Fast track pediatric cardiac surgery; comparative study between dexmedetomidine and fentanyl

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Abstract

Background: Early extubation of children after cardiac surgery has been suggested as a safe alternative to prolonged postoperative intubation. Early extubation is an essential stage in the "fast-track" protocol. Early extubation protect against the deleterious effects of mechanical ventilation such as laryngotracheal trauma, barotrauma, pneumothorax, mucus plugging in the endotracheal tube, incorrect positioning, kinking of the tube, accidental extubation and ventilator associated pneumonia.

Patients and methods: The present study included 52 pediatric patients of average age 1-3 years and average weight of 8-15 kilograms. All cases were premedicated (intramuscular injection) with 0.2mg/kg Midazolam, atropine 0.02mg/kg and 5mg/kg ketamine 20 minutes before induction of anesthesia. This is followed by intravenous induction using 2 µg/kg fentanyl, midazolam 0.1mg/kg and cisatracurium 0.15mg/kg and face mask ventilation for 3 min, followed by tracheal intubation. Maintenance of anesthesia was performed by isoflurane, midazolam infusion at 50µg/kg/hr and either dexmedetomidine or fentanyl infusion. Cisatracurium was infused at 1µg/kg/min to maintain neuromuscular blockade. The patients were divided into 2 groups namely Dexmedetomidine group (n=26) and Fentanyl group (n=26).In dexmeditomidine group, patients received dexmeditomidine, loading dose as 0.5µg/kg IV for 10 minutes followed by maintenance infusion 0.5µg/kg/hr and stopped at the end of bypass. In fentanyl group, patients received fentanyl maintenance infusion of 1 µg/kg/hr and stopped at the end of bypass. Parameters measured in the study were bispectral index (after induction, during CPB, after CPB and at the end of the operation), hemodynamic parameters: blood pressure and heart rate (after induction, at skin incision, at sternotomy, post-CPB and at the end of the operation), time for extubation after the end of operation and intensive care unit (ICU) stay.

Results: Dexmedetomidine group showed lower readings of BIS than fentanyl group after induction, on bypass, and early after bypass. Fentanyl group showed lower BIS than dexmedetomidine group at the end of surgery. Dexmedetomidine group showed early extubation and shorter ICU stay than fentanyl group which was statistically significant lower.

Conclusion: this study demonestrates that dexmedetomidine has better sedative and analgesic effect and help to extubate patients early than fentanyl.

Introduction

It was demonstrated that early extubation (within six hours) in children undergoing surgery for congenital heart disease (CHD) has no negative effect on cardiac function. [(1)]

Rapid discontinuation of mechanical ventilation that sometimes can be accomplished in the operating room (OR) at the end of the procedure or soon after intensive care unit (ICU) arrival is part of a fast tracking protocol. The introduction of dexmedetomidine in the clinical practice has helped to accomplish this goal. [2]

Dexmedetomidine is the *dextro* enantiomer of medetomidine agonist, the methylated derivative of etomidine. Its specificity for the alpha-2 receptor is seven times that
of clonidine, with an alpha-2/alpha-1 binding affinity ratio of 1620:1, and its effects are dose-dependently reversed by administration of a selective alpha-2 antagonist such as atipamezole. [3]

Dexmedetomidine is a useful sedative agent with analgesic properties, hemodynamic stability and ability to maintain respiratory function in mechanically ventilated patients facilitating early weaning. [4]

Dexmedetomidine reduces cerebral blood flow and cerebral metabolic requirement of oxygen but its effect on intracranial pressure (ICP) is not yet clear. Dexmedetomidine has sedative, analgesic, and anxiolytic action through the α 2-adrenergic receptor (AR). [5]

Dexmedetomidine appears to exert analgesic effects at the spinal cord level and at supraspinal sites. [6]

Dexmedetomidine does not suppress respiratory function, even at high doses [7].Unlike opioids, dexmedetomidine is able to achieve its sedative, hypnotic, and analgesic effects without causing any clinically relevant respiratory depression, even at high dose, and the apnea threshold is actually decreased (the patient will be less valunerable to develop apnea). [8]

The bispectral index (BIS) is a monitor of anesthetic depth approved by the Food and Drug Administration in the USA. BIS incorporates time-domain, frequency domain, and bispectral analysis of the electroencephalograph, and is displayed as a dimensionless number between 0 (deep anesthesia) and 100 (awake), with 40–60 being suitable for surgical anesthesia. [9] BIS correlates well with hypnotic state and anesthetic drug concentration, [10] and use of BIS can shorten recovery times. [11]

Postoperative ventilation of patients undergoing cardiac surgery has been standard practice for the past three decades. Initially, it was justified because of relatively high incidence of respiratory insufficiency or low cardiac state after cardiac operation and the utmost of a high-dose anesthetic technique [12]. This practice has been a driving force for fast-track cardiac anesthesia. [13]

