Original Research Article

Indian Journal of Anesthesia and Analgesia
2018; 5(12): 2053-61
DOI: http://dx.doi.org/10.21088/ijaa.2349.8471.51218.14

Comparison of Dexmedetomidine with Esmolol as Hypotensive Agents in Elective ENT Surgeries in General Anaesthesia: A Randomized Controlled Trial

Shilpa Bansal[1], Mridul M. Panditrao[2], Sumit Bansal[3], Minnu M. Panditrao[4]

[1,3]Assistant Professor [2]Professor & Head [4]Professor, Department of Anaesthesiology and Intensive Care, Adesh Institute of Medical Sciences and Research, Bathinda, Punjab 151109, India.

Abstract

Objective: To compare the efficacy of dexmedetomidine as a hypotensive agent with esmolol in elective ENT Surgeries in ASA grade I-II patients. *Methods:* This study was a prospective, randomized, double blinded study that included 60 ASA grade I and II patients, undergoing ENT surgeries 30 patients in each group. They were allocated to receive either esmolol (Group E) or dexmedetomidine (Group D) to maintain mean arterial blood pressure (MAP) between (55-65 mmHg). Intraoperative analgesic and additional hypotensive agent requirements were recorded. Standard Average Category Scale (ACS) was used for assessment of blood loss intraoperatively. Hemodynamic variables, emergence time, postoperative recovery time and sedation score following tracheal extubation were recorded. Post-operative pain, nausea and vomiting score and time needed to first analgesic were also recorded. Independent student T test was used for comparision of continuous variables and Chi square test for categorical variables. A *P* value of < 0.05 was considered statistically significant. *Result:* There were no inter group differences in haemodynamics and ACS. Emergence time, postoperative recovery and sedation score were significantly higher in Group D. VAS score was significantly lower in Group D. Time to first analgesic request was significantly longer in Group D. No postoperative nausea or vomiting was observed in both groups. *Conclusion:* Both dexmedetomidine and esmolol were effective in providing ideal surgical field. Both were safe agents for controlled hypotension. Dexmedetomidine offers the advantage of analgesia, amnesia and sedation with better intraoperative and postoperative patient satisfaction as compared to esmolol.

Keywords: Dexmedetomidine; Esmolol Hydrochloride; Controlled Hypotension; ENT Surgeries.

How to cite this article:

Shilpa Bansal, Mridul M. Panditrao, Sumit Bansal, Minnu M. Panditrao. Comparison of Dexmedetomidine with Esmolol as Hypotensive Agents in Elective ENT Surgeries in General Anaesthesia: A Randomized Controlled Trial. Indian J Anesth Analg. 2018;5(12):2053-61.

Introduction

The use of intentional reduction of blood pressure (controlled hypotension) to minimise bleeding in a variety of surgical procedures is gaining popularity. Controlled or induced hypotensive anaesthesia is a technique by which the arterial blood pressure is decreased in a predictable and deliberate manner in order to facilitate surgery and to reduce bleeding and transfusion requirement. The concept of induced hypotension is not a new one, it has been practised for decades [1,2,3,4,5].

Varieties of methods and medications are used for controlled hypotension. The ideal medication should be non-toxic with short-term effects, not affecting cardiac performance and cerebrovascular autoregulation and titrated easily [6,7].

Corresponding Author: Shilpa Bansal, Assistant Professor, Department of Anaesthesiology and Intensive Care, Adesh Institute of Medical Sciences and Research, Bathinda, Punjab 151109, India.
E-mail: shilpa_shinde24@rediffmail.com

Received on 15.09.2018, **Accepted on** 01.10.2018

Delibarate hypotension is preferred in patients undergoing neurosurgery, head and neck, spine, major orthopaedic, major hepatic resection and vascular procedures [5,8,9].

Hypotensive anaesthesia is not always suitable for every patient as there is always a risk of reduced perfusion to vital organs mainly brain, heart and kidneys [5,10].

Middle ear surgeries use microscope in a small area, so slightest bleeding at the surgical area would look larger due to the magnifying effect of the microscope, which could interfere in surgical visualization and exposure. Controlled hypotension is preferred to provide a bloodless, readily visible surgical area in middle ear surgeries [6].

Various agents e.g., vasodilators (sodium nitroprusside), nitroglycerine, magnesium sulphate beta adrenergic antagonist and inhaled anesthetics, have been used to achieve controlled hypotension [7].

