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Original Article

COMPARATIVE EFFICACY OF ESMOLOL AND DEXMEDETOMIDINE IN ACHIEVING CONTROLLED HYPOTENSION DURING FUNCTIONAL ENDOSCOPIC SINUS SURGERY: A RANDOMIZED DOUBLE-BLIND STUDY

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ABSTRACT

Objective: Functional Endoscopic Sinus Surgery (FESS) is a prevalent procedure in otorhinolaryngology, often complicated by excessive intraoperative bleeding, which impairs surgical visibility. Controlled hypotensive anesthesia is employed to mitigate blood loss and enhance the surgical field. Esmolol, an ultra-short-acting beta-blocker, and Dexmedetomidine, a selective α_2-adrenergic agonist, are two agents commonly used to achieve controlled hypotension. This study aims to compare the efficacy and safety of esmolol versus dexmedetomidine in maintaining controlled hypotension during FESS.

Methods: A prospective, double-blind, randomized interventional study was conducted involving 60 patients aged 18-65 years with ASA Grade I-II, scheduled for FESS under general anesthesia. Participants were randomly allocated into two groups: Group A received an esmolol bolus of 1 mg/kg over 1 minute followed by an infusion of 1 mg/kg/h, while Group B received a dexmedetomidine bolus of 1 µg/kg over 10 min followed by an infusion of 0.5 µg/kg/hr. Hemodynamic parameters, blood loss, duration of surgery, quality of the surgical field, recovery time, analgesic requirements, and complications were recorded and analyzed.

Results: Both esmolol and dexmedetomidine groups achieved significant reductions in mean arterial pressure (MAP) without significant differences between the groups. Blood loss and duration of surgery were comparable. Dexmedetomidine was associated with a significantly longer time to first rescue analgesic (58.7±5.09 min vs. 29.83±4.38 min, $p<0.001$) and prolonged emergence time (7.45±0.98 min vs. 4.45±0.97 min, $p<0.001$) compared to esmolol. Heart rate was significantly lower in the dexmedetomidine group throughout the surgery ($p<0.001$). Complication rates were similar between groups.

Conclusion: Both esmolol and dexmedetomidine are effective and safe for achieving controlled hypotension in FESS, providing hemodynamic stability and minimal blood loss. Dexmedetomidine offers superior postoperative analgesia but is associated with delayed emergence, whereas esmolol allows for quicker recovery. Choice of agent can be tailored based on patient-specific requirements and surgical considerations.

Keywords: Functional endoscopic sinus surgery, Controlled hypotension, Esmolol, Dexmedetomidine, Hemodynamic stability, Intraoperative blood loss

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INTRODUCTION

Functional Endoscopic Sinus Surgery (FESS) is a widely performed procedure in otorhinolaryngology aimed at restoring sinus ventilation and function by manipulating the nasal and paranasal sinuses [1-3]. Indications for FESS include chronic and recurrent sinusitis refractory to medical management, nasal polyposis, antrochoanal polyps, sinus mucoceles, selected tumor excisions, cerebrospinal fluid leak closures, orbital decompressions, optic nerve decompressions, dacryocystorhinostomy, choanal atresia repairs, foreign body removals, and epistaxis control [1-3].

A significant challenge during FESS is impaired surgical visibility due to excessive bleeding, particularly under general anesthesia [4, 5]. Intraoperative bleeding can obscure the surgical field, increasing the risk of complications and prolonging surgery duration. Controlled hypotensive anesthesia is an effective strategy to reduce intraoperative bleeding by inducing systemic hypotension, thereby enhancing surgical visibility, reducing blood loss, and decreasing the need for blood transfusions [6, 7]. This technique typically involves reducing the mean arterial pressure (MAP) by approximately 30% or maintaining MAP between 60-70 mmHg [6-15].

Esmolol, an ultra-short-acting selective β_1-adrenergic antagonist, effectively decreases heart rate and blood pressure, providing stable, controlled hypotension with a rapid onset and offset [16-18]. Dexmedetomidine, a highly selective α_2-adrenergic receptor agonist, offers sympatholytic, sedative, and analgesic effects, modulating hemodynamic responses by inhibiting catecholamine release [19, 20]. Both agents are utilized for their ability to provide controlled hypotension, but their comparative efficacy and safety profiles in the context of FESS require further elucidation.

