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Dexmedetomidine Infusion for Bloodless Surgical Field during Middle Ear Microsurgery under General Anaesthesia

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Abstract:
Background and Aims: *Middle ear surgery requires bloodless surgical field for better operatingconditions, deep level of anaesthesia and rapid emergence. Recent studies suggest that α2agonists could provide desired surgical field, sedation and analgesia. The present study was aimed to evaluate the clinical effects of dexmedetomidine infusion as anaesthetic adjuvant during middle ear microsurgery.*
Methods: *Sixty four adult patients aged 20-60 years with American Society of Anaesthesiologists Grades I and II, of both gender were randomised into two comparable equal groups of 32 patients each for middle ear micro surgery under general anaesthesia with standard anaesthetic technique. After induction of general anaesthesia, patients of GroupI were given dexmedetomidine infusion of 0.5 µg/kg/h and patients of Group II were given placebo infusion of normal saline. Isoflurane concentration was titrated to achieve a systolic blood pressure30% below the baseline value. All patients were assessed intra-operatively for bleeding at surgicalfield, haemodynamic changes, awakening time and post-operative recovery.*
Results: *Statistically significant reduction was observed in the required percentage of Isoflurane (0.8 ± 0.6%) to maintain the systolic blood pressure 30% below the baseline values in patients receiving dexmedetomidine infusion when compared to those receiving placebo infusion (1.6 ± 0.7%). Patients receiving dexmedetomidine infusion had statistically significant lesser bleeding at surgical field ($P < 0.05$).The mean awakening time and recovery from anaesthesia did not show any significant difference between the groups.*
Conclusion: *Dexm edetomidine infusion can be safely used to decrease intra-op bleeding for better visualization during middle ear microsurgery.*
Keywords: *Dexmedetomidine, middle ear microsurgery, oligaemic surgical field*

I. Introduction

Middle ear micro surgery under general anaesthesia is revolutionised with the introduction of hypotensive anaesthesia that provides a relatively bloodless field. The primary methods to minimise blood loss during middle ear surgery included mild head elevation of 15°, and infiltration or topical application of epinephrine (1: 50,000 or 1: 200,000). Currently, many inhalational or intravenous anaesthesia techniques were used to offer ideal intra-operative conditions for middle ear surgery with their advantages and disadvantages.[1-4]

Numerous pharmacological agents effectively lower the systemic blood pressure for hypotensive anaesthesia. Nitroglycerine &Sodium nitroprusside precisely control the blood pressure due to their rapid onset and short duration of action,but intra-arterial blood pressure monitoring and electrocardiogram (ECG) with S-T segment analysis are mandatory. An infusion of 10-20 µg/kg/h remifentanil is also useful but is associated with side effect of hyperalgesia.

Dexmedetomidine, a potentant selective α2-adrenoceptor agonist, is used as adjuvant to general anaesthesia during surgery. Pre-operatively for sedation, intra-operatively for analgesia and hemodynamic stability. It is valuable because of its anaesthetic and analgesic-sparing effects with predictable and dose-dependent haemodynamic effects with no respiratory depression.[5,6]

The present prospective double blind randomized control study was aimed to evaluate the effects of dexmedetomidine infusion on the requirement of isoflurane concentration to lower systolic blood pressure below 30% of baseline values, quality of oligaemic surgical field, and awakening time in patients undergoing middle ear microsurgery.

II. Methods

After approval from our institutional Ethical Committee and written informed consent, 64 adult patients of American Society of Anaesthesiologists (ASA) physical status I and II of both genders, aged 20-60 years, weighing 40-60 kg, scheduled for elective middle ear micro surgery, were enrolled for this prospective double-blind placebo controlled randomised study. Exclusion criteria were presence of cardiac or respiratory disease, hypertension, obesity (body mass index > 26 kg/m2), hepatic or renal dysfunction, bleeding or coagulation disorders. Patients with a history of anticipated difficult airway, those on sedatives, hypnotics or antihypertensive medication or allergy to any anaesthetic medications were also excluded from the study.

Patients were randomly divided into two groups of 32 patients each by computer generated random table number. Patients of Group I received infusion of dexmedetomidine 0.5 μg/kg/h and patients of Group II received placebo infusion of normal saline during middle ear surgery after induction of anaesthesia till 20 min before completion of surgery. The study drug solution was prepared by an anaesthesiologist who was blinded to study protocol and was not involved for intra-operative data collection. The surgeon and resident anaesthetist were also blinded to the treatment regimen.

All patients were admitted prior to the day of the surgery, and fasting of 6 hr was ensured. On arrival to the operation theatre, the baseline systemic blood pressure, heart rate, oxygensaturation (SpO2) and ECG were recorded. After establishing the intravenous line, lactate Ringer solution was started and they were pre-medicated with ondansetron (4μg), glycopyrrolate (0.2 mg),midazolam (2 mg) and fentanyl (2 μg/kg), 15 min before induction of anaesthesia.