They have disadvantages like cyanide toxicity for nitroprusside, resistance to vasodilators, tachyphylaxis and delayed recovery from inhaled anesthetics. High inspired concentrations of inhaled anaesthetics are used to decrease blood pressure, it can cause more bleeding due to peripheral vasodilator effects [6].

Esmolol is an ultrashort acting selective B1 adrenergic antagonist with rapid onset of action after intravenous bolus injection and infusion. It reduces heart rate and blood pressure and gradual recovery of arterial blood pressure to the pre infusion level occurred without development of rebound hypertension after stoppage of infusion. Dexmedetomidine is a potent selective alpha-2 agonist and has central and peripheral sympatholytic, antinociceptive action that manifest as anxiolysis, sedation, hypotension, bradycardia, analgesic and anaesthetics sparing effects with no respiratory depression [7].

Dexmedetomidine carry the risk of delay recovery from anaesthesia, prolonged postoperative sedation due to relatively longer duration of action [5].

Aims and objectives of this prospective study was to compare the efficacy of dexmedetomidine or esmolol as a hypotensive agent in ENT surgeries with respect to intraoperative bleeding, quality of the surgical field, recovery from anaesthesia, and safety in adult patients.

Materials and Methods

This prospective, randomized, double blinded study was done in the dept. of Anaesthesiology and Intensive care at AIMSR, Bathinda during the period from March 2017 to August 2017. After getting approval of the Institutonal ethical committee, (IEC), written informed consent was obtained from patients during the pre-anesthetic evaluation after explaining the study procedure, drug's side effects and the surgical procedure, in the language they understand.

Total of 60 ASA grade I-II patients of both sexes aged between 18-60 yrs, undergoing ENT surgeries were included in the study. These patients were equally randomly divided in to 2 groups (Group D and E, 30 patients in each group) with the help of computer generated random number table. To calculate the required sample size the result of previous studies were considered . Total 60 patients were included in the study. Power calculation suggested that a minimum of 25 subjects per group was required to detect 10% difference in mean arterial pressure between groups (taking type I or alpha error of 5%, type II or beta error of 20% and standard deviation =10), to be on a safer side, 30 patients were included in each group (n=30). Patients with systemic co-morbidities like coronory artery disease, cerebro vascular accidents, renal or hepatic disease, coagulopathies and who refused to give informed consent, were excluded from the study.

A detailed history, general physical examination and detailed systemic examination was done during the pre-anesthetic evaluation to rule out the presence of major illnesses as mentioned above. Investigations like complete blood count (CBC), renal function test (RFT), liver function test (LFT), blood sugar, electrocardiogram (ECG), chest X ray and other basal laboratory tests were done. Patients were kept Nil by mouth (NBM) for 6 hrs prior to surgery. In the operating room, two cannulae were inserted, one for infusion of dexmedetomidine or esmolol and the other for administration of fluids and other drugs. Patients vitals pulse rate (PR), respiratory rate (RR), non invasive blood pressure (NIBP), pulse oximetry (SpO_2), end tidal CO_2 ($ETCO_2$) were monitored continously using multipara monitors. All patients were premedicated with IV midazolam (20ug/kg) glycopyrolate (0.004mg/kg) and butorphanol (20 μg/Kg). Patients received propofol (2 mg/kg) IV for induction of anaesthesia followed by muscle relaxant, vecuronium (0.1 mg/kg) IV for endotracheal intubation.

Patients in Group D received loading dose of 1 μg/kg dexmedetomidine diluted in 10 ml 0.9% normal saline infused over 10 min before starting of surgery, followed by continous infusion (0.3- 0.7 μg/kg/h).

Patients in Group E received loading dose of 1 mg/kg esmolol infused over 1 min followed by continuous infusion of (0.3-0.7 mg/kg/h).

Both the study drugs were prepared in 50 ml normal saline and were administered by syringe pump. The prepration and labeling of the study drug was performed by an anaesthesiologist who was not involved in administration of study drugs. In both groups infusion rate was titrated to maintain mean arterial blood pressure (MAP) within 55-65 mmHg. Anesthesia was maintained with Isoflurane 1-2% and patients were mechanically ventilated with 60% O_2 and 40% N_2O mixture. Additional dose of butorphanol was given in case of inadequate anaesthesia. Nitroglycerine was used if target limits of MAP could not be achieved with maximum permissible dose of dexmedetomidine or esmolol. Quality of intraoperative surgical field was estimated with using average category scale of Fromme et al. [11] when MAP reached the target range (55-65 mmHg).