The early extubation helps early ambulation and feeding, increasing the patient's autonomy, and can also, by reducing the time of mechanical ventilation, reduce the medical and nursing postoperative workloads. Further potential benefits of early extubation include cost savings, lowered nursing dependency, reduced airway and lung trauma, improved cardiac output and renal perfusion with spontaneous respiration, and reduced stress and discomfort from endotracheal suctioning and weaning from ventilation. [14]

Early extubation has been documented in children [15] to avoid the potentially deleterious effects of mechanical ventilation, including laryngotracheal trauma, barotraumas or pneumothorax, mucus plugging, incorrect positioning or kinking of endotracheal tube, accidental extubation, infection and pulmonary hypertensive crises secondary to manipulation or suctioning of the endotracheal tube. [16]

The potential benefits of early extubation include cost saving, lower nursing dependency, reduced airway and lung trauma [17] improved cardiac output and renal perfusion with spontaneous respiration [18] as well as the reduced stress and discomfort of endotracheal suctioning and weaning from the ventilator. [19]

Patients and methods

This randomized controlled trial was performed in the Children Hospital of Cairo University after obtaining approval by the Hospital Ethics Committee, and a written informed consent from the parents. Fifty two children of both sexes were included, who were scheduled to undergo open-heart surgery for total correction of different acyanotic congenital heart diseases.

Children with age from 1 to 5 years and weight 8 kilogram or more of both sexes were included. Cyanotic heart diseases, weight less than 8 kg, abnormal liver & kidney functions, redo operations and pulmonary artery pressure more than 50 mmgh were excluded.

METHODS

Study groups

The two groups are (each 26 patients):

1- Group (D): Dexmeditomidine group.

Patients received dexmeditomidine, loading dose as 0.5µg/kg IV for 10 minutes followed by maintenance infusion 0.5µg/kg/hr and stopped at the end of bypass.

2- Group (F): Fentanyl group.

Patients received fentanyl maintenance infusion of 1µg/kg/hr and stopped at the end of bypass.

***Randomization method*:**

They were randomly allocated by a computer-generated table into one of the 2 study groups; the randomization sequence was concealed in sealed envelopes.

Preoperative assessment:

All patients were assessed clinically and investigated for exclusion of the above mentioned contraindications. All routine investigations were done including CBC, coagulation Profile (Prothrombin time and Prothrombin concentration), liver function tests (ALT/AST), kidney function tests (urea and creatinine), blood grouping, chest X-ray, and recent echocardiography and cardiac angiograghy as required.

Anesthetic Management:

*** Premedication:-**

In the form of 0.2mg/kg midazolam, atropine 0.02mg/kg and 5mg/kg ketamine were given intra-muscularly 20 min before induction of anesthesia.

*** Preparation:-**

Upon arrival to the operating theatre:-

- ECG and pulse oximetry were applied.
- A peripheral venous cannula was inserted and secured.
- Antibiotic as a slow bolus was given
- The patient was put on a warm surface blanket (adjusted to 37°- 38°C).

*** Induction:-**

- 2µg/kg fentanyl and midazolam 0.1mg/kg were given.
- Cisatracurium 0.15mg/kg IV was given to facilitate endotracheal intubation.
- Face mask ventilation with 100% oxygen for 3 min, followed by tracheal intubation. Tidal volume will be at 6-8 ml/kg and rate adjusted to keep PaCo2 at 35-40 mmHg.

*** Maintenance:-**

Inhalational: All patients received general anesthesia with mixture of isoflurane

0.3% - 1.5% in oxygen.
Both groups received midazolam infusion at 50μg/kg/hr and stopped after at the end of bypass.
Neuromuscular blocker: infusion of cisatracurium 1μg/kg/min to maintain neuromuscular blockade.
In Dexmedetomidine group (26 patients): loading was done by 0.5μg/kg IV over 10 min followed by maintenance infusion by 0.5μg/kg/ hr.
In Fentanyl group (26 patients): maintenance infusion by 1μg/kg/hr was given.
In both groups infusion was stopped at the end of the surgery.
Mechanical Ventilation: Pressure Controlled ventilation (PCV) was adjusted to maintain PaCO2 between 30 and 35 mmHg.
Heparin: Heparin in a dose of 300-400 IU/kg was given in central venous catheter, as heparin dose was adjusted to reach activated clotting time more than 400 sec.

***Canuulation:**

A central venous line (internal jugular or femoral vein) for inotrope and vasodilator infusion and central venous pressure monitoring.
An arterial line (radial or femoral) will be inserted for invasive blood pressure monitoring.

