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Effect of Dexmedetomidine Infusion on Halothane Requirement to Provide Oligaemic Surgical Field during Middle Ear Surgery under General Anaesthesia

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Abstract

Introduction: Middle ear surgeries require hypotensive anaesthesia to improve quality of surgical field. Dexmedetomidine is α2 agonist which provides desired surgical field, sedation and analgesia. *Aim:* The present study was aimed to evaluate the effects of dexmedetomidine infusion on requirement of halothane to provide oligaemic surgical field during middle ear surgery using operating microscope. *Materials and Method:* 90 patients of either sex between age group of 18-60 years, ASA grade I and II were randomly divided into two equal group scheduled for Middle Ear Surgery were included in this observational study. Patients of group I were given placebo infusion of normal saline and group II given inj.dexmedetomidine at rate of 1 µ g/kg i.v over 10 min 15 min before induction followed by infusion at 0.4 µ g/kg/hr i.v till 10 min prior to end of surgery. General anaesthesia given with standard anaesthetic technique. Halothane concentration was titrated to achieve mean arterial pressure 30% below baseline value. All patients assessed intra-operatively for bleeding at surgical field, haemodynamic changes and awakening time. *Result:* Mean percentage of halothane requirement to maintain mean arterial blood pressure below 30% of baseline value was significantly reduced in patients receiving dexmedetomidine infusion (0.34±0.2%) when compared to those receiving placebo infusion (0.54±0.3%). Quality of surgical field was better and mean awakening time was significantly reduced in Group II than Group I (<0.001). *Conclusion:* Dexmedetomidine infusion maintains hemodynamic stability and was safe to provide oligaemic surgical field for better visualisation under operating microscope for middle ear microsurgery.

Keywords: Dexmedetomidine, Halothane concentration, Middle ear surgery, Quality of surgical field

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Introduction

Nowadays, middle ear surgeries are routinely performed under operating microscope. The highly magnified view of the operative field can be easily obscured with even a slight increase in surgical bleeding. Under such conditions, identification of anatomical landmarks is difficult and vascular nature of the middle ear makes bleeding a particular problem, as most surgery takes place at the bottom of a cul-de-sac with no outlet, the situation is further aggravated and surgery becomes technically more difficult, time consuming and compromising the end result. So in middle ear surgery, the technique of anaesthesia should be such that produces minimal bleeding providing the surgeon with a relatively dry bloodless field [1].

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Middle ear surgeries can be performed under either local or general anesthesia. Most of surgeries are still done under general anesthesia due to special concerns; some are related to patient's anxiety caused by noise during surgery which may further increased if burr is used for drilling the bone along with dizziness and discomfort due to positioning of head and neck during surgery produce an unsteady operative field, followed by backache, claustrophobia, and earache [2]. The patient will also require some form of systemic sedative and analgesic like an intramuscular injection of opioids. This may be hazardous in a patient whose airway is not secured [1]. Other concerns are related to surgeon comfortability with the hypotensive general anesthetic techniques.

There are several non-pharmacological and pharmacological techniques to reduce bleeding. The non-pharmacological methods included mild head elevation of 15^0, avoidance of venous obstruction, normocapnia and IPPV [3]. Most commonly used technique is controlled hypotension. The pharmacological methods used for controlled hypotension include: inhalation anesthetics (e.g. halothane, isoflurane and sevoflurane),vasodilators(e.g.sodiumnitroprusside and nitroglycerin), beta adrenoceptor antagonists (labetalol and esmolol), alpha-2 adrenergic agonists (clonidine and dexmedetomidine), opioids (remifentanil), infiltration or topical application of epinephrine (1: 50,000 or 1: 200,000) and more recently magnesium sulfate [3].