After pre-oxygenation for 3 min, anaesthesia was induced with propofol (2 mg/kg) till loss of verbal command and tracheal intubation was facilitated with Sch(2mg/kg). Anaesthesia was maintained with 60% nitrous oxide in oxygen with isoflurone and vecuronium(0.1 mg/kg) as muscle relevant. Patients were mechanically ventilated to maintain the end-tida lconcentration (EtCO2) between 30 and 35 mm Hg.

Intra-operatively, the heart rate, non invasive blood pressure,ECG, EtCO2 and oxygen saturation (SpO2)were monitored and recorded at 5 min intervals till end of surgery. Concentration of isoflurane was recorded in percentage every 15 min till conclusion of surgery. Hypotension was treated by decreasing the dial concentration of isoflurane or rate of infusion and bradycardia was treated with intravenous atropine.

During procedure the bleeding at surgical site was assessed by the surgeon as Grade 0-no bleeding-excellent surgical conditions; Grade I-minimum bleeding, sporadic suction needed; Grade II-diffuse bleeding, repeated suction needed; and Grade III-considerable,troublesome bleeding, and continuous suction was needed.

After surgery, the residual neuromuscular blockade was reversed with neostigmine (0.05 mg/kg)and glycopyrrolate (0.008 mg/kg). Patients were extubated after observing adequate motor recovery and spontaneous breathing efforts. Awakening time following reversal of neuromuscular blockade was recorded. This duration of awakening time comprised from administration of reversal of neuromuscular blockade till sustained eye opening on command.

Patients were transferred to post-anaesthesia care unit for observation of any respiratory depression, haemodynamic changes, nausea/vomiting or any other drug-induced side-effects or complications.

The sample size was based on previous studies in which 28 patients were required to detect 20% decrease in bleeding in the dexmedetomidine group with type 1 error of 0.01 and power of 90%.[7] Assuming 5% drop out rate, the final sample size was set at 64 patients. The recorded data were tabulated and expressed in mean ± standard deviation. Statistical analysis was performed using Microsoft Excel and Stat graphics Centurion® for windows. The demographic data for categorical variables were compared using Chi-square test and statistical significance in time related variables were analysed using Student's t-test. $P < 0.05$ was considered as statistically significant.

III. Results

The present study evaluated the clinical effects ofdexmedetomidine infusion during middle ear micro surgery under general anaesthesia.It was successfully completed on 64 adult patients, and all patients were included in the data analysis. The demographic data of age, sex, weight,ASA physical status and duration of surgery werecomparable between the groups [Table 1].

The baseline values of mean heart rate and systolic blood pressure were comparable between the groups with no statistical significance. Though mean heartrate values were comparable during intra-operative period between the groups but bradycardia(heart rate < 54 beats/min) was observed in threepatients of Group I which promptly responded tointravenous atropine. The mean heart rate was foundto be higher in patients of Group II after the extubation while patients of Group I did not show much variationin their mean heart rate values [Table 2].

The required percentage of isoflurane concentration was significantly less ($P < 0.05$) to maintain the mean systolic blood pressure 30% below baseline values in patients of Group I who received intra-operative dexmedetomidine infusion [Table 3].

The operating microscope was used throughout the middle ear surgery and surgeons observed Grade I bleeding (minimum bleeding with sporadic suction) atsurgical site in majority of patients of Group I and none of the patients had bleeding of Grade III [Table 4]. Noneof the patients of Group II had significant reduction in bleeding at surgical site, thus it is evident that patients receiving dexmedetomidine infusion had a better surgicalfield as compared to patient of Group II (P < 0.05). The difference in bleeding at surgical site was statistically significant between the groups.

All patients were able to obey the commands, and the duration of awakening time and recovery were comparable between the groups. Post-operative respiratory rate and oxygensaturation were comparable with no episode of desaturation at any time. No side effect of dexmedetomidine infusion was observed during the study period.

Table 1: Patient demographic characteristics

Parameters	Group I	Group II
Number(n)	32	32
Age(Years)	29.7±8.3	31.2±6.7
Weight(Wt)	54.7±15.8	52.91±16.3
Gender(male/female)	19/13	17/15
ASA status I/II	25/07	23/09
Surgical time(min)	96.8±27.9	105±18.4

ASA: American society of anaesthesiologist

Table 2: Changes in heart rate during anaesthesia

Heart rate(beats/min)	Group I	Group II
Base line	94.23±12.28	92.6±10.9
After induction	73.43±7.45	72.2±8.75
After intubation		
5 min	77.83±9.13	75.23±10.39
30 min	73.2±10.4*	78.4±11.34
60 min	68.35±12.8*	87.57±8.69
After extubation	84.7±12.36	97.15±12.17

Date as mean±SD.*P<0.05 is significant. SD: Standard deviation

Table 3:Comparison of mean percentage of isoflurane requirement to reduce systolic blood pressure 30% below control value

Groups	**Percentage of isoflurane**
I (demuxed-infusion)	0.8±0.6
II (placebo)	1.6±0.7

Table 4:Assessment of intra-operative bleeding by surgeon(n:64 patients)

Grade	Suction requirement	Group I	Group II
0:No bleeding	No suction	0	0
1:Minimum bleeding	Sporadic suction	27*	03
2:Diffuse bleeding	Repeated suction	5	22*
3:Trouble bleeding	Continuous suction	0	07

Data expressed as number of patients. *P<0.05 is statistically significant

IV. Discussion

Middle ear surgeries require good surgical field visibility with no post-operative nausea and vomiting. In the present study, the dexmedetomidine infusion was used to produce decrease bleeding during middle ear micro surgery. I tis evident from the study that the patient receiving dexmedetomidine infusion has decrease bleeding and better visibility when compared to patient receiving placebo. These findings can be attributed tothe fact that dexmedetomidine reduces sympathetic activity, resulting in lower blood pressure and reduced heart rate there by decreasing blood loss at the surgical site to improve the quality of the surgical field.