***Extracorporeal Circulation:**

Activated clotting time (ACT) base line was done and heparin 300-400 IU/kg was given for anticoagulation and confirmed with a level of ACT more than 400 sec.
CPB was initiated after a standard aorto-bicaval cannulation, a membrane oxygenator and a non-pulsatile roller pump were used. Venting of the left heart was performed with a left atrial vent inserted through a small incision at the interatrial septum. Priming solutions consists of isotonic saline solution supplemented with heparin. Fresh whole blood was added to the priming solution in appropriate amounts to achieve a hematocrit of 20% to 25% during CPB.
Moderate hypothermia (28°C to 32°C) was used during CPB. Pump flows were 2.4 to 2.6 L/min/m2 during the normothermic period, mean arterial pressure (MAP) was maintained by CPB flow adjustments between 30 and 50 mmHg. Cold blood cardioplegia (20 mL/kg for initial dose) with 30 mEq/L of potassium, sodium bicarbonate 25mEq/L & xylocaine 60 mEq/L was injected into the aortic root after aortic cross clamping. This was followed by 10 mL/kg every 20 minutes during aortic cross-clamping, and throughout this period, topical myocardial cooling was used.

. * Intraoperative Monitoring:-

1-Cardiovascular system: -
Electrocardiogram: standard five - leads system.
Invasive arterial blood pressure.

Central venous pressure.
Urine output.
2-Central nervous system:-
BIS analysis using BISx (Aspect Medical Systems, Inc.) attached to Drager monitor & BIS pediatric sensor (Aspect Medical Systems, Inc.) attached to patients foreheads.
3-Ventilation: -
Oxygen saturation by pulse oximeter.
End tidal carbon dioxide by capnograghy.
Arterial blood gases samples.
4-Temperature:-
Nasopharyngeal and peripheral temperatures (Siemens Sireeust 404-1, Solna, Sweden).
5-Activated Clotting Time (ACT).

Measured parameters:

(1) Bispectral index recording after induction, during CPB, after CPB and at the end of the operation.
(2) Hemodynamic parameters: blood pressure and heart rate after induction, at skin incision, at sternotomy, post-CPB and at the end of the operation.
(3) Time for extubation after the end of operation.
(4) Intensive care unit (ICU) stay.

Criteria for extubation:

1. Regain of consciousness (BIS index more than 90).
2. Regain of motor power.
3. Adequate metabolic state guided by blood gases.
4. Normal electrolytes state (sodium and potassium).
5. Stable hemodynamics (blood pressure, heart rate and central venous pressure).

Statistical Analysis:

Data were summarized and analyzed; and the results were reported as mean ± SD. Comparison of the means of the 2 study groups was done using the student t-test. Non parametric variables were compared using Mann Whitney test. Comparisons against baseline values were performed using one-way analysis of variance (ANOVA). P value of 0.05 or below was considered statistically significant. Assuming an α level of 0.05, a sample size of 52 patients equally allocated into 2 groups (26 patients per each) was able to detect a large effect size of 0.8 in the time of extubation with a power of 80%. Estimation of sample size was performed by using G*Power program.

Results:

Table (1) demonstrated the demographic data of both groups including age, weight, gender and primary pathology. The mean age in group D was 1.8±0.97 years, and 1.7±0.84 years in group F. 16 patients in group D and 10 patients in group F were males. The mean weight in group D was 10±2.35 kg and 9.9±2 kg in group F. The most commonly included congenital defect in both groups was ventricular septal defect (VSD); accounting for 31 out of 52 patients, 18 in group D and 13 in group. Other defects were complete atrioventricular canal (CAVC) 12 in both groups, 3 in group D and 9 in group F. Atrial septal defect (ASD) accounted 7, 4 in group D and 3 in group F. Also there was one patient with ASD and VSD in group D and one patient with cortriatrium in group F.

As regards demographic data and baseline characteristics, both study groups were comparable with no statistical significant difference in age, weight, gender, and primary pathology. (table 1).

Table (1): Demographic data and baseline characteristics. Data are presented as mean (SD), number (frequency)

	Group D (n=26)	Group F (n=26)	P value
Age (years)	1.8(0.97)	1.7(0.84)	NS
Weight (Kg)	10(2.35)	9.9(2)	NS
Male gender	16(61%)	10(38%)	NS
Pathology • VSD • ASD • CAVC • Others	 18(69%) 4(15%) 3(12%) 1(4%)	 13(50%) 3(11%) 9(35%) 1(4%)	NS

Group D: dexmedetomidine group, Group F: Fentanyl group, VSD: ventricular septal defect, ASD: atrial septal defect, CAVC: complete atrioventricular canal, NS: not significant.

As regards BIS, group D showed lower readings than group F after induction (47±7 Vs 55±8, P<0.05), on bypass (13±9 Vs 18±9, P>0.05), and early after bypass (49±6 Vs 56±6, P<0.05). Group F showed lower BIS than group D at the end of surgery (79±3 Vs 87±5, P<0.05). (Table 2) (Figure 1,2)

Table (2): Bispectral index (BIS). Data are presented as mean (SD).

BIS	Group D (n=26)	Group F(n-26)	P value
after induction	47(7)	55(8)	<0.05
on bypass	13(9)	18(9)	>0.05
early after bypass	49(6)	56(6)	<0.05
at end of surgery	87(5)	79(3)	<0.05

Group D: dexmedetomidine group, Group F: Fentanyl group.

