THE EFFECT OF PROPOFOL ON SYSTEMIC VASCULAR RESISTANCE DURING CARDIOPULMONARY BYPASS : A COMPARATIVE STUDY WITH THIOPENTONE

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SUMMARY : *30 patients undergoing elective coronary artery bypass grafting surgery were allocated randomly to receive either propofol - 2.5 mg/kg- (N=10, Group I) or thiopentone - 4 mg/kg - (N=10, Group II) during cardiopulmonary bypass with constant pump flow and temperature. Two groups and another control group - receiving no medication - (N=10, Group III) were compared with respect to the changes in hemodynamic parameters, especially systemic vascular resistance (SVR).*

SVR decreased from 2489 ± 302 to 1594 ± 286 dyn sec cm -5 and remained significantly less than the control values until 16.6 ± 4 min. after the administration of propofol. Following thiopentone administration, SVR decreased from 2683 ± 298 to 2162 ± 279 dyn sec cm -5 and remained unchanged for the following 9.4 ± 3 min.

There were more significant decreases especially in cardiac index, perfusion pressure and SVR in the propofol group compared with thiopentone or control groups.

Cardiopulmonary bypass has been shown to be a useful model for studying the isolated effects of anaesthetic drugs on hemodynamic parameters.

In our study, we tried to discuss the mechanism of the hypotensive effects of anesthetic agents, especially propofol and give an idea about the possible precautions that should be taken.

Key Words : *Surgery - Coronary Artery, Anesthetics Intravenous; Propofol, Thiopentone, Measurement techniques; Cardiac output.*

INTRODUCTION

Although many authors have studied the hemodynamic effects of the 2.6 di-isopropyl phenol (propofol), which has been among the most widely used induction agent in recent years, the discussions on especially the mechanism of its hypotensive effect have never ended (9, 10, 13). Various results obtained from many studies reveal that several factors are responsible in the mechanism of the effect of this agent (9, 10). Many authors showed that this agent has a direct effect on myocardium (12), causes coronary vasodilation (7), and decreases cardiac index up to 20 %, even in normal cases (8, 9, 12). The mechanism of decreasing the systemic vascular resistance seems to be the most popular one (6, 11, 13).

The model of cardiopulmonary bypass provides a unique convenience for studying the isolated ef-

fects of different anaesthetics by creating a system where all variants are under our control (11).

This study aims at examining the hemodynamic effects of two widely used anaesthetic agents-propofol and thiopentone - comparatively in the isolated heart model especially in regard of hypotension mechanism.

MATERIALS AND METHODS

During the period from May 1993 until July 1993, 30 patients (ASA I and II) undergoing elective coronary bypass surgery (22 male, 8 female aged between 32-64, mean : 54.2 ± 8) in the Department of Cardiovascular Surgery, Gazi Univeristy - Medical School, Ankara were included in the study. All patients were premedicated with diazepam 10 mg and morphine sulphate 10 mg IM. Following 35 mcg/kg fentanyl and 0..2 mg/kg diazepam, intubation was facilitated with 0.1 mg/kg pancuronium. Then 1 mg/kg morphin sulphate infusion was started and continued until sternotomy. Patients were ventilated with 100 % oxygen throughout the procedure. ECG, heart rate, mean arterial pressure (via radial artery catheter); central venous pressure, pulmonary artery pressure, pulmonary capillary wedge pressure (via Swan - Ganz catheter), cardiac index, systemic vascular resistance, mixed venous oxygen pressure (via Abbott Oximetrix 3 so2/co computer), peripheral oxygen saturation and end - tidal CO_2 (via Multinex datascope capnograph), patient temperature (via rectal probe) were monitored. Arterial blood gases were sampled every 15 min. A roller pump (COBE) and membrane oxygenator (Sarns) were used. Patients receiving a vasoconstrictor agent before or after cardiopulmonary bypass were excluded from the study to avoid adrenergic system interference.

After the institution of cardiopulmonary bypass, at constant pump flow and temperature, the patients were allocated randomly into three groups to receive either propofol - 2.5 mg/kg (N=10, Group I) or equivalent dose of thiopentone - 4 mg/kg (5) (N=10, Group II) in 30 sec. and another control group receiving no medication.

