Impact of dexmedetomidine on hemodynamic parameters and anaesthetic requirement during induction of anaesthesia in coronary artery bypass surgery patients

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Abstract

Introduction: Laryngoscopy and tracheal intubation is associated with profound adverse hemodynamic changes. Coronary artery disease patients have compromised myocardial blood flow and usually have associated hypertension. If the stress response to tracheal intubation is not controlled, it may lead to severe hypertension, arrhythmias and myocardial ischemia. Dexmedetomidine is a new alpha agonist with high potency to control the stress response, pain and tachyarrhythmia. Hence, impact of dexmedetomidine on hemodynamic parameters during tracheal intubation in coronary artery bypass grafting (CABG) surgery patients was evaluated in the study.

Methods: Sixty patients undergoing CABG were enrolled in the study. They were divided into 3 groups. Group 1 received thiopentone 3-5mg/kg, group 2 received thiopentone plus lignocaine 1mg/kg and group 3 received thiopentone plus dexmedetomidine 0.5µg/kg prior to laryngoscopy and tracheal intubation. Heart rate (HR), mean arterial pressure (MAP) and cardiac index (CI) were measured before induction, after anaesthetic induction, at laryngoscopy, and 1min, 3min, 6min and 10min after tracheal intubation. The extra amount of fentanyl and thiopentone required controlling hypertension to laryngoscopy and intubation was noted. The values were analyzed with SPSS 20 software with a P value of <0.05 considered as significant difference.

Result: Demography variables of patients were similar among the groups. The values of MAP, HR and cardiac index were similar at base line in all three groups. The increase in the heart rate and cardiac index was less in dexmedetomidine group compared to thiopentone only group ($p<0.05$) at all-time points. Dexmedetomidine group also had lower rise in MAP after base line in comparison to group 1 and significantly less at laryngoscopy ($p< 0.0001$). Lignocaine group had better control on hemodynamic changes during intubation compared to group 1, but less attenuation compared to dexmedetomidine group. Group 3 patients required less thiopentone (23.2±27mg vs 52.5±29.1mg vs 107.5±53.8mg, $p=0.0001$) and fentanyl (26.2±30.8µg vs 58.7±39.9µg vs 108.7±35.6µg, $p=0.0001$) in comparison to group 1 and group 2.

Conclusion: Dexmedetomidine is an effective drug in attenuating the hemodynamic response to tracheal intubation in patients undergoing CABG. Dexmedetomidine reduced the requirement of rescue doses of thiopentone and fentanyl.

Keywords: Coronary artery bypass grafting surgery; dexmedetomidine; hemodynamic response; lignocaine; thiopentone; tracheal intubation

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Introduction

Laryngoscopy and tracheal intubation produces major hemodynamic alterations. Patients with coronary artery disease poorly tolerate such changes. The stress response due to laryngoscopy and tracheal intubation can cause hypertension, tachycardia, dysrhythmia andmyocardial ischemia leading to poor outcome of the patient.[1]

Many methods have been tried to attenuate the laryngoscopy and intubation response in the form of high dose opioid, lignocaine, esmolol, magnesium, clonidine and nitroglycerine.[2,3] These drugs have variable success rate . Dexmedetomidine is an alpha-adrenergic drug with good control on reducing the stress response and the sympathetic activity. It has rapid onset, analgesic and sedative property.[4]

Hence in the present study the effect of dexmedetomidine on the hemodynamic response during tracheal intubation was evaluated in CABG patients. The effect was compared with the commonly used lignocaine and control group. The aims and objective of the study was to compare the changes in hemodynamic response among dexmedetomidine, lignocaine and thiopentone as control group during tracheal intubation. The amount of rescue drugs required in the 3 groups to maintain normal heart rate and BP was also assessed.

Materials and Methodology

We conducted a prospective observational study in patients undergoing elective CABG of age 40-70yr. After obtaining the ethics committee approval sixty patients were enrolled in the study. Patients with

preoperative unstable angina, heart block, emergency surgery, left ventricle ejection fraction <30%, arrhythmia, left main coronary artery occlusion more than 50%, valvular dysfunction and difficult airway were excluded from the study. All intubation were performed by the same anaesthesiologist and intubation attempt lasting longerthan 20 seconds were also considered as exclusion criteria. All patients received their preoperative cardiac medications two hours prior to surgery. Sixty patients were divided into 3 groups with 20 patients in each group. All the patients were premedicated with morphine 0.1mg/kg and 0.3mg/kg of promethazine. Group 1 patients received fentanyl 2µg/kg, midazolam 0.05mg/kg, thiopentone 3-5mg/kg and rocuronium 0.9mg/kg for facilitating induction and tracheal intubation. Group 2 patients received same drugs as group 1 and additional lignocaine 1.5mg/kg was administered 2min prior to laryngoscopy. Group 3 patients received same drugs as group 1 and additional dose of dexmedetomidine 0.5µg/kg administered slowly over 10 minute prior to laryngoscopy.