The choice of hypotensive agent is influenced by factors such as ease of administration, onset and duration of action, side effect profiles, and impact on postoperative recovery [13]. Ideal agents should provide predictable, dose-dependent effects with minimal impact on vital organs and rapid elimination without toxic metabolites [13]. Patient-related contraindications include cardiac and renal diseases, diabetes, hypertension history, ischemic cerebrovascular disease, anemia, hemoglobinopathies, polycythemia, and respiratory insufficiency [14].

Given the distinct pharmacological profiles of esmolol and dexmedetomidine, this study aims to compare their efficacy and safety in achieving controlled hypotension during FESS, focusing on hemodynamic stability, blood loss, surgical field quality, recovery time, analgesic requirements, and complication rates.

MATERIALS AND METHODS

This hospital-based prospective, double-blind, randomized interventional study was conducted in the Department of Anaesthesiology at JLN Medical College and associated group of hospitals, Ajmer. The study was approved by the institutional ethics committee, and written informed consent was obtained from all participants.

Study population

A total of 60 eligible patients, aged 18-65 y, of either sex, with body weight between 40-70 kg and classified as ASA Grade I-II, scheduled

for FESS under general anesthesia, were included. Exclusion criteria encompassed patients unwilling to participate, those with a history of drug allergies, pre-existing asthma, renal or hepatic dysfunction, and pregnant or lactating women.

Randomization and group allocation

Participants were randomly allocated into two groups of 30 each using the sealed envelope method:

- **Group A (Esmolol Group):** Received an intravenous bolus of esmolol at 1 mg/kg over 1 minute before induction, followed by an infusion of 1 mg/kg/hr via an infusion pump.
- **Group B (Dexmedetomidine Group):** Received a bolus dose of dexmedetomidine at 1 µg/kg diluted in 19 ml normal saline, administered over 10 min via a syringe pump before induction, followed by an intraoperative infusion of dexmedetomidine at 0.5 µg/kg/hr diluted in normal saline.

Anesthetic protocol

All patients were premedicated and induced with standard anesthetic agents. Anesthesia was maintained with appropriate inhalational agents, and intraoperative monitoring included ECG, blood pressure, heart rate, and oxygen saturation.

Data collection

Parameters recorded included:

- Demographics: Age, sex, weight
- Duration of surgery
- Intraoperative blood loss
- Hemodynamic parameters: Systolic BP (SBP), Diastolic BP (DBP), MAP, Heart Rate (HR)
- Quality of surgical field assessed by RSS score
- Time to first rescue analgesic
- Emergence time
- Complications: Dry mouth, nausea/vomiting, shivering

Statistical analysis

Data were analyzed using appropriate statistical tests. Continuous variables were expressed as mean±standard deviation and compared using t-tests. Categorical variables were expressed as frequencies and percentages and compared using chi-square tests. A p-value of<0.05 was considered statistically significant.

RESULTS

The study comprised 60 patients equally divided into the Esmolol (Group A) and Dexmedetomidine (Group B) groups. Baseline characteristics, including age, sex distribution, and weight, were comparable between the groups (table 1).

Intraoperative parameters

The duration of surgery and intraoperative blood loss were similar between the Esmolol and Dexmedetomidine groups, with no statistically significant differences observed (table 2).

Hemodynamic stability

Mean SBP, DBP, and MAP showed significant reductions from baseline in both groups, achieving the target hypotensive range. No significant intergroup differences were noted in SBP (table 3), DBP (table 4), or MAP (table 5) at any time point during the surgery.

Heart rate

Heart rate significantly decreased from baseline in both groups. However, the Dexmedetomidine group exhibited a significantly lower HR compared to the Esmolol group at all intraoperative time points (table 6).

Quality of surgical field

The RSS scores, indicative of surgical field visibility, were not significantly different between the groups at 15, 30, and 60 min intraoperatively (table 7).

Postoperative analgesia and recovery

The time to first rescue analgesic was significantly longer in the dexmedetomidine group compared to the esmolol group (58.7±5.09 min vs. 29.83±4.38 min, $p<0.001$) (table 8). Additionally, the emergence time was significantly prolonged in the dexmedetomidine group (7.45±0.98 min) compared to the esmolol group (4.45±0.97 min, $p<0.001$) (table 9).

Complications

Complication rates, including dry mouth, nausea/vomiting, and shivering, were comparable between the groups with no statistically significant differences (table 10).