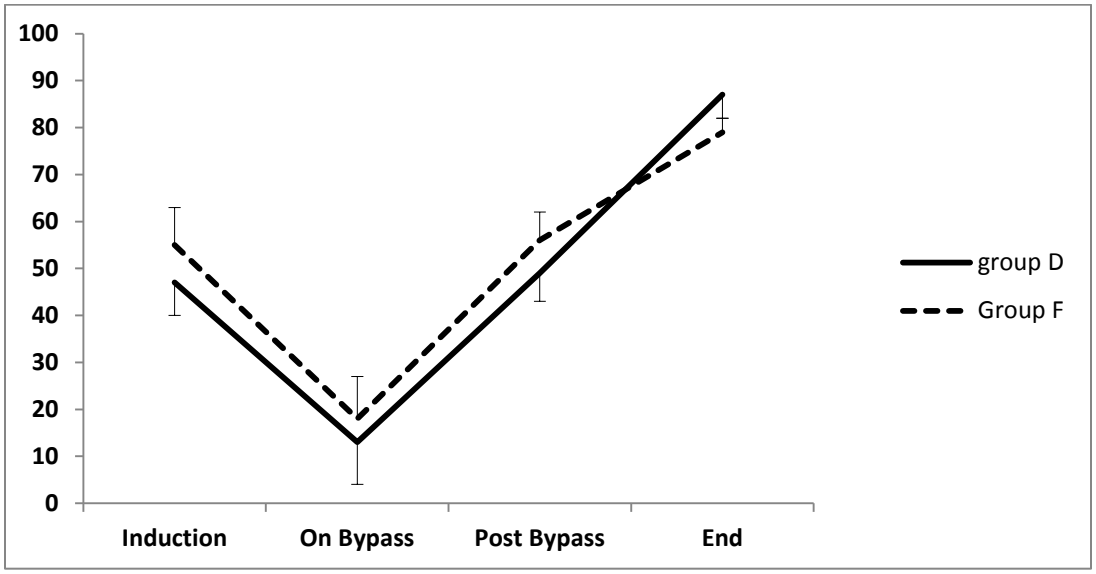

Fig (1): BIS readings. Group D: dexmedetomidine group, Group F: Fentanyl group.

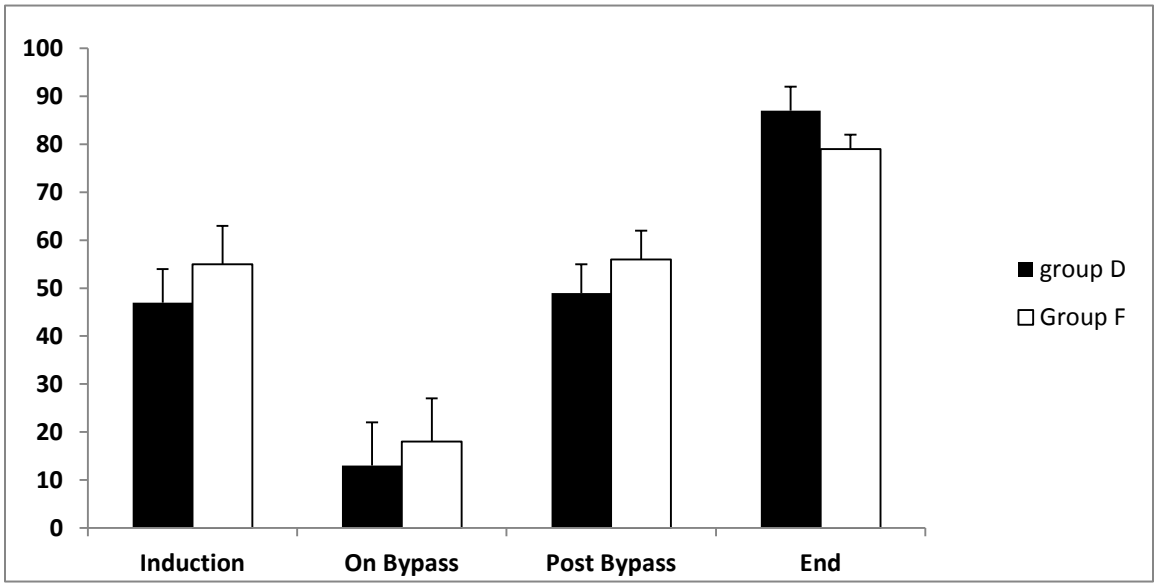

Fig (2): BIS readings. Group D: dexmedetomidine group, Group F: Fentanyl group.

As regards heart rate, group D showed lower values than group F at induction, skin incision, at sternotomy, early postbypass and at the end of surgery. In each group, heart rate showed higher values at skin incision and sternotomy than after induction (baseline) and the values were lower after bypass and at the end of surgery.