Dexmedetomidine is a highly selective $\alpha 2$ adrenergicagonist and used as adjuvant in anaesthesia to reduce the intra-operative anaesthetic and analgesic requirement. It regulates the autonomic and cardiovascular systems by acting on blood vessels and inhibiting norepinephrine release at sympathetic terminals, there by attenuating the heart rate and blood pressure responses to intra-operative stressful events of anaesthesia. It effectively minimises the surgical blood loss and improves the surgical field visibility. Its haemodynamic effects are predictable and dose-dependent.[8-10]

Currently, many inhalational or intravenous anaesthesia techniques were evaluated to offer ideal intra-operative conditions for middle ear surgery. Jellish et al. judged that the intravenous anaesthesia technique provided better haemodynamic control,less movement, and faster emergence during middle ear surgery.[1] Short acting inhalational anaesthetics such as desflurane and isoflurane produced excellent operating conditions for otological surgery.[11-13]

Even small amount of blood can obscure the microscopic operating field and decreasing the extravasation of blood may improve the results of surgical procedures. Different techniques, to minimize intra-operative blood loss during middle ear surgery are used. The conventional techniques of electively lowering the blood pressure are positive pressure ventilation and administration of hypotensive drugs.

In the study of Bekker et al., patients received an initial loading dose of 1 µg/kg of dexmedetomidine over 10 min, followed by a continuous infusion of 0.5 µg/kg/h and they determined that intra-operative dexmedetomidine infusion was effective for blunting the perioperative haemodynamic responses with no incidence of hypotension or bradycardia.[14] In a study by Kumkum et al, dexmedetonidine infusion was safe to provide oligaemic surgical field for better visualization under operating microscope for middle ear surgery keeping the hemodynamic variations within the physiological range. 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.

A meta-analysis of previous studies showed that the incidence of bradycardia requiring intervention was increased when maintenance dosages of dexmedetomidine were used in excess of 0.7 µg/kg/h. In our study, no patients suffered from bradycardia as dexmedetomidine infusion was given in dose of 0.5 µg/kg/h and loading dose of dexmedetomidine was not given.

The result of the present study indicates that the use of dexmedetomidine infusion reduced the percentage of isoflurane concentration to maintain a systolic bloodpressure 30% below baseline values. These findings confirm with a previous study of Khan et al. whichalso showed that use of dexmedetomidine reduces the requirement of inhalational anesthetic.[15]Ahoet al.[16] and Aantaa et al.[17] also reported a reduction of isoflurane requirement in their study, thus confirm the synergism between isoflurane and dexmedetomidine.

Dexmedetomidine was well tolerated, and none of the patients developed any drug-related side-effects or complications in the perioperative period. The dexmedetomidine infusion did not affect the awakening time or delay the recovery from anaesthesia.

Coughing on the tracheal tube during awakening will increase venous pressure and may cause post-operative bleeding, so deep extubation with smooth recovery is preferable. Guler et al. found that the increase in blood pressure and heart rate during extubation is decreased, and the quality of extubation is improved by dexmedetomidine.[18] Our findings were in accordance to their study.

Ebert et al. did not observe any apnoea, airwayobstruction and hypoxemia with bolus doses of dexmedetomidine in their study, and they reported that the depression of respiration may be seen due to deep sedation.[19] In our study, none of the patients suffered from respiratory depression as we did not use dexmedetomidine in high doses.

Ear surgery may cause post-operative dizziness (vertigo),nausea and vomiting as inner ear is intimately involved with a sense of balance. Induction with propofol decreases the post-operative nausea and vomiting inpatients undergoing middle ear surgery. Prophylaxis with ondansetron, tryptamine 3 receptorblocker in premedication was considered for the present study and none of the patients suffered from post-operative nausea and vomiting.

During surgery, middle ear is open to the atmosphere,and there is no pressure build up. Once the tympanic membrane graft is placed, the middle ear becomes a closed space. If nitrous oxide is allowed to diffuse into this space, middle ear pressure will rise and may interfere with tympanic membrane reconstruction.Therefore, nitrous oxide is either entirely avoided or discontinued prior to graft placement. Withdrawing nitrous oxide 10–20 min before placement of graft is the usual technique used in our institution.

V. Conclusion

Dexmedetomidine infusion was safe to provide decrease bleeding for good surgical field and better visualisation for middle ear micro surgery keeping the haemodynamic variations within the physiological range. It also reduced the requirement of isoflurane and recovery from anaesthesia was complete and smooth.

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