Anesthesia for Elective Cardioversion: A Comparison of Four Anesthetic Agents

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Elective cardioversion is a short procedure performed under general anesthesia for the treatment of cardiac dysrhythmias. Selection of the anesthetic agent is important, because a short duration of action and hemodynamic stability are required. Forty-four patients scheduled for elective cardioversion in the coronary care unit were studied prospectively. All patients were randomly assigned, according to the last digit of their clinical record number, to receive one of the four anesthetic agents studied: group 1, 12 patients who received 3 mg/kg of sodium thiopental; group 2, 10 patients who received 0.15 mg/kg of etomidate; group 3, 12 patients who received 1.5 mg/kg of propofol; and group 4, 10 patients who received 0.15 mg/kg of midazolam. All patients also received 1.5 μg/kg of fentanyl 3 minutes before induction. All four drugs provided satisfactory anesthesia for cardioversion and there were no major complications. Midazolam produced a more prolonged duration of effect and more interindividual variability. Propofol was associated with hypotension and a higher incidence of apnea, and its duration of action was similar to that of etomidate or thiopental. Etomidate produced myoclonus and pain on injection; however, it was the only agent that did not decrease arterial blood pressure. Thiopental reduced blood pressure but otherwise seemed an appropriate anesthetic for this procedure. In conclusion, all four anesthetic agents were acceptable for cardioversion, although their pharmacological differences suggest specific indications for individual patients.

CARDIOVERSION is a short procedure performed under anesthesia for the treatment of rhythm alterations in patients who often suffer significant cardiovascular derangement. It is frequently performed in areas outside the operating room, where anesthesia equipment and monitoring facilities may be less than optimal. The procedure may be performed on an outpatient basis; therefore, the anesthesiologist is requested to provide anesthesia with minimal hemodynamic alteration and rapid dissappearance of residual effects. Therefore, cardiovascular stability and short duration of action are necessary characteristics for an intravenous (IV) anesthetic agent to be selected for this procedure.[1]

It is difficult to determine the clinical advantages of the available drugs from published reports of cardioversion due to different protocols, conditions, and clinical subjects.[2-6] Therefore, the aim of this study was to compare prospectively, in a homogeneous group of patients, duration of action, arterial pressure changes, and adverse effects of sodium thiopental, etomidate, propofol, and midazolam during cardioversion.

MATERIALS AND METHODS

After institutional approval and informed consent, 44 unpremedicated adult patients, scheduled for elective cardioversion in the coronary care unit of the Catholic University Hospital in Santiago, Chile, were studied. Patients who were hemodynamically unstable and those who presented with ventricular dysrhythmias or signs of myocardial ischemia were not included in the study.

Patients were randomly assigned, according to the last digit of their clinical record number, to receive one of the four anesthetic agents studied: group 1, 12 patients who received 3 mg/kg of sodium thiopental; group 2, 10 patients who received 0.15 mg/kg of etomidate; group 3, 12 patients who received 1.5 mg/kg of propofol; and group 4, 10 patients who received 0.15 mg/kg of midazolam. All patients received 1.5 μg/kg of fentanyl, IV, 3 minutes before induction. The selected drug was injected IV over a period of 30 seconds. One third of the induction dose was added if the eyelash reflex was not lost within 2 minutes. The cardioversion was performed on loss of the eyelash reflex.

All patients were monitored with an electrocardiogram (ECG) and automated arterial blood pressure (Dinamap; Critikon, Tampa, FL). Systolic (SAP) mean, and diastolic arterial pressures, heart rate, and spontaneous ventilatory rate were recorded every 2 minutes. Any adverse effect was noted by a second anesthesiologist, who was in charge of observing the patient and collecting the data.

Induction time (IT) was defined as the time elapsed from the end of injection until the loss of the eyelash reflex. Awakening time (AT) was defined as the time elapsed from the loss of eyelash reflex until the patient could open his/her eyes in response to verbal command. Orientation time (OT) was defined as the time elapsed from opening of eyes on command until being able to recall the date of birth.

Pain during injection, apnea (defined as loss of ventilatory effort for 30 seconds or more), bradypnea (defined as a respiratory rate below 8 breaths/min), and the presence of myoclonus were also recorded. Before discharge the patients were questioned regarding awareness of pain and level of satisfaction with the anesthetic technique by means of a visual analog scale.