Table (3): Heart rate. Date were presented as number (frequency).

Heart rate	Group D	Group F
after induction	126(6)	128(8)
at skin incision	129(6)†	132(9)†
at sternotomy	130(5)†*	135(8)†
early postbypass	127(5)	130(9)†
at the end of operation	124(4)†*	129(8)

Group D: dexmedetomidine group, Group F: Fentanyl group.

* significant difference between groups ($P < 0.05$)

† significant difference vs. baseline in the same group ($P < 0.05$)

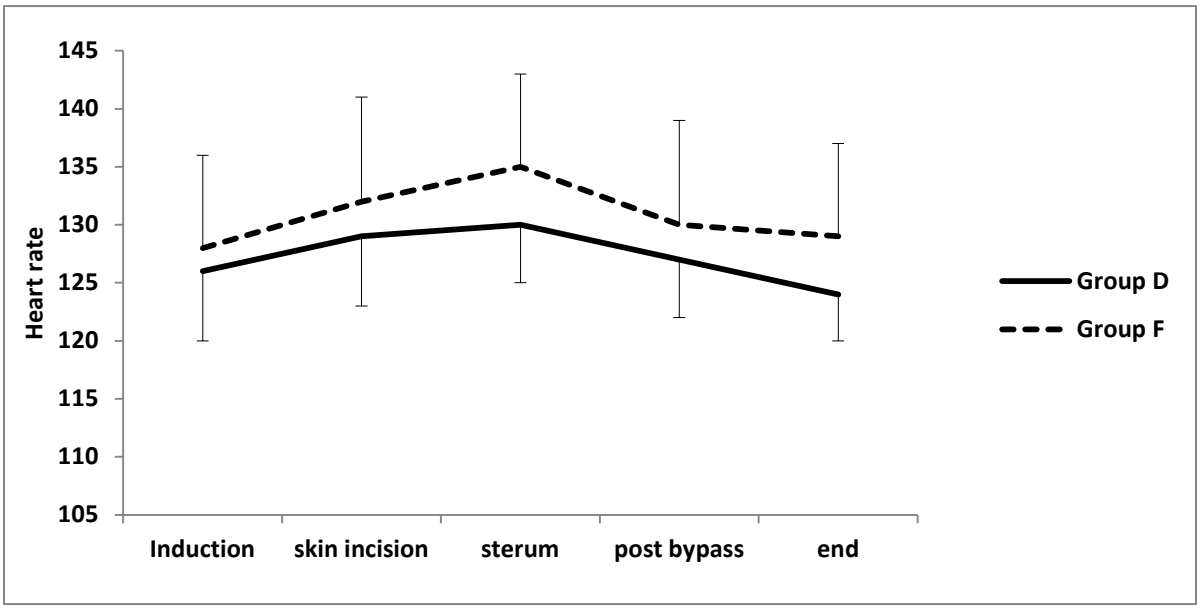

Figure (3): heart rate: Group D: dexmedetomidine group, Group F: Fentanyl group.

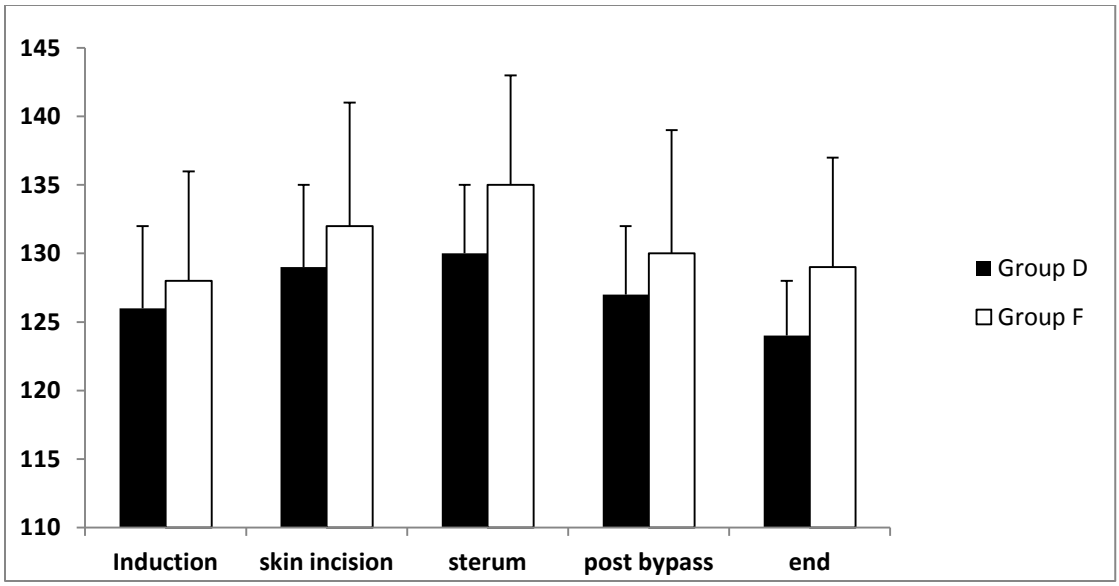

Figure (4): heart rate. Group D: dexmedetomidine group, Group F: Fentanyl group.

