Shimane J. Med. Sci., Vol.8, pp.36-44, 1984

A COMPARATIVE STUDY OF NARCOTIC ANESTHESIA DURING VALVULAR HEART SURGERY

(narcotic anesthesia/morphine/fentanyl)

Masashi KAWAMOTO*, Makoto ASANO**, Mayumi TAKASAKI***, and Yoshihiro KOSAKA***

*Department of Anesthesiology, Hiroshima University, Hiroshima 734, **Department of Anesthesiology, Sapporo Medical College, Sapporo 060, and ***Department of Anesthesiology, Shimane Medical University, Izumo 693, Japan

(Received May 31, 1984)

A retrospective study was carried out to evaluate the suitability of narcotics for valvular heart surgery. Forty patients having cardiac valvular replacement were randomly anesthetized with morphine (1, 2 and 3 mg/kg) or fentanyl with low and high dose (19 and 66 μg/kg, respectively). The patients were divided into five groups according to anesthetic agent and dosage. Heart rate, direct arterial pressure and central venous pressure were always monitored serially during the procedure. Rate pressure product (RPP) was calculated to estimate the myocardial oxygen consumption. In the group given a high dose of fentanyl(HDF), circulatory stability was obtained without any change in RPP throughout the study, but in the group given a low dose of fentanyl combined with droperidol, fluctuations in hemodynamic responses were observed with reduced RPP. Serial changes in hemodynamics were apparent in groups given morphine anesthesia. It is, therefore, concluded that HDF with nitrous oxide produces minimal changes in hemodynamic responses and can be better tolerated during valvular heart surgery.

Morphine has been widely used as a major anesthetic agent for open heart surgery, but at small doses of morphine, fluctuations in hemodynamic responses can be observed in cases with depressed cardiac performance. Fentanyl has less effects on hemodynamics in patients with poor cardiac function. Since

Stanley and his co-workers (1) proposed an anesthetic technique with a high dose of fentanyl (HDF), this technique has been widely accepted for both aortocoronary bypass (2) and valvular heart surgery. However, neuroleptanalgesia (NLA) using droperidol and small dose of fentanyl is commonly used as anesthetics for general surgery, but infrequently for cardiac operation. This study was conducted to evaluate the suitability of so-called narcotic anesthesia with morphine or fentanyl for valvular heart surgery.

MATERIALS AND METHODS

Forty patients underwent cardiac valve replacement for elective operation of whom 18 were men. Excluded from the study were patients with coronary heart disease, significant pulmonary disease and emergency cases. The patients were divided into five groups according to anesthetic agent and dosage. Group I was composed of patients anesthetized with NLA and Group II, with HDF. Groups III, IV and V were made up of patients anesthetized with morphine at 1, 2 and 3 mg/kg, respectively. As shown in Table I, their New York Heart Classes were evenly distributed in each group. Operations which were performed in this study are listed in Table II.

Table I. PREOPERATIVE PHYSICAL STATUS

Group	n	New York heart class			
		I	II	III	IV
I (NLA)	6	1	3	2	0
II (HDF)	5	1	1	2	1
III (Mor-1)	6	1	2	3	0
IV (Mor-2)	13	0	6	6	1
V (Mor-3)	10	1	4	4	1

Replacement of one and two valves was carried out in 27 and 13 patients, respectively. There were no modifications of preoperative medical regimen for the purpose of this study. Ordinary preanesthetic medication was administered with scopolamine (0.01 mg/kg), hydroxyzine (1-2 mg/kg) and/or diazepam

Table II. OPERATIONS PERFORMED

MVR	14
MVR, AVR	10
MVR, TAP	4
MVR, AVR, TAP	3
AVR	4
AVR, OMC	3
MVR, TAP	1
TVR	1
Total	40

MVR:mitral valve replacement; AVR:aortic valve replacement; TAP:tricuspid annuloplasty; OMC:open heart mitral commissurotomy; TVR:tricuspid valve replacement.

(0.2 mg/kg). On arrival in the operating room, monitoring of electrocardiography was started. Thereafter, a venous line was secured and radial arterial cannulation was performed under local anesthesia. A central venous catheter was inserted after endotracheal intubation.