Dexmedetomidine, the pharmacologically active d-isomer of medetomidine as (+)-4- (S)-[1-(2,3 dimethylphenyl) ethyl] -1H-imidazole monohydochloride is a highly specific and selective α2 adrenoreceptor agonist. The α-2:α-1 binding selectivity ratio of dexmedetomidine is 1620:1 compared to 220:1 for clonidine. It causes a dose-dependent decrease in arterial blood pressure and heart rate associated with a decrease in serum noradrenaline concentrations, [4] resulting in decreased bleeding and thus improving the quality of surgical field [5]. During dexmedetomidine infusion, the advantages are the absence of reflex tachycardia, the suppression of sympathetic nervous system allowing for not having rebound hypertension [6].

The present study was designed to evaluate the effect of dexmedetomidine bolus before induction of anaesthesia and low dose infusion during intraoperative period on the requirement of halothane to lower mean arterial pressure 30% below baseline values, quality of surgical field and awakening time in patients undergoing middle ear surgery.

Material and Methods

After approval from Institutional Ethical Committee, an observational study was conducted in 90 patients of either sex belonging to American Society of Anaesthesiologist (ASA) Grade I or II in the age group of 18-60 years scheduled for middle ear surgery under general anaesthesia. Detailed written informed consent from the participants was taken. Patient's refusal to participate in the study, ASA grade III or IV, patients coming for tympanoplasty, patients with history of anticipated difficult airway, cardiorespiratory disease and having bleeding or coagulation disorder were excluded from the study. Sample size is calculated by using EPI software.

Thorough pre-anaesthetic evaluation was carried out on the previous day of operation and patients were explained regarding the procedure.

On arrival in recovery room, preoperative heart rate and blood pressure were recorded and considered as baseline. All patients were premedicated with inj. glycopyrrolate (6- 10 µg/ kg) and inj. pentazocine (0.5 mg/kg) i.m. 30 min before surgery. In operation theatre preoperative baseline Bispectral Index-BIS value was recorded. Patients were randomly divided into two groups. Each group included 45 patients.

Group I (control group): Received normal saline 10 ml bolus over 10 min 15 min before induction followed by infusion till 10 min prior to end of surgery.

Group II (study group): Received inj. dexmedetomidine at rate of 1 µg/kg i.v diluted upto 10 ml in NS over 10 min 15 min before induction followed by infusion at 0.4 µg/kg/hr i.v till 10 min prior to end of surgery.

All the patients were preoxygenated with 100% oxygen for 3 minutes. Induction of anaesthesia was done with inj. propofol 2 mg/kg I.V. Endotracheal intubation was facilitated usig Inj. Succinylcholine 2 mg/kg I.V. and intubation done with appropriate size of cuffed endotracheal tube. Positive pressure ventilation was started. Maintenance was done with flow rate 2 L per min with halothane (%) in mixture of 50% O_2 and 50% N_2O and intermittent doses of inj. vecuronium 0.02 mg/kg IV. Halothane concentration was titrated to maintain mean blood pressure around 30% below baseline value.

The following measures were assessed:

1. Heart rate, Mean Blood Pressure, Oxygen Saturation (SpO_2), Concentration of Halothane, BIS value were recorded

intraoperatively every 15 minutes till the end of surgery.

2. Intraoperatively, quality of surgical field was assessed and graded by surgeon according to the average category scale proposed by Fromm and Boezaaart.

Fromm and Boezaart Scale. (Average category scale)

Grade 0: no bleeding.

Grade 1: slight bleeding –no blood suctioning required.

Grade 2: slight bleeding –occasional suctioning required. Bleeding does not threaten surgical field.

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

Grade 4: moderate bleeding –frequent suctioning required. Bleeding threatens surgical field immediately after suction is removed.

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

Surgical field was graded as good, fair & poor by surgeon as under: (Average category scale).

Good-- ACS 0 or 1, Fair -- ACS 2 or 3, Poor -- ACS 4 or 5.

During intraoperative period occurrence of side effects like hypotension and bradycardia (HR less than 55 beats/min) were noted. If Hypotension occurred then treated by decreasing the dial concentration of Halothane in control group or rate of infusion of Inj. Dexmedetomidine in study group and Bradycardia was treated with 0.6 mg atropine IV bolus.

