were recorded. Postoperatively, patients were assessed in the recovery room. Ramsay Sedation Score was recorded 30 minutes after extubation. The first analgesic request time and total analgesic consumption in the first 24 hours were documented. Incidence of nausea/vomiting, shivering, dry mouth, and other complications were also recorded.

Statistical Analysis:

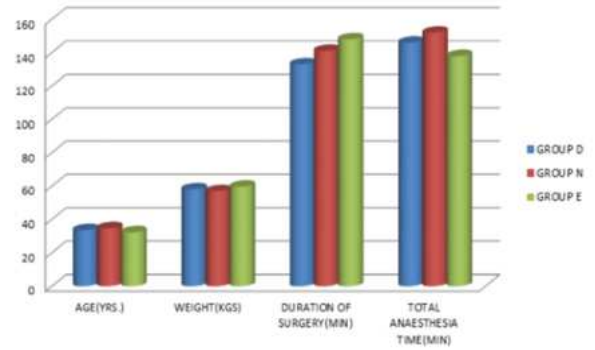
Sample size was calculated using G*Power version 3.1 with a = 0.05 and power of 0.8 to detect a 20% difference in blood loss between groups, requiring 26 patients per group; 30 were recruited to account for dropouts. Data were analysed using SPSS version 25.0 (IBM Corp., Armonk, NY). Continuous variables are presented as mean + SD and compared using one-way ANOVA with Tukey's post hoc test. Categorical data are presented as counts (%) and compared using chi-square or Fisher's exact test as appropriate. A p-value < 0.05 was considered statistically significant.

RESULTS

All 90 patients completed the study. Demographic characteristics (age, sex, weight) and duration of surgery and anesthesia were similar between groups (not shown, p>0.05,table 1).

Table 1. Demographic Variables Of Study Groups

DEMOGRAPHIC VARIABLES	Group D(n=30) mean ± SD	Group N(n=30) Mean ± SD	Group E(n=30) Mean ± SD	P value
Age(years)	33.6±9.6	34.7±8.8	32.3±8.6	---
Gender(male/female)	15/15	12/18	24/6	---
ASA-physical status(I/II)	24/6	26/4	27/3	---
Weight	58.0±6.1	56.9±5.7	59.7 ±6.9	
Duration of surgery(min)	133±32	141±37	148±29	0.92
Total anesthesia time(min)	146±32	152±29	138±38	0.88
Mean dose of fentanyl (ug/kg)used	1.6±3.1	3.2±7.3	3.1±0.2	0.000*
Emergence time(min)	6.7± 0.7	4.6±7.6	4.4±3.6	0.000*
Time to first analgesic request(min)	61.5±10.2	32.7±6.5	31.4±5.6	0.000*



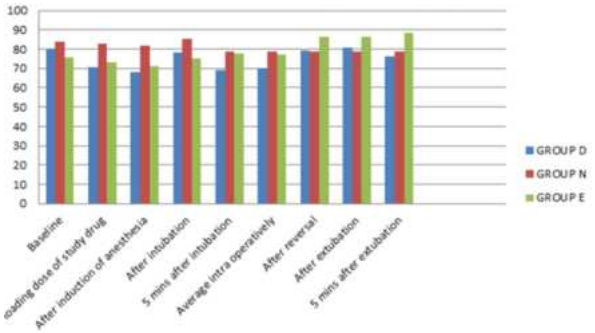
Graph 1. Demographic Variables Of Study Groups

Hemodynamics:

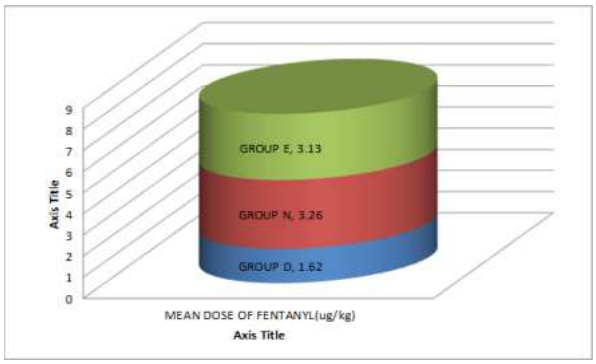
Baseline HR and MAP were comparable. After administration of study drugs, heart rate was significantly lower in the dexmedetomidine group (Group D) compared to the nitroglycerine (N) and esmolol (E) groups at all measured time points (p<0.05, Table 2). Similarly, MAP was significantly reduced in Group D after drug loading, post-induction, post-intubation, and at each intraoperative interval (mean MAP ~60–65 mmHg), whereas N and E groups required higher doses of study drug to achieve comparable MAP reduction (p<0.05, see Table 3). However, the target MAP (60–70 mmHg) was successfully achieved in all three groups without the need for rescue interventions. No patient developed refractory hypotension or bradycardia requiring treatment.

