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Original Research Article

Clonidine versus Dexmedetomidine for controlled hypotension in Functional Endoscopic Sinus Surgery (FESS)

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Abstract

Background: Quality of the surgical field is a major determinant of safety and efficiency in FESS. α2-adrenergic agonists are frequently used to achieve controlled hypotension. Comparative data between clonidine and dexmedetomidine focusing on operative field quality, hemodynamic stability and early recovery remain clinically relevant.

Objectives: To compare clonidine versus dexmedetomidine for controlled hypotension during FESS with respect to (i) intraoperative hemodynamics (MAP, HR), (ii) surgical field quality (Fromme–Boezaart score), and (iii) early recovery sedation (Ramsay Sedation Score, RSS).

Methods: Prospective randomized comparative study at a single centre; N=80 adults (ASA I–II) scheduled for elective FESS were allocated to clonidine (n=40, loading 1.5 µg/kg; infusion 0.4–0.8 µg/kg/h) or dexmedetomidine (n=40, loading 0.75 µg/kg; infusion 0.4–0.8 µg/kg/h). Standardized general anaesthesia was used. MAP/HR were recorded at baseline, post-loading, pre/post-intubation, incision, 5 min post-incision, then every 15 min to end-of-surgery. Fromme–Boezaart scores were rated at fixed intervals by the blinded surgeon, and RSS was assessed at 10, 20, 30, 45, 60 min post-extubation. Analyses used t-tests/χ^2 or Mann–Whitney as appropriate and repeated-measures ANOVA for trajectories (α=0.05).

Results: Groups were balanced for age, sex, weight and ASA class. Dexmedetomidine achieved lower MAP and HR at several intraoperative time points while remaining within the target window (representative values, mean ± SD): at incision MAP 60 ± 5 vs 64 ± 6 mmHg (p=0.001) and HR 70 ± 9 vs 76 ± 10 bpm (p=0.003); at 30 min MAP 59 ± 4 vs 63 ± 5 (p<0.001) and HR 68 ± 8 vs 74 ± 9 (p=0.001). Repeated-measures showed significant group and time effects (MAP group p<0.001; HR group p<0.001). Surgical field quality favored dexmedetomidine: overall Fromme–Boezaart 1.6 ± 0.4 vs 2.1 ± 0.5, mean difference −0.5 (95% CI −0.7 to −0.3; p<0.001), with more "excellent" ratings (A/B/C: 24/15/1 vs 12/25/3, χ^2 p=0.006). RSS was higher with dexmedetomidine early (median [IQR] at 10 min 3 [3–4] vs 2 [2–3], p<0.001; at 20 min 3 [2–3] vs 2 [2–3], p=0.020) but converged by 45–60 min (both groups median 2, p≥0.64).

Conclusions: Both α2-agonists supported controlled hypotension during FESS; however, dexmedetomidine provided tighter sympatholysis (lower MAP/HR), superior surgical field quality, and transiently deeper early sedation that normalized within an hour. Dexmedetomidine may be preferred when maximizing endoscopic visibility is paramount, while clonidine remains a pragmatic alternative.

Keywords: Functional Endoscopic Sinus Surgery; Controlled Hypotension; Dexmedetomidine; Clonidine; Fromme–Boezaart Score; Ramsay Sedation Score; Mean Arterial Pressure; Heart Rate.

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Introduction

Functional Endoscopic Sinus Surgery (FESS) has emerged as the gold standard for the surgical management of chronic rhinosinusitis and other sinonasal pathologies requiring precise anatomical visualization. The success of FESS largely depends on the clarity of the surgical field, as even minimal

bleeding can obscure endoscopic vision and significantly increase the risk of complications. Achieving a relatively bloodless surgical field is, therefore, an essential anesthetic goal. Traditional approaches to minimize intraoperative bleeding include topical vasoconstrictors, patient positioning with head elevation, and avoidance of hypertensive responses during anesthesia induction. However, these measures are often insufficient, necessitating pharmacological strategies such as controlled hypotension to optimize surgical conditions [1].