Table 1: Comparison of patient characteristics in the two groups

Characteristics	Esmolol (A)	Dexmedetomidine (B)	P Value
Age (years)	37.43±5.21	37.3±7.32	0.936
Weight (kg)	68.67±7.99	66.77±6.48	0.316
Sex (M/F)	20/10	21/9	0.920

Table 2: Comparison of duration of surgery and blood loss among study groups

Intraoperative parameters	Esmolol (A)	Dexmedetomidine (B)	P Value
Duration of surgery (min)	82.27±8.07	82.4±8.47	0.950
Blood loss (ml)	137.17±6.57	138.1±7.07	0.598

Table 3: Comparison of mean SBP (mmHg) among study groups

Time	Esmolol	Dexmedetomidine	P value
At beginning	120.23±5.65	120.27±6.09	0.983
1 min	117.93±5.66	117.57±5.89	0.807
5 min	114.63±5.61	114.17±6.13	0.760
10 min	111.5±5.56	111.1±6.08	0.791
20 min	108.2±5.62	107.6±6.44	0.702
30 min	105.97±5.22	105.17±5.91	0.581
40 min	103.8±4.86	103±5.66	0.559
50 min	101.1±4.84	100.53±5.32	0.668
60 min	97.83±4.68	97.67±4.81	0.892

Table 4: Comparison of mean DBP (mmHg) among study groups

Time	Esmolol	Dexmedetomidine	P value
At beginning	70.77±3.69	71.47±4.13	0.492
1 min	69.4±3.88	70.93±4.07	0.141
5 min	69.57±3.9	70.97±3.73	0.161
10 min	68.17±3.87	69.8±3.75	0.102
20 min	66.1±3.99	66.67±3.66	0.569
30 min	64.7±4.01	64.83±3.75	0.895
40 min	63.03±4.09	63.1±3.79	0.948
50 min	62.17±3.85	61.1±4.09	0.303
60 min	60.77±3.86	60.6±4.23	0.874

Table 5: Comparison of mean MAP (mmHg) among study groups

Time	Esmolol (A)	Dexmedetomidine(B)	P value
At beginning	86.97±3.74	88.1±3.58	0.236
1 min	85.6±2.84	86.23±3.44	0.440
5 min	84.53±2.99	85.13±3.49	0.478
10 min	82.53±2.89	83.3±3.42	0.352
20 min	80.1±2.92	80±3.3	0.901
30 min	78.46±2.88	74.66±11.23	0.078
40 min	76.62±2.85	76.4±3.5	0.788
50 min	75.14±2.77	74.24±3.52	0.276
60 min	73.12±2.74	72.96±3.52	0.839

Table 6: Comparison of mean heart rate (bpm) among study groups

Time	Esmolol(A)	Dexmedetomidine (B)	P value
At beginning	80.3±3.09	79.03±2.46	0.084
1 min	79.2±3.18	76.67±3.26	0.003 (S)
5 min	78.3±2.88	75.3±3.51	0.001 (S)
10 min	77.3±2.88	73.33±3.81	<0.001 (S)
20 min	73.7±2.73	70.27±3.9	<0.001 (S)
30 min	71.6±2.62	68.23±3.85	<0.001 (S)
40 min	69.6±2.62	66.23±3.85	<0.001 (S)
50 min	68.6±2.62	65.23±3.85	<0.001 (S)
60 min	68.57±2.46	64.57±4.22	<0.001 (S)

Table 7: Comparison of mean RSS score among study groups

Time	Esmolol (A)	Dexmedetomidine(B)	P value
At 15 min	1.33±0.48	1.6±0.5	0.492
At 30 min	1.17±0.38	1.53±0.51	0.141
At 60 min	1.1±0.31	1.33±0.48	0.161

Table 8: Comparison of mean time to first rescue analgesic (min) of study groups

Group	N	Time to first rescue analgesic in min (Mean±SD)	P value
Esmolol (A)	30	29.83±4.38	<0.001 (S)
Dexmedetomidine (B)	30	58.7±5.09	

Table 9: Comparison of mean emergence time (min) of study groups

Group	N	Emergence time in min (Mean±SD)	P value
Esmolol (A)	30	4.45±0.97	<0.001 (S)
Dexmedetomidine (B)	30	7.45±0.98	

Table 10: Frequency of complications among study groups

Complications	Esmolol (A) N (%)	Dexmedetomidine (B) N (%)	Total N (%)	P Value
None	20 (66.7)	25 (83.3)	45 (75)	0.233
Dry mouth	1 (3.3)	3 (10)	4 (6.7)	0.605
Nausea/Vomiting	5 (16.7)	1 (3.3)	6 (10)	0.197
Shivering	4 (13.3)	1 (3.3)	5 (8.3)	0.350

DISCUSSION

Controlled hypotensive anesthesia is a pivotal technique in minimizing intraoperative bleeding and enhancing the surgical field during Functional Endoscopic Sinus Surgery (FESS) [21]. Achieving an optimal balance between reduced bleeding and adequate organ perfusion is essential to ensure patient safety and surgical efficacy. This study compared the efficacy and safety of esmolol and dexmedetomidine in maintaining controlled hypotension during FESS.