Table 2. Comparison Of Mean Heart Rate Of Study Groups

TIME OF MEASUREMENT(beats/min)	GroupD(n=30) mean ± SD	GroupN(n=30) mean ± SD	GroupE(N=30) mean ± SD	P value
Baseline	80.5 ±3.5	83.8±7.4	75.5 ±9.2	0.000*
After loading dose of study drug	70.7 ±3.9	83.0±5.1	73.3±8.9	0.000*
After induction of anesthesia	68.1±3.2	81.8 ±6.2	71.3 ±7.7	0.000*
After intubation	78.0±1.9	85.1 ±10.3	75.3±5.7	0.000*
5 mins after intubation	69.0±1.5	78.7±4.9	77.6±5.6	0.000*
Average intra operatively	70.1±0.3	78.1±0.3	76.9±0.3	0.000*
After reversal	79.1±2.2	82.6±7.5	86.2±4.9	0.000*
After extubation	80.6±2.8	84.0±3.7	86.5±3.1	0.000*
5 mins after extubation	76.2±2.2	86.9±4.0	88.3±2.1	0.000*



Graph 3 Comparision Of Heart Rate Of Study Groups



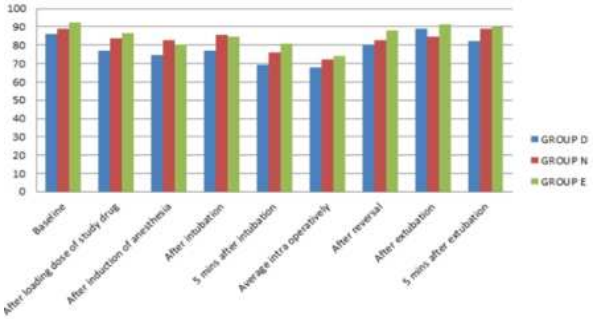
Graph 2 - Mean Total Dose Of Fentanyl Used the mean total dose of fentanyl in ug/kg used was significantly lower in group D compared to groups N and E(1.62±3.18vs3.26±7.34,3.13±0.28 respectively.

Analgesic Consumption: The mean total fentanyl dose (μg/kg) was lowest in Group D (1.62±3.18) compared to Group N (3.26±7.34) and Group E (3.13±0.28) (ANOVA p<0.05). This is reflected in Graph 2, which shows significantly higher opioid requirements in the nitroglycerine and esmolol groups. Correspondingly, the time to first postoperative analgesic was significantly longer in Group D (61.5±10.2 minutes) than in Group N (32.7±6.5) and Group E (31.4±5.6) (p<0.05).

None of the patients experienced bradycardia, resistant hypotension or hypertension during the study period. None of them required additional atropine or mephentermine.

Table 3. Comparison Of Mean Arterial Pressure

TIME OF MEASUREMENT	GroupD(n=30) mean ± SD	GroupN(n=30) mean ± SD	GroupE(N=30) mean ± SD	P value
Baseline	86.3 ±5.9	89.2±9.6	92.5±4.4	0.19
After loading dose of study drug	76.9±5.6	83.7 ±9.9	86.4±3.1	0.000*
After induction of anesthesia	74.5±6.9	82.5±7.5	80.1±4.9	0.000*
after intubation	76.8 ±3.0	85.8±8.7	84.5 ±5.2	0.000*
5 mins after intubation	69.2±2.5	75.9 ±5.0	80.9±5.4	0.000*
Average intra operatively	68.0±0.2	72.4±0.9	74.2±1.2	0.000*
After reversal	80.3±3.6	82.8±4.4	88.2 ±3.9	0.000*
After extubation	89.1±4.8	84.5 ±4.0	91.2±1.8	0.000*
5 mins after extubation	82.2±2.0	89.0±2.3	90.0±2.0	0.000*



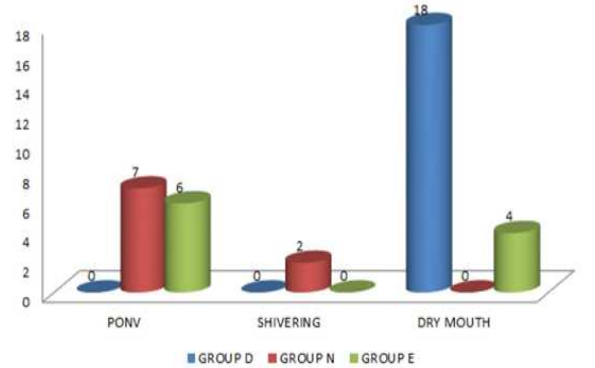
Graph 4. Comparison Of Mean Arterial Pressure Of Study Groups

Side Effects:

No serious adverse events occurred in any group. Incidence of nausea and vomiting was similar across groups (approximately 10–15%). The most common side effect in Group D was dry mouth, occurring in 36% of patients (vs. 0% in N and E), which was transient and self-limited. Shivering rates were low and did not differ significantly between groups. No patient required additional vasoactive drugs (atropine or vasopressors) at any time.