The monitoring techniques included 5lead ECG, invasive arterial BP, cardiac index with non-invasive electrical cardiometry monitor (electrical cardiometry monitor, ICON cardiotronics, Inc., La Jolla, CA 92307; Osypka Medical GmbH, Berlin, Germany) ETCO2, pulse oximetry, transesophageal echocardiography and bispectral index. All cannulations were performedunder local anesthesia. In all patients heart rate, mean arterial blood pressure and cardiac index were measured at before induction (T1), after induction (T2), at laryngoscopy (T3), after 1min (T4), 3min (T5), 6min (T6) and 10min (T7) of tracheal intubation. The amount of rescue anaesthetics like fentanyl and thiopentone used in the three groups to maintain normal range of BP were calculated.

Statistical analysis was performed with statistical package for social science (SPSS) 20 version from Armonk, NY: IBM Corp. The sample size of 60 was selected by convenience sampling. The continuous values were presented as mean±standard deviation and categorical values as number and percentage. All the 3 groups were compared with analysis of variance (ANOVA) and Fisher's exact test. Comparison by groups was calculated by Bonferroni test. The values within the same group were compared by pairwise comparisons Bonferroni test. P value of <0.05 was considered significant difference.

Results

All the 60 patients who were enrolled had completed the study. The demographic parameters of age, sex, weight, height, body surface area (BSA), number of hypertensive and diabetic patient were similar in all the three groups(p> 0.05) (Table 1).

Table 1: Demographic parameters

Parameters	Group 1 (n=20)	Group 2 (n=20)	Group3 (n=20)	P value
Age (yr)	61.7±5.8	61.4±7.6	59.5±7.4	0.551
Sex M: F (n, %)	16:4 (80:20)	17:3 (85:15)	15:5 (75:25)	0.732
Weight (kg)	66.4±9.3	68.8±8.8	65.6±6.8	0.459
Height(cm)	159.2±2.9	161±3.3	159.8±4.2	0.291
BSA(mt^2)	1.6±0.1	1.6±0.08	1.6±0.09	0.459
Hypertension (n, %)	6 (30)	7 (35)	8 (40)	0.942
Diabetes (n, %)	5 (25)	4 (20)	5 (25)	0.839

The heart rate(HR) of the patients in all the three groups were similar at baseline (T1). Group 1 patients had higher increase in HR in comparison to lignocaine and dexmedetomidine groups (Table 2, Fig. 1). Dexmedetomidine group (Group 3) patients had stable HR in the range 70.1-81.6 /min and significantly less rise (p< 0.05)in HR compared to thiopentone (Group 1) and lignocaine (group 2) from T2- T7.

Table 2: Inter-group comparison of mean heart rate (bpm) changes at various intervals

Time point	Group 1 (n=20), T	Group 2 (n=20), L	Group3 (n=20), D	P value
T1	69.3±10.5	65.7±9	70.1±11.2	0.363
T2	79.3±13.1	71.4±7.7	70.4±8.3	0.012*#
T3	96.3±9.6	84.3±10.6	74.8±8.4	0.000*#$
T4	101.2±12.9	91.9±13.1	81.6±12.2	0.001#$
T5	95.2±14.5	91.2±14.2	80.2±12.4	0.003*#$
T6	88.7±15	84.7±14.7	76.8±14.3	0.04#
T7	82.5±14.8	83±10.8	70.4±11.6	0.002#$

*p<0.05 between group 1 vs 2, #p<0.05 between group 1 vs 3, $p<0.05 between group 2 vs 3
T= Thipentone, L= Lignocaine, D= Dexmedetomidine

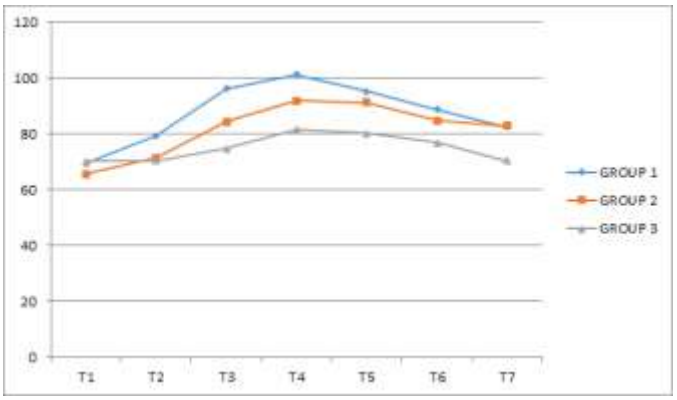

Fig. 1: Changes in the heart rate observed in the three groups during the study period

Mean arterial blood pressure among the 3 groups at base line (T1) was similar. Dexmedetomidine group patients had better control of MAP from T2- T7 time points and significantly less rise at laryngoscopy, p=0.0001, (Table 3, Fig. 2).