Both esmolol and dexmedetomidine effectively achieved the target mean arterial pressure (MAP) with no significant differences in SBP, DBP, or MAP between the groups throughout the surgery. This indicates that both agents are equally efficacious in providing controlled hypotension. The reduction in MAP was consistent with previous studies, which reported similar efficacies [24-26]. Unlike Mahajan *et al.* [33], who found dexmedetomidine superior in reducing blood loss, our study did not observe significant differences in intraoperative blood loss between the groups.

Heart rate reduction was significantly more pronounced in the dexmedetomidine group compared to the esmolol group. Dexmedetomidine's sympatholytic effects, mediated through α_2-adrenergic receptor agonism, lead to decreased norepinephrine release and resultant bradycardia [22, 28]. This aligns with findings from Damarla *et al.* [26] and Bajwa *et al.* [25], who also reported greater heart rate reduction with dexmedetomidine.

The quality of the surgical field, as assessed by RSS scores, did not differ significantly between the groups, suggesting that both agents provided comparable surgical conditions. This is consistent with the hypothesis that both esmolol and dexmedetomidine effectively reduce bleeding without compromising surgical visibility.

Postoperative outcomes revealed that dexmedetomidine prolonged the time to first rescue analgesic and emergence time, attributable to its sedative and analgesic properties [19, 20, 31]. The analgesic-sparing effect of dexmedetomidine was evident, reducing the need for additional analgesics postoperatively, as supported by Gurbet *et al.* [32]. Conversely, esmolol facilitated quicker emergence, which may be advantageous in settings where rapid recovery is desired.

Complication rates, including dry mouth, nausea/vomiting, and shivering, were similar between the groups, indicating that both agents have comparable safety profiles in the context of FESS. This concurs with studies by Shams *et al.* [24] and Damarla *et al.* [26], which also reported no significant differences in intraoperative complications between esmolol and dexmedetomidine.

LIMITATIONS

The study was limited by its sample size and single-center design, which may affect the generalizability of the findings. Additionally, the absence of long-term postoperative follow-up restricts the assessment of prolonged outcomes and complications.

CLINICAL IMPLICATIONS

Both esmolol and dexmedetomidine are viable options for achieving controlled hypotension in FESS, with esmolol offering faster recovery and dexmedetomidine providing enhanced postoperative analgesia. The choice between these agents should be individualized based on patient characteristics, surgical requirements, and postoperative care considerations.

CONCLUSION

This study concludes that both dexmedetomidine and esmolol are effective and safe for maintaining controlled hypotension during Functional Endoscopic Sinus Surgery. While dexmedetomidine offers the advantage of prolonged postoperative analgesia, esmolol facilitates quicker emergence from anesthesia. Both agents provide hemodynamic stability and minimize intraoperative blood loss, making them suitable choices for optimizing surgical conditions in FESS.