As regards blood pressure, group D showed lower values than group F in both systolic and diastolic blood pressure in all readings. Systolic blood pressure was higher in both groups relative to baseline (after induction) at skin incision, at sternotomy and early after bypass. Also diastolic blood pressure was higher in both groups relative to baseline (after induction) at skin incision and at sternotomy.

Table (4): Blood pressure (systolic and diastolic): data presented as number (frequency).

Systolic & diastolic blood pressure (mmgh)	Group D	Group F
SBP at induction	92(8)	95(8)
SBP at skin incision	95(6)†*	100(7)†
SBP at sternotomy	97(8)†*	102(8)†
SBP early postbypass	94(4)†*	98(6)†
SBP at the end of surgery	94(4)	97(6)
DBP at induction	56(6)	60(6)
DBP at skin incision	59(4)†*	63(5)†
DBP at sternotomy	60(5)†*	64(5)†
DBP early postbypass	57(3)*	61(5)
DBP at the end of surgery	57(4)*	61(5)

Group D: dexmedetomidine group, Group F: Fentanyl group. SBP: systolic blood pressure, DPB: diastolic blood pressure.

* significant difference between groups (P < 0.05)

† significant difference vs. baseline in the same group (P < 0.05)

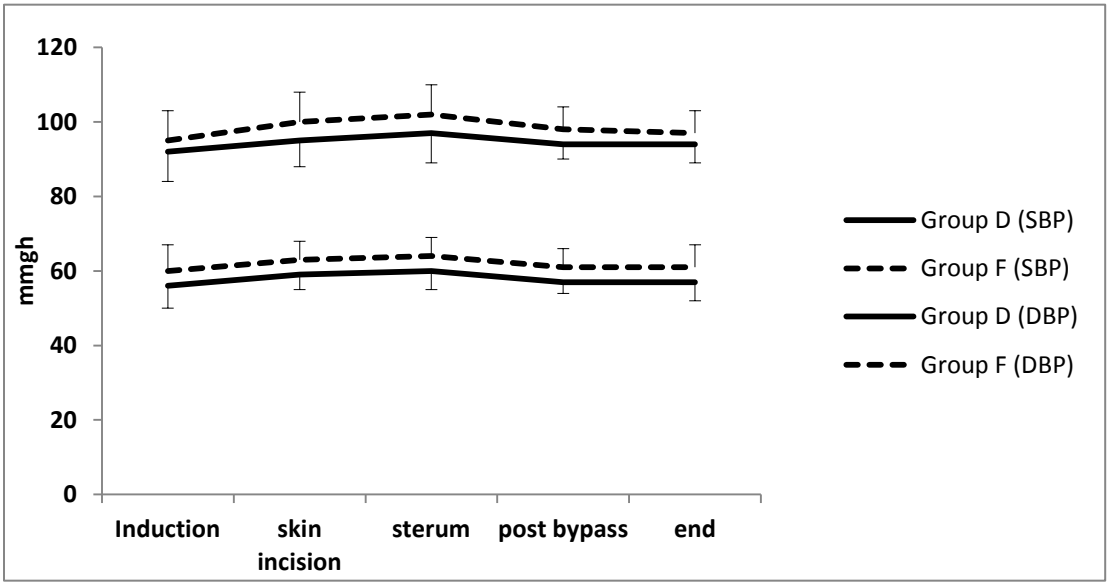

Figure (5): Systolic and diastolic blood pressure. Group D: dexmedetomidine group, Group F: Fentanyl group. SBP: systolic blood pressure, DBP: diastolic blood pressure

Postoperative parameters

As regards time of extubation, group D showed early extubation than group F, in group D 2±1.7 hours compared to 9±13 hours in group F which was statistically significant (P value<0.05).

As regards ICU stay, there was statistically significant difference between both groups (P value<0.05), ICU stay in group D was 2.38±0.49 days while in group F was 3.34±1.19 days. Table (5)

Table (5): Postoperative parameters. Data were presented as number (frequency)

	Group D (n=26)	Group F(n-26)	P value
Time to extubation (hours)	2(1.7)	9(13)	<0.05
ICU stay (days)	2.38(0.49)	3.34(1.19)	<0.05