In Group I, anesthesia was induced with a loading dose of fentanyl (4-6 μg/kg) and droperidol (0.16 mg/kg), followed by intermittent intravenous injections of fentanyl (2 μg/kg) every 20-40 minutes. In Group II, anesthesia was induced with HDF using drip infusion of fentanyl. Total doses of fentanyl, 20 μg/kg in group I and 70 μg/kg in group II, were given before initiating extracorporeal circulation. In Groups III, IV and V, morphine (0.2-0.6 mg/kg) was administered with intermittent bolus injections. Before initiating extracorporeal circulation total doses of morphine at 1, 2 and 3 mg/kg were given in groups III, IV and V, respectively. All patients were randomly given either succinylcholine chloride (1 mg/kg) or pancuronium bromide (0.1 mg/kg) to facilitate endotracheal intubation. They were ventilated mechanically with 67% nitrous oxide in oxygen after intubation. Respiration was controlled to maintain $Paco_2$ between 35 and 45 torr.

Measurements of heart rate (HR), arterial pressure and central venous pressure (CVP) were made (a) 5 minutes before induction of anesthesia, (b) 10 minutes after endotracheal

intubation, (c) 10 minutes after skin incision, (d) immediately after median sternotomy and (e) 5 minutes before initiation of extracorporeal circulation. Rate pressure product (RPP) was calculated from systolic arterial pressure and HR. Data before induction of anesthesia were defined as control, except that the value of CVP at (b) after induction of anesthesia was specified as control. Serial changes were compared with the control.

One way layout analysis of variance was used to compare control values among five groups, and paired t-test was used for comparison of serial changes with control. Statistical significance was defined as p value less than 0.05. Values were expressed as means $\pm$ SEM.

RESULTS

The patients were 46.2 $\pm$ 1.8 years of age and 50.0 $\pm$ 1.4 kg of weight with no significant differences among the five groups. Total dosages of fentanyl were significantly different between Groups I and II. Dosages of morphine were also significantly different among Groups III, IV and V as shown in Table III. Control values were insignificantly different among five groups in HR, mean arterial pressure (MAP), RPP and CVP as shown in Tables IV and V.

Serial changes are given in Fig. 1. HR was not altered in Group II, but it was depressed in Group I. Fluctuations in HR were observed in Groups III, IV and V. After endotracheal intubation, MAP was not changed in Groups II and V, but it was decreased in Group I and increased in Groups III and IV. However, immediately after median sternotomy, MAP was increased in all Groups except for Group II. RPP was well maintained in Group II throughout the procedure. In Group I, RPP was reduced but fluctuated. Marked increases in RPP were observed after intubation in Group III and after sternotomy in Group V. In Group IV, RPP was relatively well maintained. CVP was not significantly changed in all groups, except in Group I.

When surgical stimuli were applied to the right atrium, HR was increased and MAP was decreased in all groups. Therefore, changes in RPP before extracorporeal circulation were not due to anesthetics but to surgical manipulations.

Table III. GROUP CHARACTERISTICS

Group	Age (yr)	Weight (kg)	Dose of narcotics	
			Fentanyl (μg/kg)	Morphine (mg/kg)
I	43.8±6.6	49.3±5.2	18.7±2.4	-
II	47.0±3.8	54.8±4.5	65.8±2.6#1	-
III	42.8±3.7	53.3±2.7	-	1.2±0.1
IV	51.5±2.4	48.3±2.1	-	2.0±0.3#2
V	42.1±4.1	48.0±2.5	-	3.1±0.1#3

Values are means±SEM.
#1 Significantly different ($P<0.05$) from Group I value.
#2 Significantly different ($P<0.05$) from Group III value.
#3 Significantly different ($P<0.05$) from Group IV value.

Table IV. CONTROL VALUES IN HR, MAP AND RPP

Group	HR(bpm)	MAP(torr)	RPP
I	96.7±8.9	90.7±6.4	12230±1632
II	84.0±7.0	95.4±4.2	9480±1010
III	99.2±5.7	89.5±2.6	11000± 739
IV	91.3±5.0	89.2±2.7	11090± 566
V	86.1±4.6	90.1±2.8	10170±2000

Values are means±SEM.
HR:heart rate; MAP:mean arterial pressure;
RPP:rate pressure product.