Controlled hypotension is defined as a deliberate reduction of mean arterial pressure (MAP) to 50–65 mmHg or approximately 30% below baseline values, with the aim of reducing surgical field perfusion while maintaining adequate end-organ oxygenation [2].

Several pharmacological agents including vasodilators, β-blockers, and inhalational anesthetics have been used to achieve controlled hypotension, but each carries limitations such as reflex tachycardia, rebound hypertension, or prolonged recovery. In recent years, α2-adrenergic agonists such as clonidine and dexmedetomidine have gained prominence because of their sedative, anxiolytic, and analgesic properties, in addition to their ability to reduce sympathetic outflow and produce stable hypotension [3].

Clonidine, an imidazoline derivative, is a selective partial α2-adrenergic agonist with a well-established role in anesthesia as a sedative and antihypertensive agent. Its perioperative benefits include reduced anesthetic and opioid requirements, attenuation of sympathetic responses, and improved hemodynamic stability [4]. Dexmedetomidine, a more recently introduced α2-adrenergic agonist, is highly selective and approximately eight times more specific for α2-receptors than clonidine. This enhanced selectivity translates to more predictable hemodynamic control, potent sedation resembling natural sleep, and favorable recovery characteristics without significant respiratory depression [5].

Multiple comparative studies have evaluated the efficacy of clonidine and dexmedetomidine in providing controlled hypotension during FESS. Mugabo et al. reported that both agents yielded excellent surgical field visibility, though dexmedetomidine produced more pronounced hypotension and bradycardia, which was advantageous in reducing bleeding [1]. Similarly, Bafna et al. demonstrated that dexmedetomidine not only provided effective hypotension but also conferred additional benefits of postoperative analgesia and conscious sedation [2]. In contrast, Escamilla et al. found no major difference in intraoperative bleeding between the two drugs, suggesting that clonidine, with its longer clinical experience and lower cost, remains a viable alternative in many surgical settings [6]. The mechanisms underlying the effectiveness of α2-agonists extend beyond mere blood pressure reduction. Both clonidine and dexmedetomidine decrease norepinephrine release from presynaptic terminals, leading to reduced sympathetic tone. Dexmedetomidine, in particular, provides better suppression of sympathetic responses to intubation and surgical stimuli, thereby minimizing intraoperative hemodynamic fluctuations [7]. Additionally, these drugs decrease anesthetic and opioid requirements, which further contributes to hemodynamic stability and improved recovery profiles [3].

Despite their advantages, important considerations remain in choosing between clonidine and dexmedetomidine. Dexmedetomidine is associated with dose-dependent bradycardia and hypotension, necessitating careful titration. Clonidine, although less selective, offers predictable pharmacokinetics and a longer history of perioperative use, making it especially relevant in resource-limited settings where cost-effectiveness is a priority [4,6].

Given the increasing reliance on FESS as a minimally invasive approach to sinonasal surgery, optimizing anesthetic protocols for better surgical field quality, minimal blood loss, and patient safety is crucial. A systematic comparison of clonidine and dexmedetomidine in this context is therefore warranted. This study aims to evaluate and compare the efficacy of intravenous clonidine and dexmedetomidine in achieving controlled hypotension, maintaining hemodynamic stability, and enhancing surgical field quality in patients undergoing FESS.

Methodology

Study Design and Setting: This study was designed as a randomized, prospective, comparative clinical trial conducted in the Department of Anaesthesiology and Critical Care at People's Hospital, Bhanpur, Bhopal, and Madhya Pradesh. The study period extended over six months and included patients scheduled for elective Functional Endoscopic Sinus Surgery (FESS).

Ethical Considerations: The study protocol was approved by the Institutional Ethics Committee of People's College of Medical Sciences and Research Centre, Bhopal.

Written informed consent was obtained from all participants in their preferred language before enrollment. Patient confidentiality was maintained throughout the study.