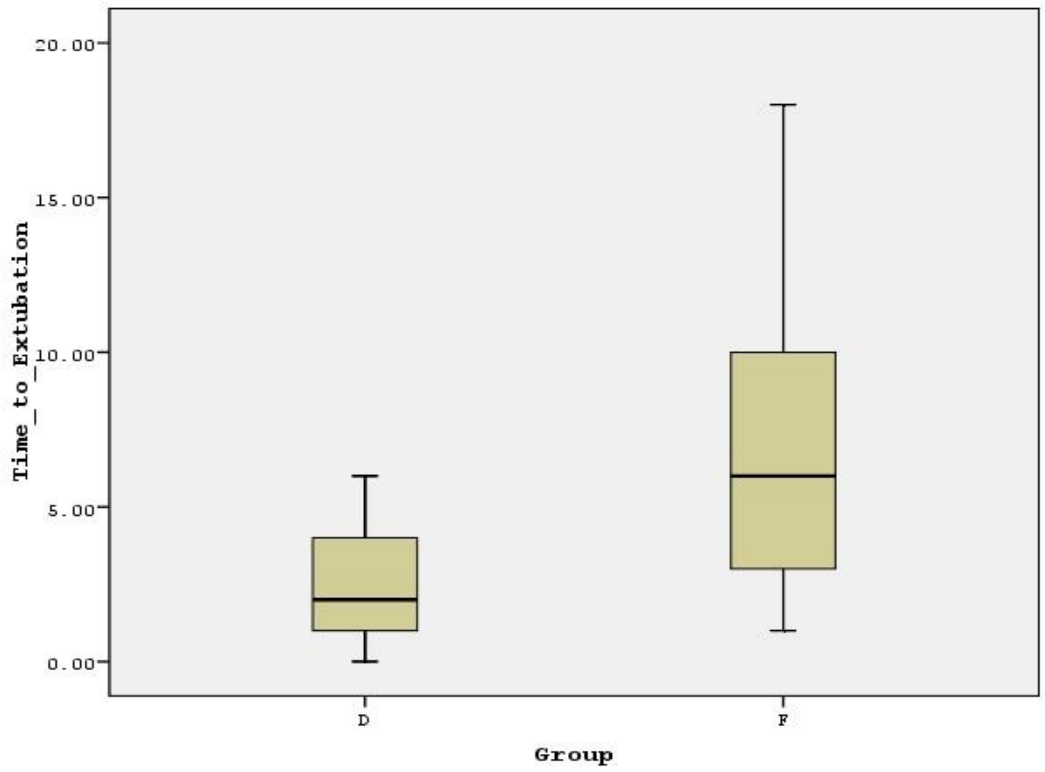

Figure (6): Time to extubation. Group D: dexmedetomidine group, Group F: Fentanyl group. Solid horizontal lines represent medians and boxes represent IQRs. Whiskers extend to the range of the data.

Discussion

This study compared dexmedetomidine with fentanyl in order to test the sedative and analgesic effects of it in anesthesia for pediatric cardiac surgery undergoing corrective cardiac surgery using cardiopulmonary bypass. The study included 52 patients assigned into 2 groups (26 patients each), dexmedetomidine group (group D) and Fentanyl group (group F).

In the current study, the parameters included were; bispectral index, hemodynamic parameters (heart rate and blood pressure) and postoperative parameters (time to extubation and ICU stay).

In the current study, regarding BIS index, dexmedetomidine group showed statistically significant lower values than fentanyl group after induction, early after bypass and at end of surgery.

Barr et al. [20], ***Mychaskiw et al.*** [21] and ***Myles et al.*** [22] also used BIS monitor to detect awareness during cardiac surgeries. BIS is the only monitor for anesthetic depth evaluated by a multicenter study. It was found that, it has a sensitivity of 97.3% and a specificity of 94.4 %. An adequate level of anesthesia is achieved with BIS ranging between 40 and 60. Monitoring BIS is proposed to reduce the risk of intraoperative awareness**.** ***Myles et al.*** concluded a lower incidence of awareness among high-risk patients monitored with the bispectral index system. [22]

In the current study, it was noticed that the lowest BIS values were recorded during bypass period. This may support the hypothesis that hypothermia decreases metabolism of anesthetic drugs and agrees with the results of ***Mathew et al.*** [23] who concluded that hypothermia decreases the BIS by 1.12 units per degree Celsius decline in temperature during cardiopulmonary bypass. Also, hypothermia depresses CNS functions. In our study, moderate hypothermia (28°C to 32°C) was used during CPB.

As regards heart rate and blood pressure (systolic BP and diastolic BP), group D showed lower values than group F at induction, skin incision, at sternotomy, early postbypass and at the end of surgery. In each group, heart rate showed higher values at skin incision and sternotomy than after induction and the values were lower after bypass and at the end of surgery.

Mukhtar et al. [24] studied the neuroendocrinal response to surgery in pediatric patients undergoing corrective cardiac surgery for congenital heart diseases. Administration of dexmedetomidine resulted in a significant decrease in heart rate (HR) and mean arterial blood pressure (MAP) relative to baseline, starting after the administration of the drug and continuing until the end of the study. In the control group, HR and MAP increased significantly relative to baseline, starting from skin incision and continuing until the end of the study. Patients in the control group had significantly more rapid HR and higher MAP levels relative to those in the dexmedetomidine group after the administration of the drug and lasting for the rest of the study period ($P < 0.05$).