Table V. CONTROL VALUES AND SERIAL CHANGES IN CVP (cmH_2O)

Group	After intubation (control)	After skin incision	After sternotomy	Before extracorporeal circulation
I	10.1±1.7	9.0±1.9	8.3±1.7#	10.1±1.9
II	9.0±2.7	8.3±2.2	9.0±1.3	8.8±2.0
III	10.3±2.4	13.4±2.5	12.4±2.0	11.4±2.0
IV	12.2±1.8	12.1±1.5	12.3±1.6	11.1±1.4
V	10.1±3.2	11.7±1.7	10.6±1.3	10.0±1.3

Values are means±SEM.
Significantly different ($P<0.05$) from control value.
CVP:central venous pressure.

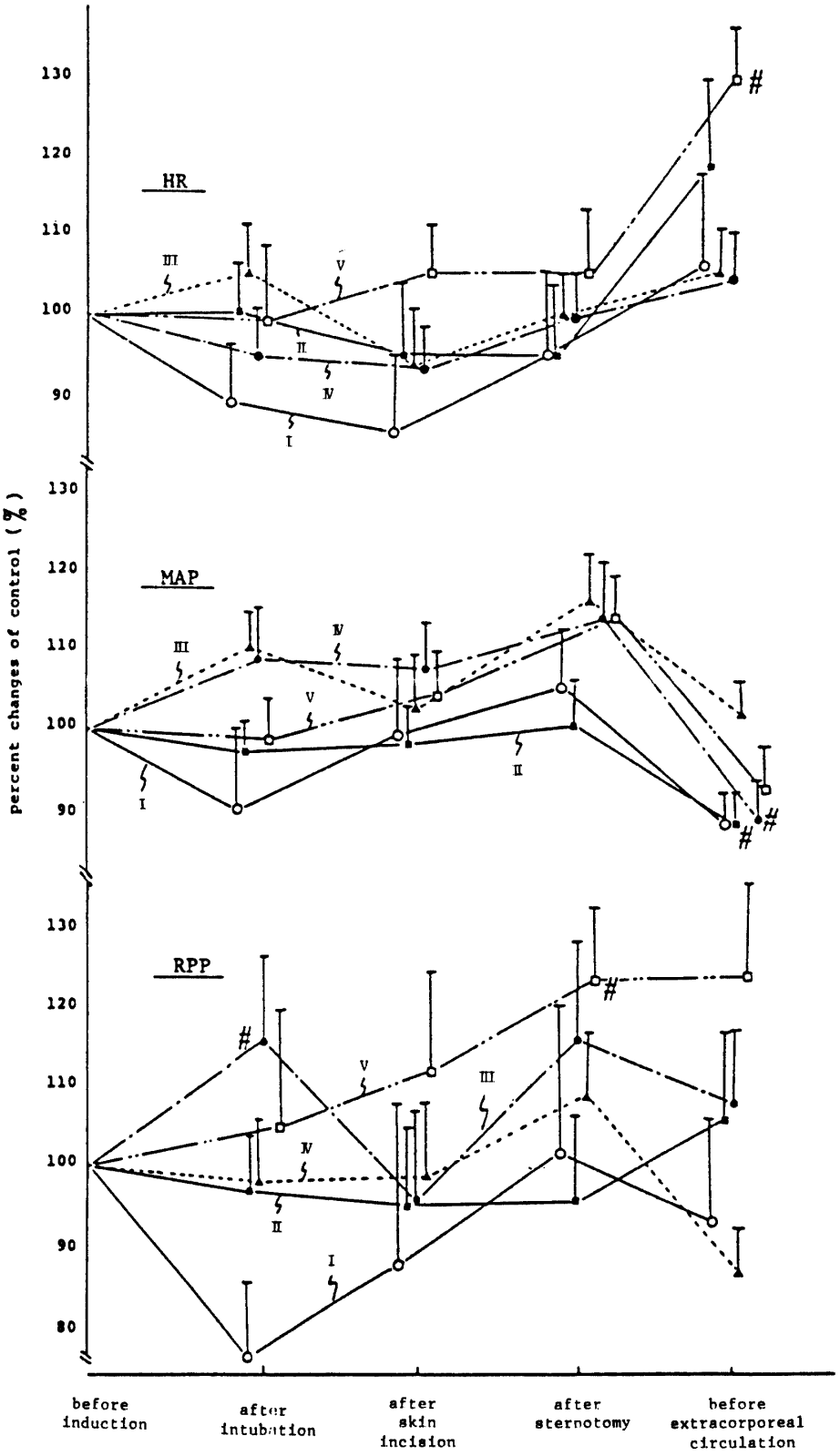

Fig. 1. Serial changes in HR, MAP and RPP during cardiac anesthesia. Values are means± SEM. # Significantly different ($P < 0.05$) from control value. HR:heart rate; MAP:mean arterial pressure; RPP:rate pressure product.

DISCUSSION

Myocardial oxygen consumption ($M\dot{V}O_2$) can be determined by afterload, preload, heart rate and myocardial contractility. RPP, the product of systolic arterial pressure and HR, correlates well with $M\dot{V}O_2$ (3). Therefore, RPP should be maintained below 12,000 during anesthesia (10). HR and MAP should be also kept at less than awake levels before initiating extracorporeal circulation. In our study, RPP was best maintained below 12,000 in the group with HDF throughout the measurement.

In patients with valvular stenosis, such as mitral stenosis and aortic stenosis, tachycardia is to be avoided and drugs that tend to produce tachycardia should be used with caution. Bradycardia should be avoided in patients with valvular regurgitation, such as mitral regurgitation and aortic regurgitation (3).

Inhalational agents such as halothane and enflurane may be dangerous in patients with severely decreased cardiac performance (3) because all conventional induction and inhalational anesthetic agents produce some degree of cardiovascular depression, including tachycardia and bradycardia which is undesirable in patients with limited cardiovascular reserve (4).

In contrast, morphine combined with nitrous oxide (5) has been found to be well tolerated in patients with poor cardiac performance. Morphine in small, analgesic dose has been used in the past decade as a primary anesthetic agent with or without nitrous oxide in dose of 1-3 mg/kg for both valvular stenosis and regurgitation (3,6). In patients with aortic stenosis or mitral stenosis, morphine leads to reductions