At 15 minute before the end of surgery, administration of inhalational anaesthetic agent was discontinued and at end of surgery reversal of neuromuscular blockage was done using inj. glycopyrrolate (0.008 mg/kg) IV and inj. neostigmine (0.05 mg/kg) IV. Endotracheal extubation was done after the return of adequate muscle tone, power, protective reflex (cough) and smooth spontaneous breathing efforts.

Total duration of surgery and awakening time (time from administration of reversal of neuromuscular blockade till sustained eye opening on command) were recorded. All patients were then shifted to the post operative room and monitored for HR, Blood pressure and SpO_2 every 15 min upto 1 hour. Side effects such as nausea, vomiting, respiratory depression, sedation, hypotension, bradycardia or any other were observed upto 1 hour.

All observations were recorded and results were analysed. This study included Quantitative data. Quantitative data presented as mean ± SD. The result of the study between two groups were compared statistically using 'p' value obtained from independent t- test at 95% level of significance, data analysis was done by using Microsoft excel and SPSS 18 software. A value of $p < 0.05$ was considered statistically significant.

Results

The present study was conducted in 90 patients of either sex belonging to ASA Grade I or II in the age group of 18-60 years scheduled for middle ear surgery under general anaesthesia. All patients were divided into two groups of 45 patients in each, Group I and Group II. Both groups were comparable with respect to age, sex, weight and duration of surgery (Table 1). As regards HR, there was significant reduction in heart rate from baseline following loading dose of dexmedetomidine. Thus mean heart rate was significantly lower in Group II throughout the intraoperative period in comparison to group I ($p<0.001$) (Fig. 1). Mean arterial blood pressure was significantly reduced in group II as compared to group I upto 30 min of induction (<0.001). Then after 30 minutes of induction, mean arterial blood pressure was comparable in both the groups till extubation ($p>0.05$) (Fig. 2). Mean concentration of halothane required to reduce mean artetial BP below 30% of baseline value during intraoperative period was significantly decreased in group II as compared to group I. (Table 2).

Table 1: Demographic data of patients and duration of surgery

	Group I (n=45) Mean ± SD	Group II (n=45) Mean ± SD	p value
Age (years)	30.7 ± 10.81	29.3 ± 9.97	>0.05
Weight (kg)	50.9 ± 4.47	50.2 ± 4.52	>0.05
Sex (male/female)	18/27	22/23	>0.05
Duration of surgery (minute)	163.7 ± 9.49	158.3 ± 10.4	>0.05

Table 2: Mean concentration of halothane and awakening time

	Group I Mean ± SD	Group II Mean ± SD	p value
Concentration of Halothane (%)	0.54 ± 0.3	0.34 ± 0.2	<0.001
Awakening Time (minute)	12.93 ± 1.45	7.47 ± 0.86	<0.001