Average category scale for assessment of intraoperative surgical field:

0- No bleeding

1- Slight bleeding - no suctioning of blood required

2- Slight bleeding - occasional suctioning required. Surgical field not threatened

3- Slight-bleeding - frequent suctioning required. Bleeding threatens surgical field a few seconds after suction is removed

4- Moderate bleeding - frequent suctioning required. Bleeding threatens surgical field directly after suction is removed

5- Severe bleeding - constant suctioning required Bleeding appears faster than can be removed by suction. Surgical field severely threatened and surgery not possible.

Surgeon was blinded to the hypotensive agent used. The total blood loss was measured from the suction apparatus. Average category scale two or three values were supposed to be ideal values. Ten minutes before the anticipated end of surgery infusion of the study drugs was stopped, and isoflurane was stopped at the end of the surgery. Neuromuscular blockade was antagonized with neostigmine (0.05 mg/kg) and glycopyrolate (0.01 mg/kg).

Hemodynamics were recorded preoperatively (baseline), intraoperatively (before induction, post-induction i.e. after administration of hypotensive and anesthetic agent and after stoppage of hypotensive agents) and lastly postoperatively i.e. after recovery. Hemodynamics were recorded at a interval of 15 min throughout perioperative period. Intraoperative butrum consumption and requirements for additional hypotensive agent (nitroglycerine) were recorded.

Emergence time in minutes was also recorded. Emergence time, defined as the interval between the discontinuation of anesthetics to response of eye opening to verbal command [7], was recorded. After extubation patient was assessed for postoperative recovery in post anaesthesia care unit (PACU) by using a modified Aldret Score (0-10) [7], Time needed to achieve ≥ 9 (score required for discharge) was recorded.

Parameter	Score		
	2	1	0
Activity	Moves all extremities voluntarily or on command	Moves two extremities voluntarily or on command	Unable to move extremities
Respiration	Breathes deeply and coughs freely	Dyspnea, shallow or limited breathing	Apneic
Circulation	BP ± 20 mm of preanesthetic level	Bp ± 20–50 mm of preanesthetic level	BP ± 50 mm of preanesthetic level
Consciousness	Fully awake	Arousable on calling	Not responding
Oxygen saturation	SpO2 >92% on room air	Supplemental O2 required to maintain SpO2 >90%	SpO2 <90% with O2 supplementation
Total score = 10; A score of ⩾9 required for discharge			

Post Anesthesia Recovery Score (Modified Aldrete Score)

Sedation score [7] was measured using the sedation score scale at 15, 30, 45 and 60 minutes after tracheal extubation.

1= Anxious, agitated, or restless.

2= Cooperative, oriented, and tranquil.

3= Responsive to commands.

4= A sleep, but with brisk response to light, glabellar tap, or loud auditory stimulus.

5= A sleep, sluggish response to glabellar tap, or auditory stimulus.

6= A sleep, no response.

Post-operative pain was also assessed and monitored with the help of a Visual Analogue Scale (VAS) and time to first analgesic request was recorded.

Visual Analogue Scale (VAS) for Pain score

0 — — — 3 — — — 5 — — — 7 — — — 10

Pain score, 0-3 :	Mild Pain
Pain score, 4-7 :	Moderate Pain
Pain score, >7 :	Severe Pain

The nausea vomiting score [12] was also recorded.

Post-operative Nausea-Vomiting Scale (PONV Scale)

0 - No nausea

1 - Mild nausea

2 - Moderate nausea

3 - Severe nausea

4 - Retching / Vomiting

The nausea vomiting score, sedation score and VAS was recorded after 15 minutes, 30 minutes, 45 minutes, 60 minutes, 2 hours, 6 hours after the completion of surgery. Patients in both the groups were administered injection ondansetron (4mg) intravenously in case they complained of nausea/ vomiting. Patients were given injection diclofenac 1 mg/kg intramuscularly when the VAS was ≥ 4. A specific mention of this was made in the record of the patient. Patients were also asked about recalling intraoperative events or any sign of awareness.

Statistical Analysis

The data collected from this study was entered in to Microsoft excel sheet, Windows XP 2007 and Epi Info. Necessary statistical tables were constructed. The statistical constants like arithmetic mean, standard deviation, percentage etc were computed to get valid inference about the data for comparison. Independent student T test was used for comparision of continuous variables between two groups. Chi square test was used to compare the categorical variables. A p value of less than 0.05 was considered statistically significant.