in systemic vascular resistance and pulmonary arterial pressure, and to increase in cardiac output (3). In our patients, morphine produced a little fluctuation in hemodynamic responses at doses of 2 and 3 mg/kg. However, morphine anesthesia is not free of complications. Conahan et al. (7) and Sebel et al. (4) have pointed out hypertension, hypotension, cardiovascular depression when combined with nitrous oxide and increased circulatory catecholamines.

NLA with droperidol has been widely accepted for general surgery. However, only a few clinical reports have been published on NLA for cardiac valve replacement. In our study, remarkable fluctuations in circulation was observed when anesthetic or

surgical stimuli were applied. Negative inotropic action of droperidol and nitrous oxide, and insufficient depth of anesthesia with low dose of fentanyl might produce fluctuations in hemodynamic responses (8).

Stanley et al. (1) have demonstrated that HDF with oxygen only for valvular heart surgery is an attractive alternative to morphine in patients with little cardiac reserve. Their patients required fentanyl at a total dose of 74 μg/kg. Hemodynamic stability is a feature of HDF (9). Therefore, neither intubation nor surgical stimulation significantly altered cardiovascular variables (2). With a total dose of 75 μg/kg before extracorporeal circulation, Waynands et al (10) have observed hemodynamic stability in patients with poor left ventricular performance. However, in fentanyl anesthetized patients undergoing cardiac surgery, sternotomy was found to increase MAP (11). Edde et al. (11) have stressed that hypertension should be anticipated quickly with vasodilator therapy. Both sympathetic nervous system and renin-angiotensin mechanism apparently contribute to hypertension (12). In our patients with HDF, minimal changes in hemodynamic responses were observed even at median sternotomy. A mean dose of fentanyl of 65.8 μg/kg administered in our series was less than other workers who used 71 (1) or 74 (2) μg/kg with oxygen only. Supplementary anesthetic agents, such as nitrous oxide and diazepam, are frequently required for HDF to maintain hemodynamic stability (9) and combination with nitrous oxide could reduce the total dosage of fentanyl (1,4).

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