Statistical analysis of the data was performed using ANOVA, Fischer's Protected Least Significant Difference, and Friedman's and Fischer exact tests, as appropriate.

RESULTS

The four groups were comparable with regard to age, sex, weight, height, and baseline arterial blood pressure (Table 1). Atrial fibrillation was the most common dysrhythmia in all groups and atrial flutter was present in the remaining patients.

The four agents studied provided clinically satisfactory conditions for performing cardioversion. Two patients in the thiopental group, 1 receiving etomidate, and 3 with midazolam required one supplementary dose. After full recovery of consciousness, all patients were questioned regarding their perception regarding the anesthetic; all of them were satisfied with the technique used and there were no instances of recall.

IT, AT, and OTs were comparable for thiopental, propo-

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Table 1. Demographics and Preinduction Arterial Pressure

	Thiopental (n = 12)	Etomidate (n = 10)	Propofol (n = 12)	Midazolam (n = 10)
Age (yr)	58.3 ± 14.9	54.5 ± 10.8	56.9 ± 7.4	60.6 ± 12.2
Sex (F/M)	6/6	7/3	7/5	3/7
Weight (kg)	66.3 ± 9.9	66.4 ± 12.9	56.9 ± 7.4	70.3 ± 12.0
Height (cm)	170.5 ± 9.9	165.2 ± 8.6	166.7 ± 1.1	172.4 ± 7.7
Systolic (mm Hg)	142.6 ± 20.6	131.3 ± 16.5	134.7 ± 16.6	133.4 ± 19.2
Diastolic (mm Hg)	92.6 ± 14.5	83.6 ± 13.7	85.3 ± 13.1	83.6 ± 13.7

NOTE. Data given as Mean ± SD; differences were not significant.

fol, and etomidate (Table 2). However, midazolam resulted in significantly longer ITs, ATs, and OTs than the other three agents. In addition, midazolam was associated with more pronounced interindividual variability than the other three drugs (Table 2).

Compared with preinduction values, SAP decreased significantly with thiopental (19%) and midazolam (19%) and even more markedly with propofol (29%), whereas no significant change was evident in those patients receiving etomidate (Table 3). Arterial blood pressure returned to baseline values following cardioversion with thiopental and midazolam, stayed below baseline in patients anesthetized with propofol, and increased by 16% in the etomidate group. Arterial pressures in Table 3 represent the means of the minimal and maximal values observed for each individual patient.

The incidence of apnea appeared higher in the propofol group (Table 4). Although there were no differences in the incidence of bradypnea, it lasted longer when present in patients receiving midazolam. Pain on injection was observed only in the etomidate (40%) and propofol (33%) groups. Myoclonus was recorded in 3 patients, all in the group receiving etomidate. No other adverse effects of the drugs were found in this series of patients.

The success rate of cardioversion and the energy levels required are shown in Table 5. There were no statistically significant differences among the groups.

DISCUSSION

The four drugs provided adequate anesthetic conditions for elective cardioversion. The observed differences are in agreement with the known pharmacological characteristics of these drugs.[7]

Table 2. Duration of Action

	Thiopental (n = 12)	Etomidate (n = 10)	Propofol (n = 12)	Midazolam (n = 10)
IT (s)	31 (10-50)	34 (12-49)	17 (10-40)	68 (30-220)*
AT (min)	4.5 (1.3-9.9)	5.5 (3.2-11)	5.3 (2.4-18)	7.1 (0.6-66)†
OT (min)	1.0 (0.2-2.5)	0.9 (0.4-2.1)	1.1 (0.3-2.1)	1.6 (0.7-10)†

NOTE. Data given as median (range).

Abbreviations: IT, induction time; AT, awakening time; OT, orientation time.

*$P < 0.01$ between groups.

†$P < 0.05$ between groups.