Results

Patients of the study groups were comparable with respect to demographic data and operative data [Table 1]. Statistical analysis shows that there were non-significant differences between the two study groups with regard to age, weight, duration of surgery and duration of anaesthesia.

Intraoperative hemodynamics were recorded preoperatively (baseline), intraoperatively (before induction, post-induction i.e. after administration of hypotensive and anesthetic agent and after stoppage of hypotensive agents) and lastly postoperatively i.e. after recovery.

Hemodynamics were recorded at interval of 15 minutes perioperatively. Baseline values of MAP and HR were comparable in both groups. After the administration of hypotensive agent in both groups, there was significant decrease in heart rate below baseline. Patients in Group E showed significant increase in HR after stoppage of hypotensive agent and after recovery compared to GroupD [Figure 1].

In Groups D and E, there was a significant reduction of MAP. There was no intergroup significant difference during hypotensive period but we observed that both groups differ from each other with respect to infusion dose required to achieve the desired MAP (55-65mmHg). We achieved target MAP in Group D at maximum dose of 0.5 μg/kg/h and in Group E at maximum dose of 0.7 mg/kg/h. Both groups reached the desired MAP (55-65 mmHg). Additional hypotensive agent like nitroglycerine was not required intraoperatively in both groups. There was significantly lower MAP in Group D after stoppage of hypotensive agent and after recovery compared to Group E [Figure 2].

There was no additional intraoperative requirement of opioids in both groups. The quality of surgical field as measured by average category scale (ACS) was comparable in both groups with target MAP (55-65 mmHg). Best possible field of surgery was achieved in both groups with no significant difference in between group scores and scores were low (≤ 2) through the hypotensive period in both groups [Table 2].