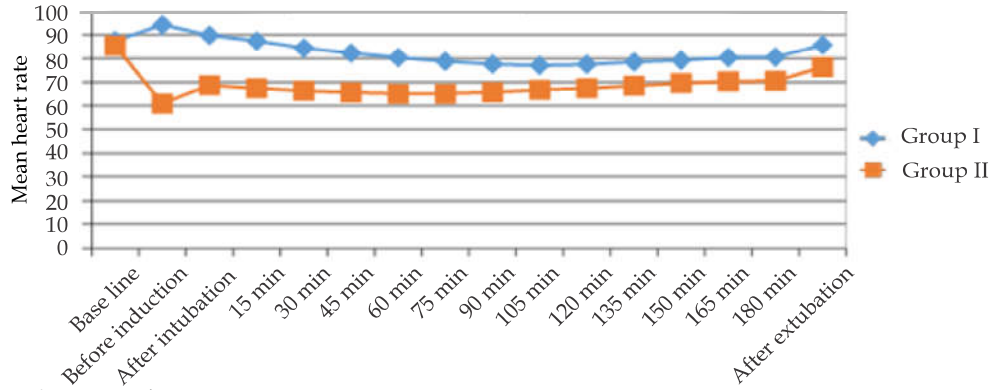

Fig. 1: Mean heart rate

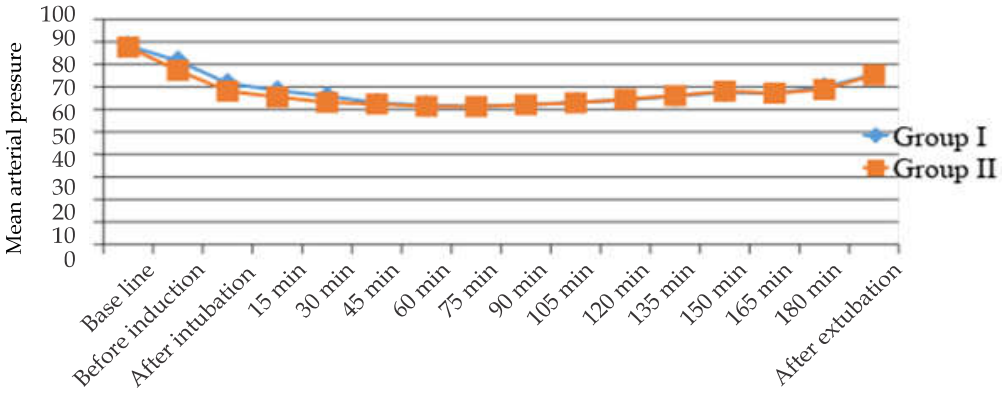

Fig. 2: Mean arterial pressure

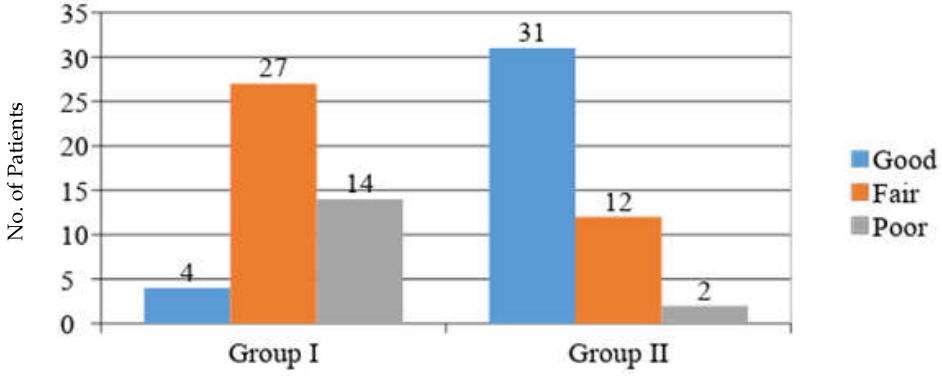

Fig. 3: Quality of surgical field

The surgeon who was not aware of the selected hypotensive agent was asked to assess the quality of surgical field according to the quality scale proposed by Fromm and Boezzart. Group II patients had better quality of surgical field as compared to group I.(Fig. 3). Mean awakening time was significantly reduced in group II as compared to group I. (Table 2).

None of the patient in both groups developed significant bradycardia and hypotension that required treatment anytime during study period. No other side effects observed in any of the patient during post operative period in both groups.

Discussion

Middle ear surgery under general anaesthesia requires good surgical field for better operating conditions, deep level of anaesthesia and a smooth recovery without coughing or straining [1]. Even small amount of blood can obscure the microscopic operating field and decreasing the extravasation of blood may improve the results of surgical procedures. Controlled hypotension is commonly used to achieve a bloodless operative field which is needed for successful middle ear microsurgery [4].