The measurements of central venous pressure, pulmonary artery pressure, pulmonary capillary wedge pressure, cardiac index and capnographic changes were recorded before and after cardiopulmonary bypass.

During cardiopulmonary bypass - at constant pump flow and temperature - after the administration of the anaesthetic agents, the changes in perfusion pressure were monitored at 1st, 2nd, 3rd, 4th, 5th, 10th, 15th, 20th min. and systemic vascular resistance was calculated according to the following formula (10) :

$$\text{SYSTEMİC VASCULAR RESISTANCE (dyn sec cm}^{-2}\text{)} : \frac{\text{PERFUSION PRESSURE (mmHg)}}{\text{PUMP FLOW (Lt/min)}} \times 80$$

Meanwhile, additional use of cardioplegia, declamping of aorta, or changes in pump flow or temperature were accepted as a reason of exclusion of the patient from the study.

The data were evaluated according to Student's t-test in microsta PC programme.

RESULTS

The demographic data and changes in hemodynamic parameters for three groups are listed in Tables 1, 2, 3. There were no significant differences with respect to age or weight between all groups. Tenth minute after the institution of constant flow and temperature were taken as the criteria for the comparison of the hemodynamic effects for both anaesthetics.

Perfusion pressure decreased at a mean of 20.14 % after propofol and 8 % after thiopentone administration, resulting in a significant difference in favour of propofol, statistically ($p< 0.05$). Cardiac index decreased 18.7 % in the propofol group, and 17.4 % in the thiopentone group, resulting in a significant difference with respect to control group ($p< 0.05$). There was no significant difference in any of the other forementioned parameters, except systemic vascular resistance.

After 10 min., systemic vascular resistance decreased from the mean of 2653 ± 298 to 2162 ± 279 dyn sec cm^{-2} in the thiopentone group (19.65 %) and from 2489 ± 302 to 1594 ± 286 dyn sec cm^{-2} (36.62 %) in the propofol group. Only 2 % of decrease was observed in the control group. The decrease in the propofol group was significant statistically with respect to either thiopentone or control groups ($p< 0.001$) (Fig 1).

The decrease in the sytstemic vascular resistance lasted for 16.6 ± 4 min. for the propofol group and 9.4 ± 3 min. for the thiopentone group, respecti-

PATIENT	10	
AGE (YRS)	53.8 ± 3	
WEIGHT (Kg)	73.4 ± 6	
	BEFORE CPB	AFTER CPB
MEAN ARTERIAL P. (PERFUSION P.) (mmHg)	70.3 ± 25	55.8 ± 23
PUMP FLOW (Lt/min)	2255 ± 500	2250 ± 500
PCWP (mmHg)	6.65 ± 0.8	7.43 ± 0.7
CVP (mmHg)	8.21 ± 0.8	9.32 ± 0.9
CI (Lt/m^2)	4.42 ± 0.22	3.66 ± 0.34
Po2 (mmHg)	397 ± 25	389 ± 32
	BEFORE ANAESTHETIC ADMINISTRATION	AFTER ANAESTHETIC ADMINISTRATION (10. min)
SVR (dyn sec cm^{-2})	2489 ± 302	1594 ± 286

PCWP : Pulmonary capillary wedge pressure
CVP : Central venous pressure
CI : Cardiac index
Po_2 : Partial oxygen pressure
SVR : Systemic vascular resistance
CPB : Cardiopulmonary bypass

Table 1 : Demographic and hemodynamic data of the propofol group before and after the procedure.

PATIENT	10	
AGE (YRS)	54.7 ± 4	
WEIGHT (Kg)	74 ± 5	
	BEFORE CPB	AFTER CPB
MEAN ARTERIAL P. (PERFUSION P.) (mmHg)	72.4 ± 22	66.3 ± 24
PUMP FLOW (Lt/min)	2250 ± 450	2250 ± 450
PCWP (mmHg)	9.31 ± 0.7	11.2 ± 0.6
CVP (mmHg)	7.32 ± 0.5	9.52 ± 0.7
CI (Lt/m^2)	3.93 ± 0.33	3.18 ± 0.5
Po2 (mmHg)	357 ± 24	324 ± 32
	BEFORE ANAESTHETIC ADMINISTRATION	AFTER ANAESTHETIC ADMINISTRATION (10. min)
SVR (dyn sec cm^{-2})	2653 ± 298	2162 ± 279

PCWP : Pulmonary capillary wedge pressure
CVP : Central venous pressure
CI : Cardiac index
PO_2 : Partial oxygen pressure
SVR : Systemic vascular resistance
CPB : Cardiopulmonary bypass

Table 2 : Demographic and hemodynamic data of the thiopentone group before and after the procedure.

vely. The duration of decrease for propofol group was significant with respect to either thiopentone or control groups ($p<0.05$).