Table 4. Comparison Of Side Effects Of Study Groups

Side effects	GroupD(n=30) (%)	GroupN(n=30) (%)	GroupE(N=30) (%)	p
PONV	0	7(14)	6(12)	0.02
shivering	0	2(4)	0	0.12
Dry mouth	18(36)	0	4(8)	0.0001*



Graph 5. Side- Effects Comparison Of Study Groups

Postoperative Sedation: Group D patients were more sedated postoperatively. In Group D, 48% of patients had a Ramsay Sedation Score of 3, whereas in Groups N and E the majority (60% and 50%, respectively) had a score of 2. The difference in sedation level was statistically significant (p<0.05) (Table 5).

Table 5. Degree Of Post Operative Sedation (Ramsay Sedation Score)

Ramsay sedation score	GroupD(n=30) (%)	GroupN(n=30) (%)	GroupE(N=30) (%)	p
1	0	0	4(8)	0.000
2	2(4)	30(60)	25(50)	0.000
3	24(48)	0	1(2)	0.0001*
4	4(8)	0	0	0.000
5	0	0	0	0.000
6	0	0	0	0.000

DISCUSSION

In this randomized study of FESS patients, dexmedetomidine achieved effective controlled hypotension with notable advantages. All three agents (nitroglycerine, esmolol, dexmedetomidine) successfully reduced MAP to target levels. However, dexmedetomidine produced a more pronounced reduction in heart rate and MAP throughout the procedure, reflecting its combined sympatholytic effects. Similar findings have been reported by others: for example, Bajwa et al[17]. (2016) found that dexmedetomidine reduced anaesthetic and opioid requirements and provided a better surgical field than nitro glycerine or esmolol.

We observed that total intraoperative fentanyl consumption was significantly lower with dexmedetomidine. This analgesic-sparing effect of dexmedetomidine is well documented and was consistent with our expectations. The prolonged time to first analgesic request in Group D indicates better postoperative pain control and sedation. Indeed, sedation scores were higher in the dexmedetomidine group, which likely contributed to patient comfort but also delayed immediate postoperative recovery. None of our patients experienced severe bradycardia or hemodynamic instability, although dexmedetomidine is known to potentially cause bradycardia; we monitored all patients closely for this reason.

Our results align with previous research. Karabayirli et al [16]. (2017) reported that dexmedetomidine improved surgical conditions and reduced opioid use compared to remifentanil . Das et al [15](2016) also showed that dexmedetomidine as a hypotensive agent led to lower fentanyl consumption than clonidine . In the context of FESS, Shams et al.[10] (2013) compared dexmedetomidine to esmolol and found higher sedation and less bleeding in the dexmedetomidine group, similar to our findings. From a safety standpoint, none of our patients had refractory hypotension or required rescue interventions; this is consistent with the literature that emphasizes careful titration of these agents to achieve moderate hypotension. We noted dry mouth in a significant fraction of the dexmedetomidine group (36%), which is a known side effect of α2-agonists. Apart from this, dexmedetomidine was well tolerated. The esmolol and nitroglycerine groups had hemodynamics that were easier to reverse (heart rate and blood pressure returned to baseline more quickly once infusions stopped), leading to shorter emergence times.

The study has certain limitations: Dexmedetomidine is expensive, which may limit its routine use. It also requires cardiovascular monitoring due to the risk of bradycardia. Our sample included only ASA I–II patients; results might differ in higher-risk populations, which warrants further research.

A strength of this study is its randomized, double-blind design with an adequate sample size (n=90), which enhances validity. The topic is clinically relevant, as optimizing hemodynamic management in FESS can improve patient safety and surgical outcomes.

In conclusion, while all three agents can be used for controlled hypotension in FESS, dexmedetomidine provided better hemodynamic stability and operative field conditions, along with reduced anaesthetic and analgesic requirements. These benefits should be weighed against its cost and side effect profile when choosing an agent for induced hypotension in sinus surgery.

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Conflict Of Interest: None

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