Study Population: Patients between 15 and 50 years of age with American Society of Anesthesiologists (ASA) physical status I and II,

who were scheduled for elective FESS, were considered eligible. Patients were excluded if they had ASA grade III or IV, pre-existing hemodynamic instability (hypotension or bradycardia), cardiovascular, hepatic, or renal disorders, known drug allergies, or if they were pregnant or lactating. Written informed consent was obtained from all participants prior to enrolment.

Randomization and Group Allocation: Patients were randomly allocated into two groups using alternate allocation. Group 1 received intravenous clonidine, while Group 2 received intravenous dexmedetomidine. The allocation sequence was applied in the preoperative area, and the assigned intervention was prepared by an independent anesthesiologist not involved in intraoperative management or data collection, ensuring blinding of the operating surgeon and outcome assessor.

Interventions: Group 1 (Clonidine): Patients received a loading dose of clonidine hydrochloride 1.5 µg/kg diluted in 10 mL of 0.9% normal saline, infused intravenously over 10 minutes before induction of anesthesia. This was followed by a continuous infusion at 0.4 µg/kg/h, titrated up to a maximum of 0.8 µg/kg/h to maintain target mean arterial pressure (MAP) and heart rate (HR).

Group 2 (Dexmedetomidine): Patients received a loading dose of dexmedetomidine 0.75 µg/kg diluted in 10 mL of 0.9% normal saline, infused intravenously over 10 minutes before induction of anesthesia. This was followed by a continuous infusion at 0.4 µg/kg/h, titrated up to a maximum of 0.8 µg/kg/h to maintain hemodynamic targets.

Anesthesia Technique: All patients underwent a pre-anesthetic evaluation, including airway assessment, and were kept nil per oral as per standard guidelines.

In the operating room, standard ASA monitors were attached, and baseline parameters (HR, systolic blood pressure, diastolic blood pressure, MAP, and SpO_2) were recorded. Two intravenous lines were secured: one for drug infusion and one for fluid and drug administration.

Premedication was avoided. Patients were preoxygenated with 100% oxygen for three minutes, followed by induction with fentanyl (2 µg/kg) and propofol (2 mg/kg titrated to loss of consciousness). Vecuronium (0.5 mg/kg) was administered to facilitate endotracheal intubation. The trachea was intubated with an appropriately sized endotracheal tube, and the oropharynx was packed with a saline-soaked throat pack.

Anesthesia was maintained with oxygen (2 L/min), nitrous oxide (3 L/min), isoflurane (target expired MAC 1.2), and vecuronium (loading 0.5 mg/kg, maintenance 0.1 mg/kg). Patients were positioned with head elevation, and two drops of 0.1% xylometazoline were instilled in each nostril. Intravenous ondansetron (0.1 mg/kg) was administered after induction for antiemetic prophylaxis, and dexamethasone (0.1 mg/kg) was given 30 minutes before the end of surgery. Intravenous paracetamol (1000 mg) was used for multimodal analgesia. At the end of surgery, neuromuscular blockade was reversed with neostigmine (0.04 mg/kg) and glycopyrrolate (0.01 mg/kg). Extubation was performed once patients were awake and breathing spontaneously.

Outcome Measures

- Hemodynamic parameters (MAP, HR): were recorded using standard monitors at predefined time points (baseline/pre-drug, post-loading dose, pre- and post-intubation, at incision, 5 minutes after incision, and then at 15-minute intervals until the end of surgery).
- Demographics (gender, age, weight, ASA status): were documented from the pre-anesthetic evaluation to describe and compare the study groups.
- Ramsay Sedation Score (RSS): was assessed in the recovery period at fixed intervals (10, 20, 30, 45, and 60 minutes after extubation).
- Fromme–Boezaart surgical field score: was rated intraoperatively by the operating surgeon at standardized intervals; lower scores indicated a clearer, drier field.

Statistical Analysis: Data were collected prospectively and entered into a predesigned proforma. Statistical analysis was performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were expressed as frequencies and percentages. Comparisons between the two groups were carried out using independent Student's t-test for continuous variables and chi-square test for categorical variables. A p-value <0.05 was considered statistically significant.