DISCUSSION

Propofol has been one of the most widely studied agents since it was first revised in the form of an emulsion, again (2, 4). Propofol decreases systolic and diastolic pressure particularly during induction (9, 10, 13). One of the reasons of the hypotensive effect is related to its dose, since it is considered to be safe when it is administered slowly (3). However, there was a significant decrease even in a long administration period of 30 sec. in our cases. The 18.7 % decrease in cardiac index following propofol is very similar to results of Patrick et al. (12).

PATIENT	10	
AGE (YRS)	52.5 ± 5	
WEIGHT (Kg)	76.4 ± 8	
	BEFORE CPB	AFTER CPB
MEAN ARTERIAL P. (PERFUSION P.) (mmHg)	70.2 ± 22	71.4 ± 21
PUMP FLOW (Lt/min)	2246 ± 450	2246 ± 450
PCWP (mmHg)	7.34 ± 0.5	7.23 ± 0.5
CVP (mmHg)	7.65 ± 0.3	7.45 ± 0.4
CI (Lt/m^2)	4.35 ± 0.3	4.23 ± 0.5
Po2 (mmHg)	367 ± 23	376 ± 33
	BEFORE ANAESTHETIC ADMINISTRATION	AFTER ANAESTHETIC ADMINISTRATION (10. min)
SVR (dyn sec cm $^{-2}$)	2653 ± 298	2162 ± 279

PCWP : Pulmonary capillary wedge pressure
CVP : Central venous pressure
CI : Cardiac index
PO_2 : Partial oxygen pressure
SVR : Systemic vascular resistance
CPB : Cardiopulmonary bypass

Table 3 : Demographic and hemodynamic data of the control group before and at the 10th min. of cardiopulmonary bypass.

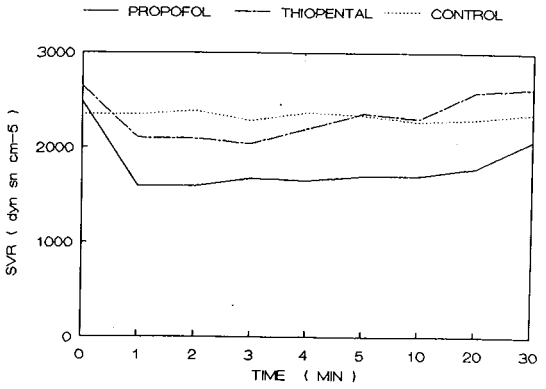

Fig - 1 : The effects of anaesthetics on SVR.

But our results are contrary to Lepage et al. who observed a decrease in mean arterial pressure and cardiac index without a change in systemic vascular resistance after propofol administration (9). Our study also resembles to Boer et al. who found that systemic vascular resistance decreased without an effect of adrenergical mechanism, after propofol infusion (1). Videcod et al. studied the effects of droperidol on systemic vascular resistance in a similar procedure and observed that different doses of droperidol affects blood pressure in a non - dose dependant way, related to a direct effect on peripheral blood vessels and systemic vascular resistance (14).

Induction of anaesthesia is the most critical period for the anaesthetists, especially in cardiac patients because of sudden hemodynamic changes. Our study group consisted of patients undergoing coronary bypass surgery having critical ventricular performance usually with left anterior descending coronary artery lesion. During induction of anaesthesia, sudden changes in coronary perfusion pressure may lead to a peroperative myocardial infarction and may result in poor surgical outcome. The hypotensive effects of the most common induction agents, propofol or thiopentone are well - known. Our study indicates that propofol has a higher hypotensive effect with respect to thiopentone and revealing the mechanism, it aims at providing the guidance for precautions that should be taken considering the systemic vascular resistance as a basis.

The model characterized by cardiopulmonary bypass on which the study is founded creates a very suitable procedure for studying the isolated effects of various anaesthetics and thus enabling to understand the mechanisms of action.

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