Table 3: Inter-group comparison of Mean arterial blood pressure (mmHg) changes at various intervals

Time point	Group 1 (n=20), T	Group 2 (n=20), L	Group3 (n=20), D	P value
T1	102.8±16.9	104±11.9	106.6±85.58	0.641
T2	86.6±14.2	88.8±11.6	91±9.6	0.522
T3	114.2±14.2	100.8±12.1	95.9±11.3	0.0001*#
T4	114.1±12.3	110.2±17.7	103.2±22.2	0.144
T5	106.7±14	100.9±12.9	97.2±17.1	0.136
T6	93.5±12.5	90.2±13.2	90.7±12.1	0.672
T7	85.6±13.3	88.3±15.1	79.2±12.7	0.109

*p<0.05 between group 1 vs 2, #p<0.05 between group 1 vs 3, $p<0.05 between group 2 vs 3
T= Thipentone, L= Lignocaine, D= Dexmedetomidine

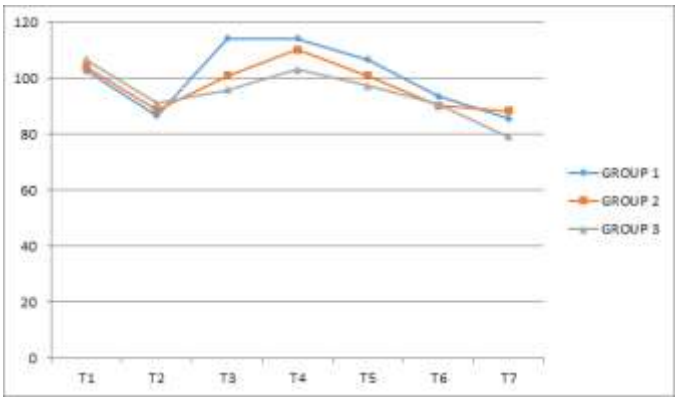

Fig. 2: Changes in the mean arterial pressure observed in the three groups during the study period

Cardiac index (CI) recorded at base line (T1) was having no significant difference, (Table 4). Dexmedetomidine group patients had significantly (p<0.05) controlled CI in comparison to group 1 and group 2, (Table 4, Fig. 3). The rise in CI was highest at laryngoscopy in thipentone (Group 1) and lignocaine (Group 2) patients.

Table 4: Inter-group comparison of cardiac index at various intervals

Time point	Group 1 (n=20), T	Group 2 (n=20), L	Group3 (n=20), D	P value
T1	3.9±0.2	4±0.3	4.1±0.2	0.113
T2	3.8±0.3	3.8±0.3	4.1±0.3	0.039#
T3	4±0.3	4.2±0.3	3.8±0.2	0.0004*$
T4	4.3±0.7	4.4±0.4	3.8±0.4	0.005#$
T5	4±0.7	4.1±0.4	3.5±0.2	0.001#$
T6	3.7±0.6	3.7±0.3	3.3±0.1	0.023$
T7	3.5±0.5	3.4±0.3	3.1±0.2	0.013#

*p<0.05 between group 1 vs 2, #p<0.05 between group 1 vs 3, $p<0.05 between group 2 vs 3
T= Thipentone, L= Lignocaine, D= Dexmedetomidine

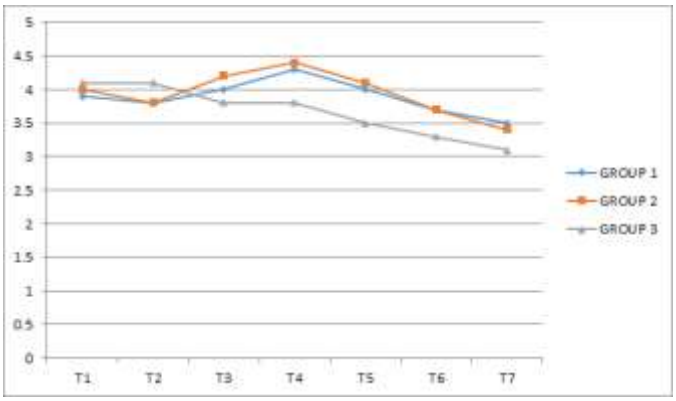

Fig. 3: Changes in the cardiac index observed in the three groups during the study period

Group 3 patients, receiving dexmedetomidine had less requirement of extra thiopentone and fentanyl to control the blood pressure to acceptable range. In contrast, group 1 and 2 patient's required significantly larger amount of rescue anaesthetics to control the high rise in MAP. (Table 5, Fig.4).