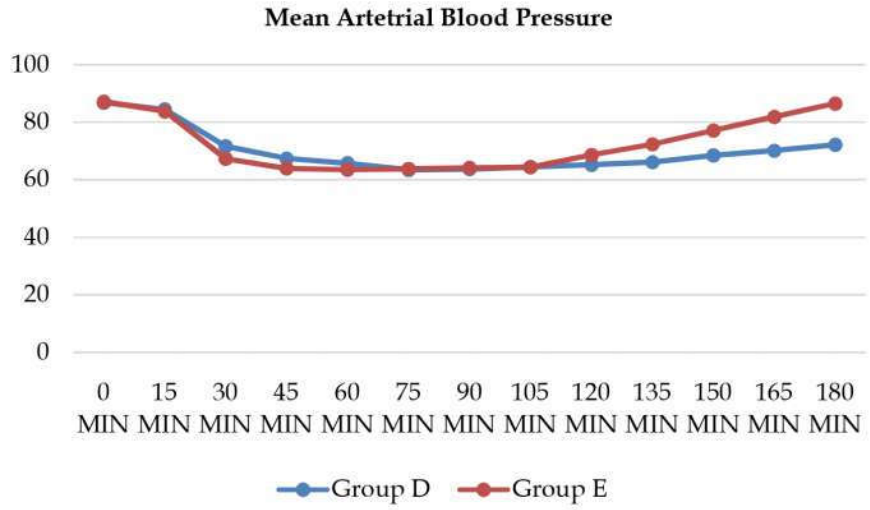

Fig. 1: Comparision of Heart Rate in Both Groups at Various Intervals

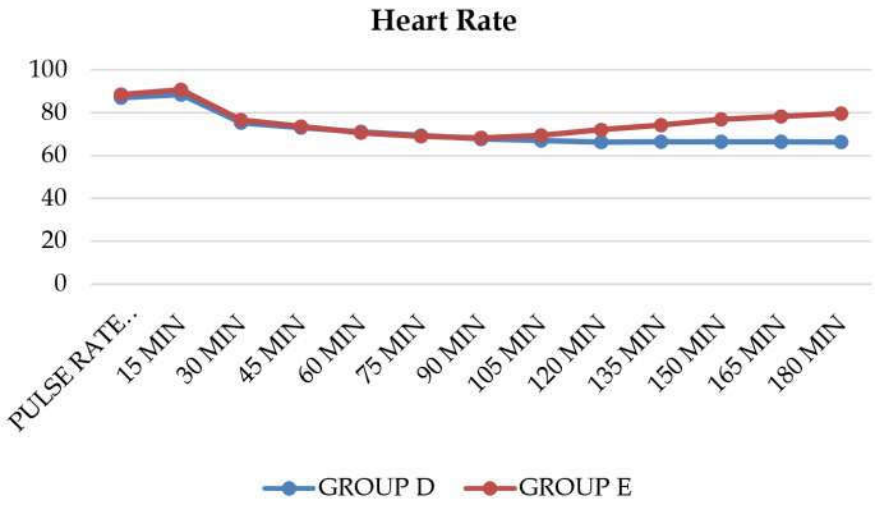

Fig. 2: Comparision of Mean Arterial Blood Pressure in Both Groups at Various Intervals

Table 1: Demograghic and Operative Data

Variables	Group D (n=30)	Group E (n=30)	P value
Age (Years)	31.07±10.498	33.43± 11.11	0.40
Weight (Kg)	55.33±7.034	56.3±8.095	0.62
Duration of Surgery (Min)	94.5±16.782	96±16.782	0.72
Duration of Anaesthesia (Min)	128.5±29.13	118±25.141	0.14

Group D – Dexmedetomidine group; Group E – Esmolol group; Mean±SD

The median range of surgical field scores was in between 1-3 in both groups.

There was significantly longer Emergence time was in Group D 7.8 (1.1) min. as compared to Group E 4.63 (0.9) min. ($p < 0.001$). Time needed to achieve ≥ 9 of modified Aldrete score was significantly longer in Group D 10.27 (0.9) min. as compared to Group E 7.6 (0.8) min. ($P<0.001$) [Table 3] .

There were significantly higher mean postoperative sedation scores in Group D as compared to Group E at 15 min 4.0 (0.7) vs 2.4 (0.4) , at 30 min. 3.6 (0.6) vs 2.1 (0.3) and at 45 min. 2.9 (0.4) vs 2.1 (0.3) ($p <0.001$). There was no significant difference in sedation score at 60 min in both groups. There was no complaint of any signs of awareness [Table 4].

Mean postoperative Visual analogue scores were significantly lower in Group D than Group E at 15 min 0.03 (0.1) vs 0.3(0.4) ($p<0.006$), at 30 min 0.3 (0.4) vs 1.4 (0.7), at 45 min1.4 (0.6) vs 4.3 (0.9) and at 60min 3.3 (0.6) vs 5.5 (1.20) ($p<0.001$) (Table 5). There was complaint of moderate pain after 45 min in Group E.

Time recorded to first analgesic request was significantly longer in Group D than Group E (57.7± 6.28 min)versus (28.73±3.17 min) respectively ($p<0.001$) [Table 5]. No complaints of postoperative nausea or vomiting was observed in both groups.

Table 2: Surgical Field Score

Surgical Field Score at (Time)	Group	N	Mean	Std. Deviation	t	DF	P Value
30 Min	Group D	30	1.97	1.97	0.728	58	0.47
	Group E	30	1.87	0.507			
60 Min	Group D	30	1.8	0.714	-1.485	58	0.143
	Group E	30	2.1	0.845			
90 Min	Group D	30	1.57	0.728	-1.186	54.776	0.241
	Group E	30	1.77	0.568			
120 Min	Group D	30	1.43	0.568	-0.961	58	0.34
	Group E	30	1.57	0.504			

Group D – Dexmedetomidine group; Group E – Esmolol group; Mean±SD

Table 3: Emergence Time and Modified Aldrete Score

Parameters	Group	N	Mean	Std. Deviation	t	df	P Value
Emergence Time (Min)	Group D	30	7.8	1.126	11.518	58	<0.001
	Group E	30	4.63	0.999			
Modified Aldrete Score	Group D	30	10.27	0.907	11.465	58	<0.001
	Group E	30	7.6	0.894			

Group D–Dexmedetomidine group; Group E– Esmolol group; Mean±SD

Table 4: Sedation Scale

Sedation Scale at (Time)	Group	N	Mean	Std. Deviation	t	DF	P Value
15 Min	Group D	30	4.07	0.74	10.236	58	<0.001
	Group E	30	2.4	0.498			
30 Min	Group D	30	3.67	0.606	12.03	46.049	<0.001
	Group E	30	2.13	0.346			
45 Min	Group D	30	2.9	0.481	7.092	58	<0.001
	Group E	30	2.13	0.346			
60 Min	Group D	30	2.37	0.49	1.433	56.098	0.157
	Group E	30	2.2	0.407			