In the present study, the dexmedetomidine infusion was used to evaluate the effect of Dexmedetomidine infusion on halothane requirement to provide oligaemic surgical field during middle ear surgery under general anaesthesia. It is evident from the study that the patient receiving dexmedetomidine infusion has oligaemic surgical field and better visibility when compared to patient receiving placebo.

Dexmedetomidine is a potent highly selective α2 adrenergic receptor agonist and used as adjuvant in anaesthesia to reduce the intra-operative anaesthetic and analgesic requirement. The central and peripheral sympatholytic action of dexmedetomidine is mediated by α2 adrenergic receptor and is manifested by dose-dependent decrease in arterial blood pressure, heart rate, cardiac output and norepinephrine release [2], resulting in decreased bleeding and thus improving the quality of surgical field vision in a predictable and dose dependent manner.

In the study of Bayazit Dikmen et al. [7], patients received an initial loading dose of 1 μg/kg of dexmedetomidine over 10 min before induction, followed by a continuous infusion of 0.2-0.7 μg/kg/h and they determined that intra-operative dexmedetomidine infusion was effective for maintaining the perioperative haemodynamic responses when compared with the placebo with no incidence of hypotension or bradycardia. Our present study was in accordance with their study as all patients were haemodynamically stable, and none of them required vasopressor support or bolus administration of fluid to maintain haemodynamic status.

The result of the present study indicates that the use of dexmedetomidine infusion reduced the percentage of halothane concentration to maintain mean arterial pressure 30% below baseline values. These findings confirm with a previous study of Farah Nasreen et al. [8] which also showed that use of dexmedetomidine reduces the requirement of inhalational anesthetic. C.J. Lawrence et al. [9] and Kumkum Gupta et al. [10] also reported a reduction of isoflurane requirement in their study.

In the present study we found that the quality of surgical field visualization during microscopic middle ear suergeries as assessed by Fromm and Boezaart scale was better in the dexmedetomidine group than in the placebo group. These findings can be attributed to the fact that dexmedetomidine reduces sympathetic activity, resulting in reduction of blood pressure and heart rate thereby decreases bleeding at the surgical site and improving the quality of surgical field. This correlates with study by Farah Nasreen et al. [8] they studied in 42 adult patients scheduled to undergo middle ear surgery, reported that a better surgical field was provided in the group that received dexmedetomidine (n=21) at a dose of 0.4 μg kg-1 hr-1 compared to the control group (n=21) that received saline and Chiranjib Sarkar et al. [1] found that dexmedetomidine provided better quality of the surgical field vision assessed by the surgeons when compared with the placebo.

Farah Nasreen et al. [8] examined dexmedetomidine for hypotensive effect in the middle ear surgery, they found that mean awakening time was reduced in dexmedetomidine group. This is comparable with present study, which could be explained by the fact that dexmedetomidine reduces the requirement of inhalational anaesthetic used. This is in agreement with the finding of Sunil Chiruvella et al. [11] Intraoperative Bispectral index (BIS) monitoring is definitely more objective in deciding the depth of anaesthesia and the requirement of anaesthetic agent. In our study BIS levels were at the hypnotic range. In our study, no incidence of hypotension or bradycardia was seen in any patient peri operatively and no incidence of adverse effects like respiratory depression, nausea and vomiting was observed in any of the patients during post-operative period in both the groups. The same observation was made by Kumkum Gupta et al. [10], Zeynel Abidin Erbesler et al. [12] and Sunil Chiruvella et al. [11] while using dexmedetomidine in their studies.

Limitation

In this study, the amount of actual blood loss was not measured during surgery which may be direct evidence for the effectiveness of dexmedetomidine in reducing blood loss, as the blood loss in middle ear surgery is of very small quantity.

Conclusion

Thus it was concluded that Dexmedetomidine infusion maintains hemodynamic stability during intraoperative period and was safe to provide oligaemic surgical field for better visualisation under operating microscope for middle ear microsurgery. It also reduced the requirement of halothane and recovery from anaesthesia was complete and smooth.

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