Table 5: Amount of rescue anesthetics required

Parameters	Group 1	Group 2	Group3	P value
Extra fentanyl (µg)	108.7±35.6	58.7±39.9	26.2±30.8	0.0001
Extra thiopentone (mg)	107.5 ±53.8	52.5±29.1	23.2±27	0.0001

Analyzing the values with in the same group the rise in HR, MAP and CI was more visible in group 1 compared to lignocaine (group 2) and dexmedetomidine (group 3) patients.

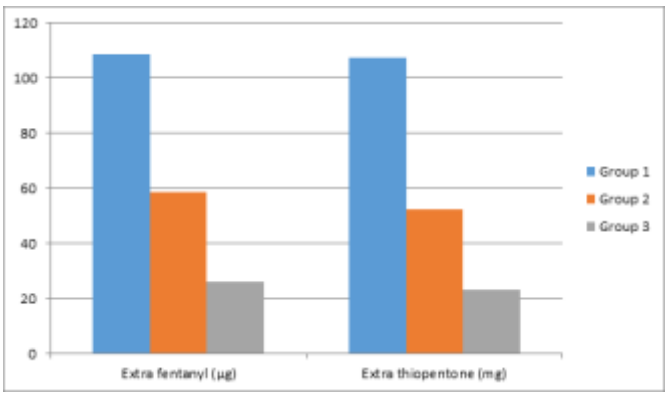

Fig. 4: Extra Amount of Anesthetic Drugs Required in the three groups

Discussion

The present study found the effective attenuation of hemodynamic stimulation by dexmedetomidine surrounding laryngoscopy and tracheal intubation. Dexmedetomidine treated group had minimumrise in HR, MAP and CI during induction compared to thiopentone only and lignocaine group. The trends of HR, MAP and CI were consistent with least fluctuations in dexmedetomidine group. The rescue dose of thiopentone and fentanyl to control the hemodynamic surge was least in dexmedetomidine group thiopentone and lignocaine group patients.

Laryngoscopy and tracheal intubation period is stressful phase at induction of anaesthesia. The sympatho-adrenal system is stimulated, resulting in tachycardia and hypertension, arrhythmias and myocardial ischemia. This may increase the postoperative morbidity and mortality.[1] The control of high rise in hemodynamic parameters during intubation is essential in management of cardiac surgical patients. Dexmedetomidine by the α2 adrenergic agonist action, is able to block the sympathetic reflex pathway.[4] Dexmedetomidine has also stress reduction, analgesic and sedative property. All these combined action helped us to attenuate the hemodynamic response to tracheal intubation in our study. The extra rescue dose of thiopentone and fentanyl was also less in dexmedetomidine group compared to lignocaine and

thiopentone only group due to its analgesic and sedative action.

Sulaiman S et al showed that HR, systolic blood pressure (SBP), MAP and diastolic blood pressure (DBP) had minimum rise with dexmedetomidine pretreatment to tracheal intubation in CABG patients. The finding supports our study.[5] The pulmonary artery pressures were also less affected during intubation in the study by Sulaiman S et al. Similar to our study. Sulaiman S et al also used 0.5µg/kg dose of dexmedetomidine. The authors also found that increase in cardiac output and CI was better controlled with dexmedetomidine. In our study we measured the changes in cardiac index by non-invasive cardiac output monitoring and we found similar observation with dexmedetomidine

In a placebo controlled randomized study Menda F et al detected that surge in HR, SBP, MAP and DBP was better attenuated with dexmedetomidine in fast tract CABG patients.[6] This corroborates to our study. Menda F et al also detected no bradycardia and hypotension due to dexmedetomidine use. The present study also has the similar finding and supports the use dexmedetomidine.

Vora KS et al in a study detected the better attenuation of tracheal response and reduction of adjuvant anaesthetics like thiopentone.[7] The study finding corroborates our result of lowest requirement of rescue fentanyl and thiopentone by pretreatment of dexmedetomidine.

Limitations

The study was confined to induction and tracheal intubation period. The effect of dexmedetomidine on hemodynamic parameters in the subsequent intraoperative and postoperative period was not included in the study.

Conclusion

Dexmedetomidine was most effective in attenuating the increase in hemodynamic parameters during tracheal intubation compared to standard thiopentone and thiopentone plus lignocaine induction in patients undergoing CABG. Dexmedetomidine also reduced the requirement of rescue doses of thiopentone and fentanyl to treat hypertension as well as tachycardia during intubation.

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