Results

Eighty patients were randomized (Clonidine n=40, Dexmedetomidine n=40). There were no protocol deviations and no missing data. Baseline demographics were comparable between groups (all $p>0.05$) as seen in Table 1.

Table 1: Baseline demographics

Variable	Clonidine (n=40)	Dexmedetomidine (n=40)	p value
Age, years, mean ± SD	31.8 ± 8.5	32.1 ± 8.2	0.86
Male sex, n (%)	26 (65.0)	25 (62.5)	0.82
Weight, kg, mean ± SD	64.8 ± 9.1	65.4 ± 8.7	0.73
ASA I / II, n	27 / 13	26 / 14	0.82

Tests: t-test for continuous, χ^2 for categorical variables.

Both regimens achieved controlled hypotension. Dexmedetomidine produced lower MAP and HR at several intraoperative time points while remaining within the target window (MAP 55–65 mmHg). Repeated-measures analysis showed significant group and time effects, with a modest group×time interaction as seen in Table 2.

Table 2: Mean arterial pressure (MAP, mmHg) and heart rate (HR, bpm) at key time points

Time point	Clonidine MAP	Dexmedetomidine MAP	p	Clonidine HR	Dexmedetomidine HR	p
Baseline (pre-drug)	94 ± 9	94 ± 8	0.88	84 ± 11	85 ± 10	0.72
Post loading dose	76 ± 8	72 ± 7	0.01	72 ± 9	66 ± 8	0.002
Post-intubation	86 ± 10	80 ± 9	0.003	88 ± 12	80 ± 11	<0.001
Skin incision	64 ± 6	60 ± 5	0.001	76 ± 10	70 ± 9	0.003
30 min	63 ± 5	59 ± 4	<0.001	74 ± 9	68 ± 8	0.001
60 min	63 ± 6	59 ± 5	0.002	74 ± 9	69 ± 8	0.010
End of surgery	66 ± 7	61 ± 6	0.001	78 ± 10	72 ± 9	0.004

Per-timepoint comparisons: t-tests. Repeated measures (all time points): MAP—group p<0.001, time p<0.001, interaction p=0.020; HR—group p<0.001, time p<0.001, interaction p=0.038.

Dexmedetomidine yielded consistently better surgical field ratings (lower scores = drier field). The between-group difference in the overall mean score was clinically and statistically significant. Surgeon satisfaction distribution also favored dexmedetomidine as observed in Table 3.

Table 3: Fromme–Boezaart surgical field (overall case mean and satisfaction classes)

Measure	Clonidine (n=40)	Dexmedetomidine (n=40)	Effect
Mean score across case, mean ± SD	2.1 ± 0.5	1.6 ± 0.4	Δ −0.5 (95% CI −0.7 to −0.3), p<0.001
Surgeon satisfaction (A/B/C)*	12 / 25 / 3	24 / 15 / 1	χ^2 p=0.006

***A = excellent (scores 0–1), B = good (2–3), C = poor (4–5/6).**

Immediately after extubation, both groups were arousable. Dexmedetomidine showed higher (deeper) early sedation that converged by 45–60 minutes as seen in Table 4.

Table 4: Ramsay Sedation Score (median [IQR]) after extubation

Time after extubation	Clonidine (n=40)	Dexmedetomidine (n=40)	p value*
10 min	2 [2–3]	3 [3–4]	<0.001
20 min	2 [2–3]	3 [2–3]	0.020
30 min	2 [2–2]	2 [2–3]	0.090
45 min	2 [2–2]	2 [2–2]	0.640
60 min	2 [2–2]	2 [2–2]	1.000

***Mann–Whitney U test (ordinal scale).**

Discussion

In this randomized comparative study of patients undergoing FESS, both clonidine and dexmedetomidine produced reliable controlled hypotension and acceptable operative conditions. Baseline characteristics were well balanced, minimizing confounding from demographic or ASA status differences. Across the intra-operative period, dexmedetomidine was associated with lower MAP and HR at several prespecified time points while staying within the predefined target window for deliberate hypotension; these trajectories are consistent with its stronger central sympatholytic profile and attenuation of pressor surges to laryngoscopy and surgical stimulation [8,9].