Group D – Dexmedetomidine group; Group E – Esmolol group; Mean±SD

Table 5: Visual Analogue Score (VAS) and Time to First Analgesic

Parameters	Group	N	Mean	Std. Deviation	t	df	P Value
VAS at 15 Min	Group D	30	0.03	0.183	-2.918	37.695	0.006
	Group E	30	0.3	0.466			
VAS at 30 Min	Group D	30	0.3	0.466	-6.693	47.731	<0.001
	Group E	30	1.4	0.77			
VAS at 45 Min	Group D	30	1.4	0.621	-14.36	58	<0.001
	Group E	30	4.3	0.915			
VAS at 60 Min	Group D	30	3.37	0.615	-8.374	42.212	<0.001
	Group E	30	5.5	1.253			
Time to First Analgesic (Min)	Group D	30	57.7	6.282	22.545	42.89	<0.001
	Group E	30	28.73	3.172			

Group D – Dexmedetomidine group; Group E – Esmolol group; Mean±SD

Discussion

Controlled hypotension is a technique of controlling intraoperative bleeding to provide the best field for surgery. In case of various ENT surgeries induced hypotention has been used to optimize the surgical condition [7].

In our study both dexmedetomidine or esmolol were effective in giving best surgical field by achieving MAP of 55 to 65 mmHg. Both group of patients who were treated with loading dose of dexmedetomidine or esmolol after induction of anesthesia had significant decrease in MAP and HR. Dexmedetomidine induced sympatholysis is due to dominant cardiovascular effect of α2 agonists even at lower doses. Alpha 2 receptors inhibit norepinephrine release by acting on sympathetic terminal. They are also located on blood vessels, where they mediate vasoconstriction [7].

Dexmedetomidine has been used effectively as an anaesthetic adjuvants for balance anaesthesia. Its role as a hypotensive agent is comparable to other techniques used for induced hypotension in general anaesthesia [5].

Esmolol provided stable controlled hypotension and good surgical field and benefits in blood conservation. It decreases MAP by decreasing cardiac output secondary to negative chronotropic and ionotropic effects of β adrenergic antagonism [7].

In our study we used the loading dose of esmolol 1mg/kg followed by infusion 0.3-0.7mg/kg which is different from the study of Pilli et al. [13] who investigated use of esmolol for controlled hypotension in tympanoplasty surgeries using esmolol in the lowest dose of 50 μkg^{-1} infusion without administering bolus dose and increased maximum dose up to 500 $\mu\ kg^{-1}\ min^{-1}$. They achieved the target successfully but late as compared to our study.

In our study both Group D and E provided good hemodynamic stability and dry surgical field .There was no need of additional hypotensive agent to achieve the desired MAP in the either of groups. There was significant decrease in heart rate relative to baseline in both groups after administration of hypotensive agent intraoperatively and there was significant increase HR in Group E after stoppage of hypotensive agent, at end of surgery and after recovery compared to Group D [Figure 1].

The effectiveness of dexmedetomidine had been reported previously for providing better surgical field during controlled hypotension during various ENT surgeries like tympanoplasty, septoplasty and maxilofascial surgery [7].

Sham T et al. in their study of total forty patients scheduled for functional endoscopic sinus surgery compared efficacy of dexmedetomidine with esmolol for controlled hypotension. They observed that average category scale for intraoperative surgical field was low in both groups and median range of score was 2 (1-3) in both groups. Both drugs provided better surgical conditions which was similar to our study [7].

In our study we achieved ASC of ≤ 2 during hypotensive period. We achieved best possible field for surgery. There was no complaint of excessive blood loss in any patient in both groups.

In the present study there was no additional intraoperative opioid requirement in both groups. There is high density of α2 receptors in the Locus ceruleus which is the predominant noradrenergic nucleus in the brain. Dexmedetomidine inhibits the

release of norepinephrine and decreases sympathetic tone through presynaptic activation of the α2 adrenoceptors due to high ratio of specificity for the α2 versus α1 receptor. It attenuates the neuroendocrine and hemodynamic responses to anesthesia and surgery and results in sedation and analgesia [7,14].

Patients are able to return to their baseline level of consciousness when stimulated. This is due to preservation of psychomotor function which is beneficial for MAC [15].