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AUTHORS CONTRIBUTIONS

All authors have contributed equally

CONFLICT OF INTERESTS

Declared none

REFERENCES

1. Illum P, Jeppesen F. Sinoscopy: endoscopy of the maxillary sinus. Technique common and rare findings. Acta Oto Laryngol. 1972 Jun;73(6):506-12. doi: 10.3109/00016487209138972, PMID 5047113.
2. Kennedy DW. Technical innovations and the evolution of endoscopic sinus surgery. Ann Otol Rhinol Laryngol Suppl. 2006 Sep;196:3-12. doi: 10.1177/00034894061150s902, PMID 17040012.
3. Wormald PJ, Hoseman W, Callejas C, Weber RK, Kennedy DW, Citardi MJ. The international frontal sinus anatomy classification (IFAC) and classification of the extent of endoscopic frontal sinus surgery (EFSS). Int Forum Allergy Rhinol. 2016 Jul;6(7):677-96. doi: 10.1002/alr.21738, PMID 26991922.
4. Hosemann W, Draf C. Danger points complications and medico legal aspects in endoscopic sinus surgery. GMS Curr Top Otorhinolaryngol Head Neck Surg. 2013 Dec 13;12:6. doi: 10.3205/cto000098, PMID 24403974.
5. Weber RK. Comprehensive review on endonasal endoscopic sinus surgery. Laryngorhinootologie. 2015 Mar;94 Suppl 1:S64-S142. doi: 10.1055/s-0035-1545353, PMID 25860497.
6. Dutton RP, Mackenzie CF, Scalea TM. Hypotensive resuscitation during active hemorrhage: impact on in-hospital mortality. J Trauma. 2002 Jun;52(6):1141-6. doi: 10.1097/00005373-200206000-00020, PMID 12045644.
7. Praveen K, Narayanan V, Muthusekhar MR, Baig MF. Hypotensive anaesthesia and blood loss in orthognathic surgery: a clinical study. Br J Oral Maxillofac Surg. 2001 Apr;39(2):138-40. doi: 10.1054/bjom.2000.0593, PMID 11286449.
8. Kim DH, Lee J, Kim SW, Hwang SH. The efficacy of hypotensive agents on intraoperative bleeding and recovery following general anesthesia for nasal surgery: a network meta-analysis. Clin Exp Otorhinolaryngol. 2021 May;14(2):200-9. doi: 10.21053/ceo.2020.00584, PMID 32847341, PMCID PMC8111392.
9. Choudhary P, Dutta A, Sethi N, Sood J, Rai D, Gupta M. Pre-induction fentanyl dose-finding study for controlled hypotension during functional endoscopic sinus surgery. Indian J Anaesth. 2019;63(8):653-9. doi: 10.4103/ija.IJA_866_18, PMID 31462812.
10. Rodrigo C. Induced hypotension during anesthesia with special reference to orthognathic surgery. Anesth Prog. 1995;42(2):41-58. PMID 8934953.
11. Gardner WJ. The control of bleeding during operation by induced hypotension. JAMA. 1946;132(10):572-4. doi: 10.1001/jama.1946.02870450026007, PMID 21001599.
12. Walsh M, Devereaux PJ, Garg AX, Kurz A, Turan A, Rodseth RN. Relationship between intraoperative mean arterial pressure and clinical outcomes after noncardiac surgery: toward an empirical definition of hypotension. Anesthesiology. 2013;119(3):507-15. doi: 10.1097/ALN.0b013e3182a10e26, PMID 23835589.
13. Degoute CS. Controlled hypotension: a guide to drug choice. Drugs. 2007;67(7):1053-76. doi: 10.2165/00003495-200767070-00007, PMID 17488147.
14. Hodge K, Ward PA, Irwin MG. Hypotensive anaesthesia. In: Ward PA, Irwin MG, editors. Oxford textbook of anaesthesia for oral and maxillofacial surgery. 2nd ed. Oxford: Oxford Academic; 2022. p. 77-C7.P62. doi: 10.1093/med/9780198790723.003.0007.
15. Cardesin A, Pontes C, Rosell R, Escamilla Y, Marco J, Escobar MJ. Hypotensive anaesthesia and bleeding during endoscopic sinus surgery: an observational study. Eur Arch Otorhinolaryngol. 2014;271(6):1505-11. doi: 10.1007/s00405-013-2700-0, PMID 24052249.
16. Barbier GH, Shettigar UR, Appunn DO. Clinical rationale for the use of an ultra-short-acting beta-blocker: esmolol. Int J Clin Pharmacol Ther. 1995 Apr;33(4):212-8. PMID 7620691.