From a surgical standpoint, this translated into better operative fields, reflected by lower (i.e., drier) Fromme–Boezaart scores and a shift toward "excellent/good" satisfaction classes, a finding that aligns with prior ENT trials in which dexmedetomidine improved endoscopic visualization and reduced bleeding scores versus standard care or alternative agents [9-11].

Quality of the surgical field is a key determinant of safety and efficiency in endoscopic sinonasal surgery. Validated grading systems such as the

Fromme–Boezaart and related video-based scales correlate with surgeon efficiency and case progress, and they have been recommended for routine reporting in FESS trials [12,13]. Our use of repeated Fromme–Boezaart assessments at fixed time points provides a granular view of operative conditions and mirrors contemporary methodological guidance [12,13]. The superiority signal with dexmedetomidine observed here—together with tighter MAP and HR control—supports a biologically plausible link: stable, lower perfusion pressures in richly vascular mucosa yield less oozing and clearer endoscopic vision.

Sedation findings also followed expected pharmacodynamics. Dexmedetomidine produced higher early RSS values (cooperative, arousable sedation) that converged with clonidine by 45–60 minutes, consistent with its locus-coeruleus mediated sedation and opioid-sparing properties without clinically relevant respiratory depression at the doses used [9,14].

From a recovery standpoint, this pattern is typically acceptable in ambulatory or short-stay pathways, provided vigilant monitoring and standardized discharge criteria are followed [14].

Clonidine remained a clinically valuable comparator. It achieved target MAP with acceptable stability and delivered satisfactory surgical fields in most cases—results that echo earlier studies in which clonidine premedication improved visualization and, in some series, shortened operative time compared with alternative sedatives [15].

In resource-limited settings or when cost-effectiveness is a priority, clonidine therefore remains a reasonable option, with dexmedetomidine reserved for cases where the "driest possible" field is crucial (e.g., extensive polyp disease, revision surgery) or when more pronounced sympatholysis is desired.

Strengths and limitations- Strengths include prospective design, standardized anesthetic technique, dense hemodynamic sampling across clinically relevant milestones, and blinded, repeated surgeon-rated field scores using a validated scale. Limitations include single-center conduct and alternate allocation (rather than concealed sequence generation), which may introduce selection bias. We also did not incorporate additional video-based scoring or inter-rater reliability testing, which some authors advocate to enhance objectivity in endoscopic field assessment. Finally, although the hemodynamic and field-quality signals favored dexmedetomidine, external validity to higher-risk populations (e.g., ASA III–IV) and longer, more hemorrhagic cases warrants multicenter confirmation.

Clinical implications - Within an ASA I–II FESS population, dexmedetomidine appears to offer more consistent control of HR and MAP and superior operative fields, with predictable, transient early sedation that normalizes within the first postoperative hour. Clonidine remains an effective, economical alternative when budget or availability shape drug choice. Future trials should consider harmonized bleeding/field outcomes (including video-based scoring), concealed randomization, and cost-utility analyses to refine α2-agonist selection and dosing during FESS.

Conclusion

In ASA I–II patients undergoing FESS, both clonidine and dexmedetomidine achieved deliberate hypotension with acceptable intraoperative stability. Compared with clonidine, dexmedetomidine produced lower MAP and HR across multiple intraoperative time points, yielded superior surgical field quality (lower Fromme–Boezaart scores and more "excellent/good" ratings), and exhibited predictably deeper early sedation (higher RSS at 10–20 minutes) that equalized by 45–60 minutes.

These data support dexmedetomidine as the preferred α2-agonist when the driest operative field and tighter sympatholysis are desired, while clonidine remains a safe, economical alternative in routine cases.

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