Dexmedetomidine reduces opioid requirements and stress response to surgery with stable hemodynamic state [16,17].

There was significant decrease in the consumption of inhalational agent, fentanyl and analgesics in the dose dependent manner during dexmedetomidine used perioperatively [7].

In our study, there was significantly longer emergence time and time to total recovery from anesthesia in Group D compared to Group E. Similar to our study, Sham T et al. also observed that dexmedetomidine group patients had significantly longer mergence time as well as time to total recovery from anaesthesia as compared to esmolol group.

In our study patients of Group D had significant higher postoperative sedation scores than those in Group E. Prolonged postoperative analgesia was observed in Group D and time to request of first analgesic was also longer in Group D than Group E. No complaints of postoperative nausea or vomiting was observed in both groups. Analgesic and sedative properties of dexmedetomidine had been proved in various studies [7].

In the present study, there was no difference regarding the demographic and operative data. Both dexmedetomidine and esmolol were similar with respect to intraoperative hemodynamic stability, surgical bleeding, surgical field, surgeon satisfaction, additional hypotensive agent requirement and analgesic requirements. Compared with esmolol, dexmedetomidine has advantage of analgesia, amnesia sedation and anesthetic sparing effect.

Conclusion

Both dexmedetomidine and esmolol were effective in providing ideal surgical field. Both were safe agents for controlled hypotension. Dexmedetomidine offers the advantage of analgesia, amnesia and sedation with better intraoperative and postoperative patient satisfaction as compared to esmolol.

Source of Support: Nil

Conflicting Interest: Nil

References

1. Precious DS, Splinter W, Bosco D. Induced hypotensive anesthesia for adolescent orthognathic surgery. J Oral Maxillofac Surg. 1996;54(6):680-3.
2. Leigh JM. The history of controlled hypotension. Br J Anaesth. 1975;47(7):745-9.
3. Choi WS, Samman N. Risks and benefits of deliberate hypotension: a systemic review. Int J Oral and Maxillofacial Surgery. 2008;37(8):687-703.
4. Rodrigo C. Induced hypotension during anesthesia with special reference to orthognathic surgery. Anesth Prog. 1995;42(2):41-58.
5. Upadhyay SP et al. Controlled hypotension in Modern Anaesthesia: A Review and Update. International Journal of Biological & Pharmaceutical Research. 2015;6(7):532-42.
6. G Turan, E Dincer, A Ozgultekin, C Uslu, F Ormanci, N Akgun. Comparison of dexmedetomidine, remifentanil and Esmolol in Controlled Hypotensive Anaesthesia.The internet journal of Anesthesiology. 2007;17: 2.
7. 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;7:175-80.
8. Lindop MJ. Complications and morbidity of controlled hypotension. Br J Anaesth. 1975;47(7):799-803.
9. Warner WA, Shumrick DA, Caffrey JA. Clinical investigation of prolonged induced hypotension in head and neck surgery. Br J Anaesth. 1970;42(1): 39-44.
10. Mostert JW. Safe hypotensive anesthesia. JAMA. 1973; 225(1):64-5.
11. Fromme GA, MacKenzie RA, Gould AB Jr, Lund BA, Offord KP. Controlled hypotension for orthognatic surgery. Anesth Analg. 1986;65:683-6.
12. Panditrao et al. A prospective study to compare the incidence of postoperative nausea, vomiting (PONV) in female patients undergoing surgical procedures under general anaesthesia during proliferative and secretory phase of menstrual cycle. Int J Stud Res. 2011;1(2):51-6.
13. Pilli G, Guzeldemir ME, Bayhan N. Esmolol for hypotensive anesthesia in middle ear surgery. Acta Anaesthesiologica Belgica. 1996;47:85-91.
14. J.E. Hall, T.D. Uhrich, J.A. Barney, et al. Sedative, amnestic and analgesic properties of small-dosee dexmedetomidine infusions. Anesth Analg. 2000;90: 699–705.

15. T. Kamibayashi, M. Maze Clinical uses of alpha-2 adrenergic agonists. Anesthesiology, 2000;93:1345–9.
16. Arain SR, Ebert TJ. The efficacy, side effects, and recovery characteristics of Dexmedetomidine versus propofol when used for intraoperative sedation. Anesth Analg. 2002;95:461-6.
17. Abdalla MI, Mansouri FA, Bener A. Dexmedetomidine during local anesthesia. J Anesth. 2006;20:54-6.