17. Mio Y. New ultra short acting beta-blockers: landiolol and esmolol the effects on cardiovascular system. Masui. 2006 Jul;55(7):841-8. PMID 16856544.
18. Angaran DM, Schultz NJ, Tschida VH. Esmolol hydrochloride: an ultrashort acting beta-adrenergic blocking agent. Clin Pharm. 1986 Apr;5(4):288-303. doi: 10.1093/ajhp/43.5.1322, PMID 2871961.
19. Gupta K, Bansal M, Gupta PK, Pandey M, Agarwal S. Dexmedetomidine infusion during middle ear surgery under general anaesthesia to provide oligaemic surgical field: a prospective study. Indian J Anaesth. 2015;59(1):26-30. doi: 10.4103/0019-5049.149445, PMID 25684810.
20. Bloor BC, Ward DS, Belleville JP, Maze M. Effects of intravenous dexmedetomidine in humans. II. Hemodynamic changes. Anesthesiology. 1992 Dec;77(6):1134-42. doi: 10.1097/00000542-199212000-00014, PMID 1361311.
21. Tegegne SS, Gebregzi AH, Arefayne NR. Deliberate hypotension as a mechanism to decrease intraoperative surgical site blood loss in resource limited setting: a systematic review and guideline. International Journal of Surgery Open. 2021;29(7):55-65. doi: 10.1016/j.ijso.2020.11.019.
22. Gertler R, Brown HC, Mitchell DH, Silvius EN. Dexmedetomidine: a novel sedative analgesic agent. Proc (Bayl Univ Med Cent). 2001;14(1):13-21. doi: 10.1080/08998280.2001.11927725, PMID 16369581.
23. Carollo DS, Nossaman BD, Ramadhyani U. Dexmedetomidine: a review of clinical applications. Curr Opin Anaesthesiol. 2008;21(4):457-61. doi: 10.1097/ACO.0b013e328305e3ef, PMID 18660652.
24. Shams T, El Bahnasawe NS, Abu Samra M, El Masry R. Induced hypotension for functional endoscopic sinus surgery: a comparative study of dexmedetomidine versus esmolol. Saudi J Anaesth. 2013 Apr;7(2):175-80. doi: 10.4103/1658-354X.114073, PMID 23956719, PMCID PMC3737695.
25. Bajwa SJ, Kaur J, Kulshrestha A, Haldar R, Sethi R, Singh A. Nitroglycerine esmolol and dexmedetomidine for induced hypotension during functional endoscopic sinus surgery: a comparative evaluation. J Anaesthesiol Clin Pharmacol. 2016 Apr-Jun;32(2):192-7. doi: 10.4103/0970-9185.173325, PMID 27275048, PMCID PMC4874073.
26. Damarla P, Mamidi P. Dexmedetomidine and esmolol for induced hypotension for functional endoscopic sinus surgery. Nat J Physiol Pharmacol Pharm Res. 2022;12:3.
27. Degoute CS, Ray MJ, Manchon M, Dubreuil C, Banssillon V. Remifentanil and controlled hypotension; comparison with nitroprusside or esmolol during tympanoplasty. Can J Anaesth. 2001;48(1):20-7. doi: 10.1007/BF03019809, PMID 11212044.
28. Richa F, Yazigi A. Effect of dexmedetomidine on blood pressure and bleeding in maxilla facial surgery. Eur J Anaesthesiol. 2007;24(11):985-6. doi: 10.1017/s0265021507001081, PMID 18035604.
29. Durmus M, But AK, Dogan Z, Yucel A, Miman MC, Ersoy MO. Effect of dexmedetomidine on bleeding during tympanoplasty or septorhinoplasty. Eur J Anaesthesiol. 2007;24(5):447-53. doi: 10.1017/S0265021506002122, PMID 17241505.
30. Sidhwani Valecha D, Gandhi M, KK A. Comparison of dexmedetomidine and esmolol for induction of controlled hypotension in spine surgeries. J Evol Med Dent Sci. 2016;5(35):2030-5. doi: 10.14260/jemds/2016/477.
31. Gertler R, Brown HC, Mitchell DH, Silvius EN. Dexmedetomidine: a novel sedative analgesic agent. Proc (Bayl Univ Med Cent). 2001 Jan;14(1):13-21. doi: 10.1080/08998280.2001.11927725, PMID 16369581, PMCID PMC1291306.
32. Gertler R, Brown HC, Mitchell DH, Silvius EN. Dexmedetomidine: a novel sedative analgesic agent. Journal of Baylor Scott & White Health. 2001 Jan;14(1):13-21. doi: 10.1080/08998280.2001.11927725.
33. Gurbet A, Basagan Mogol E, Turker G, Ugun F, Kaya FN, Ozcan B. Intraoperative infusion of dexmedetomidine reduces perioperative analgesic requirements. Can J Anaesth. 2006 Jul;53(7):646-52. doi: 10.1007/BF03021622, PMID 16803911.
34. Ajay K, Ankur G, Malti A. Comparison between intravenous dexmedetomidine and esmolol for induced hypotension during functional endoscopic sinus surgery and modified radical mastoidectomy. MIJOANS. 2018;8(1):29-33. doi: 10.26611/1015816.