Yacout et al. [25] studied the effect of intravenous dexmedetomidine infusion in adult patients undergoing major abdominal surgery on stress response markers and HR and MAP. Heart rate and mean arterial pressure were significantly lower in group D (dexmedetomidine) relative to group P (saline) during most of the intra- and postoperative periods. Baseline values of HR and MAP were comparable in both groups. Intraoperatively, the HR and MAP were significantly lower in group

D relative to group P after intubation and during most of the intra- and postoperative periods.

Jaakola et al. [26] concluded that dexmedetomidine attenuates the increase in heart rate and blood pressure during intubation. The dose used for this study was 0.6µg/kg, which is almost similar to the dose used in our study (0.5µg/kg).

Scheinin et al. [27] studied the effect of dexmedetomidine on tracheal intubation, the required dose of induction agent. They concluded that the required dose of thiopentone was significantly lower in the dexmedetomidine group and the drug attenuated the hemodynamic responses to intubation. The concentration of noradrenaline in mixed venous plasma was lesser in the dexmedetomidine group.

Lawrence et al. [28] found that a single dose of 2µg/kg of dexmedetomidine before induction of anesthesia attenuated the hemodynamic response to intubation as well as that to extubation. Bradycardia was observed at the 1st and 5th min after administration. This might have been due to bolus administration. The dose of dexmedetomidine in our study was 0.5µg/kg as an infusion over 10 min. Bradycardia was not observed during our study.

Sukhminder et al. [29] studied the ability of intravenous dexmedetomidine in decreasing the dose of opioids and anesthetics for attenuation of hemodynamic responses during tracheal intubation, surgery and extubation. This study included 100 patients scheduled for elective general surgery which randomized into 2 groups: D (dexmedetomidine) and F (fentanyl) (n=50 in each group). Group D were administered 1µg/kg each of dexmedetomidine and fentanyl while group F received 2µg/kg of fentanyl preoperatively. Hemodynamic parameters were recorded at regular intervals during induction, intubation, surgery and extubation. The pressor response to intubation, surgery and extubation were effectively decreased by dexmedetomidine and were highly significant. The mean dose of fentanyl and isoflurane were also decreased significantly by administration of dexmedetomidine.

When we come to practice early extubation in our study, extubation could be achieved earlier in group D than group F and the difference was statistically significant (P value<0.05). As regards ICU stay, there was statistically significant lower values in dexmedetomidine group compared to fentanyl (P value<0.05), while ICU stay in group D was shorter than group F.

Chetpaophan et al. [30] conducted a prospective study aiming to evaluate the effect of an early extubation practice among pediatric patients submitted to congenital cardiac surgery. 56 patients with congenital heart disease who underwent open heart surgery were enrolled in the study. An early extubation practice group (n = 27) were compared with the conventional postoperative cardiac care (n =29). Average postoperative ventilator time was significantly shorter in the early extubation group ($p < 0.05$). The ICU stay and hospital stay were not significantly different between the groups ($p > 0.05$). Postoperative complications were not found in the early extubation group. Four patients in the conventional group had postoperative complications and one (3.4%) required reintubation.

Davis et al. [31] did a retrospective multivariate analysis study of 219 patients less than 36 months age and the pathology was either simple or complex. 47% of cases were extubated within 24 hours. The primary outcome was extubation within 24 hours. Factors associated with prolonged MV (failed early extubation) were young age, pulmonary hypertension, congestive heart failure (CHF), prematurity and aortic cross clamp time (>45 minute). In our study, cyanotic congenital pathology, pulmonary hypertension (pulmonary artery pressure >50mmgh) and age < 1year were excluded from the study. In our study 100% of patients were extubated within 24 hours.

Other anesthetic techniques have been used in other studies (e.g, neuroaxial blocks) to supplement analgesia and help to decrease anesthetic and narcotic requirments and facilitate early extubation but this was an invasive technique.

Mittnacht et al. [32] who did a retrospecive study, included 224 patients (>1 month and < 18 years) and the cases were simple as ASD and VSD & complex as tetralogy of fallot. 79% of the patients were extubated in OR and no patient needed reintubation. Neuroaxial block was used. Factors associated with prolonged MV (failed early extubation) were young age, longer CPB time and higher inotropic use.

Also ***Peterson et al***. [33] did a similar study in which neuroaxial block was used. 220 patients were included in the study. 89% of patients were extubated in OR.

Heinle et al. [34] did a retrospecive study in which neuroaxial block was used, 56 patients (<90 days) were included. 50% of neonates and young infants were extubated in OR or within 3 hours on ICU (3 patients required reintubation and patients extubated early had shorter ICU/hospital stay).

Conclusion:

Data obtained in this study showed that dexmedetomidine has better sedative and analgesic effect and help to extubate patients early than fentanyl. Also dexmedetomidine has attenuated the hemodynamic response caused by anesthesia and cardiopulmonary bypass.

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