Table 3. Systolic Arterial Pressure Before and After Induction

	Thiopental (n = 12)	Etomidate (n = 10)	Propofol (n = 12)	Midazolam (n = 10)
Baseline	143 ± 21	131 ± 17	135 ± 17	133 ± 19
Lowest	114 ± 10*	123 ± 18	97 ± 20*†	108 ± 11*
Highest	140 ± 18	152 ± 20	123 ± 19‡	136 ± 21

NOTE. Data given in mm Hg; mean ± SD.

*$P < 0.01$ *v* baseline.

†$P < 0.05$ *v* thiopental.

‡$P < 0.05$ *v* baseline.

Midazolam showed the largest interindividual variability and the longest duration of action. This has also been observed with other benzodiazepines used as induction agents.[8] Although it has been stated that midazolam is different from the rest of its class in that it possesses a very short induction time and half-life, the present results did not support this assertion.[8]

Propofol has been proposed as a drug especially suited for short and ambulatory procedures.[9] In this study, it did not show any discernible advantage over thiopental and etomidate in terms of duration of action. However, it should be mentioned that this study did not compare residual effect of the drugs 1 or 2 hours after recovery of consciousness. It has been stated that propofol could be advantageous in that it would provide fewer residual effects and more alert patients than the other induction agents presently used. On the other hand, propofol induced a more pronounced reduction of arterial pressure and a higher incidence of apnea and pain on injection. Some practitioners could object that the dose used was higher than that required for this procedure and that the fentanyl administered before induction was not strictly required. It is possible that administering the drug by itself and in a smaller dose could have resulted in a better outcome.

Etomidate was the only agent that induced myoclonus; it also produced pain on injection, but ventilatory and blood pressure alterations were minimal. In spite of not being advantageous for routine use, its superior hemodynamic stability could make it advisable for patients in whom hypotension is to be avoided. However, the authors' clinical experience has been that this drug should be used with caution in unstable or critically ill patients.

Thiopental remains a perfectly adequate agent for induction of anesthesia and for performing short procedures. In the authors' experience, thiopental, administered cautiously in terms of dosages and speed of injection, can be safely used even in relatively sick patients. The newer drugs

Table 4. Side Effects

	Thiopental (n = 12)	Etomidate (n = 10)	Propofol (n = 12)	Midazolam (n = 10)
Apnea (no.)	2	1	7*	1
Range (min)	1	0.5	1-6	5
Bradypnea (no.)	2	4	2	3
Duration (range, min)	3-3.5	2-8	5-12	10-30
Pain (no.)	1	4	4	0
Myoclonus (no.)	0	3	0	0

*$P < 0.05$ between groups.

Table 5. Success of Cardioversion and Energy Level

	Thiopental	Midazolam	Propofol	Etomidate	*P* Value
Return to sinus rhythm (%)	100	90	90	70	NS
No. of Shocks	1-3	1-3	1-3	1-3	NS
Minimal energy level (J)	50	30	25	30	NS
Maximal energy level (J)	300	400	400	350	NS

did not seem to possess advantages of sufficient magnitude so as to displace thiopental from its position as the primary short-acting anesthetic and induction agent.[10]

The authors chose to use fentanyl in all patients to secure a minimal degree of analgesia and to prevent pain on injection, which is frequently observed with some of the agents used. The dose was relatively small and was uniform in all groups; therefore, it should not have introduced a major error in the comparison among groups. However, it is possible that the prolongation of anesthetic effect and the incidence and duration of apnea that were observed were influenced by the addition of fentanyl. It is the authors' clinical experience that it is possible to provide satisfactory anesthesia for cardioversion with the four agents studied without the need for fentanyl supplementation.

Cardioversion is a short and relatively simple procedure; however, the anesthesiologist should be aware that it is not exempt from risks.[1] It is frequently performed in clinical areas that may lack the equipment and monitoring facilities customary in an operating room; before induction, the anesthesiologist should verify the availability of facilities for tracheal intubation and assisted ventilation with high oxygen concentration. Patients may have a full stomach, yet very often the procedure cannot be delayed due to the adverse hemodynamic effects of the dysrhythmia. The patients may also suffer from significant cardiac disease; in fact, cardiopulmonary, valvular dysfunction, or myocardial ischemia are commonly the underlying causes of the dysrhythmia. Selection of the anesthetic agent is important, but even more important is to correctly evaluate the associated risk factors and to provide careful anesthetic management.

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