ANAESTHESIA FOR CARDIOVERSION:
A comparison of diazepam, thiopentone and propanidid

R. ORKO

SUMMARY
Three groups of 50 patients were anaesthetized with diazepam 0.32 mg/kg or thiopentone 3.7 mg/kg or propanidid 4.6 mg/kg for elective cardioversion. Propanidid caused more hypotension than diazepam or thiopentone. Apnoea was most frequent following thiopentone and excitatory side-effects were most prominent following propanidid; the electric countershock worsened the excitatory phenomena. The success rate of conversion was higher in the diazepam group than in the other groups, but the difference was not statistically significant. Diazepam failed to produce amnesia in about 33% of the patients. Thiopentone is suitable and pleasant for cardioversion. Diazepam is recommended in poor-risk patients and in emergency situations.

Following the introduction of direct current countershock for the restoration of sinus rhythm, thiopentone seems to have been the most popular anaesthetic agent for this procedure (Lown, Amarasingham and Newman, 1962; Lown et al., 1963). However, since Muenster and colleagues (1967) reported a greater frequency of ventricular extrasystoles in patients anaesthetized with thiopentone than in those given diazepam, the latter has become a popular anaesthetic agent for cardioversion (Winters et al., 1968; Somers et al., 1971; Vinge, Wyant and Lopez, 1971).

Johnstone and Barron (1968) found that propanidid has a quinidine-like anti-arrhythmic effect and considered it to be superior to thiopentone for the induction of anaesthesia. Propanidid has a useful brevity of action (Clarke, 1969). However, it has not been compared with other anaesthetics for cardioversion.

The course of anaesthesia, the success rate of conversion of arrhythmia and the occurrence of ventricular arrhythmias in patients anaesthetized with diazepam, thiopentone or propanidid for the application of d.c. countershock have been compared.

PATIENTS AND METHODS
One hundred and fifty unselected patients undergoing elective cardioversion were divided randomly into three groups. Group I was anaesthetized with diazepam, group II with thiopentone and group III with propanidid. The groups were comparable (tables I and II).

Digoxin treatment was discontinued 2 days before the d.c. shock. In patients who were receiving quinidine, the dose was adjusted so that the serum concentration was within the range 1–3 mg/litre (Härtel et al., 1970).

The patients fasted overnight and arrived at the cardiovascular laboratory without premedication. Atropine 0.01 mg/kg was given i.v. 2 min before anaesthesia.

Diazepam (Valium) was given over a period of about 1 min until the patient's speech became sluggish and ptosis was obvious. Thiopentone (Hypnostan) and propanidid (Epontol), both in 2.5% solutions, were also injected over about 1 min. When the patient did not respond to questions, the level of anaesthesia was considered adequate for the application of d.c. shock. All patients were given 100% oxygen through a non-rebreathing valve and facepiece from 1 min before the induction of anaesthesia to the time of countershock. Controlled ventilation was instituted if the duration of apnoea exceeded 30 sec. The author administered all the anaesthetics. In group I the patients were drowsy only. In groups II and III, the duration of anaesthesia was timed from the start of the anaesthetic injection to the moment at which the patient responded to a command.

About 2–3 min after the anaesthetic injection began, the d.c. shock or shocks were given with the aid of a d.c. defibrillator (Electrodyne C-100 M or Olli defibrillator). One electrode was placed between the scapular angle and the spine, the other over the left sternal border. The energy discharge initially was 100 Wsec and it was increased successively, when necessary, to 200 and 300 Wsec. A maximum of three countershocks was given on each occasion.

Arterial systolic pressure was determined by indirect sphygmomanometry. The e.c.g. was recorded for a 2-min period during the 4 hr before the patient's arrival at the laboratory, during the 2 min...
before the induction of anaesthesia and from the start of the anaesthetic injection until 3 min after the d.c. shock. The heart rate was calculated and possible ventricular arrhythmias were noted from the e.c.g. records. The analysis of arrhythmias was performed without any knowledge of the group to which the patient belonged.

Problems during anaesthesia and the immediate recovery period were noted. The patients were observed at the laboratory for 30 min after the procedure.

On the next day most of the patients were visited by the anaesthetist and a note was made as to whether or not the sinus rhythm had been maintained. The patients were asked if they recalled the procedure.

Student's \textit{t} test or the Chi-square test was used for analysis of the results, unless indicated otherwise. The criterion for statistical significance was taken as \( P<0.05 \).

### RESULTS

The mean dose of diazepam required to achieve drowsiness was 0.32 (\( \pm \) SD 0.09) mg/kg. The dose of thiopentone was 3.7 \( \pm \) 1.1 mg/kg and of propanidid 4.6 \( \pm \) 1.4 mg/kg. The duration of anaesthesia in the thiopentone group was 4.7 \( \pm \) 2.0 min and in the propanidid group 4.9 \( \pm \) 1.8 min, the difference being not statistically significant.

### Electrocadiographic findings

Conversion of the arrhythmia was achieved in 42 patients (84\%) in the diazepam group, 36 (72\%) in the thiopentone group and 35 (70\%) in the propanidid group (table III). The differences are not statistically significant. Twenty-four hours after the countershock, sinus rhythm was present in 40 of the 42 patients in group I, in 35 of the 36 in group II and in all 35 patients in group III. The final success rates were 80\%, 70\% and 70\%.

An average of 1.9 countershocks per patient was required to achieve conversion in groups I and III, whereas group II required an average of 2.1 countershocks. The difference between these values is not statistically significant.
DIAZEPAM, THIOPENTONE, PROPANIDID FOR CARDIOVERSION

Table IV. Occurrence of ventricular extrasystoles (VES) before and during the procedure

<table>
<thead>
<tr>
<th>Number of VES/min</th>
<th>Diazepam</th>
<th>Thiopentone</th>
<th>Propanidid</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>32</td>
<td>36</td>
<td>33</td>
</tr>
<tr>
<td>1-4</td>
<td>16</td>
<td>11</td>
<td>15</td>
</tr>
<tr>
<td>5 or more</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Before premedication</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>After premedication</td>
<td>31</td>
<td>33</td>
<td>38</td>
</tr>
<tr>
<td>During anaesthesia, before shock</td>
<td>31</td>
<td>32</td>
<td>37</td>
</tr>
<tr>
<td>After shock</td>
<td>32</td>
<td>30</td>
<td>37</td>
</tr>
</tbody>
</table>

Table IV shows data on the prevalence of ventricular extrasystoles. The statistical analysis of these data was based on the increases and decreases in the number of patients showing ventricular extrasystoles. Within the groups, there were no statistically significant changes in the prevalence of ventricular extrasystoles. The comparison between the groups did not reveal any statistically significant differences either (hypergeometrical distribution). Ventricular tachycardia, fibrillation or standstill did not occur in any patient.

Arterial pressure and heart rate

The values of systolic pressure and heart rate, measured 2 min after the administration of atropine (table V) compared with values obtained before premedication (table I) show no change in arterial pressure and a marked increase in heart rate. The percentage changes in arterial pressure and heart rate at various stages (table VI) and the reference values representing 100% (table V) show a remarkable stability of systolic pressure in the diazepam group.

Two minutes after the start of anaesthesia, the decrease in arterial pressure in the propanidid group was significantly different from that in the diazepam group (P<0.001). The difference between the thiopentone and the diazepam groups was significant (P<0.05), whereas the difference between the propanidid and the thiopentone groups was not. Immediately after countershock, there were significant differences between the groups in the changes in arterial pressure (diazepam v. propanidid, P<0.001; diazepam v. thiopentone, P<0.05; thiopentone v. propanidid, P<0.01). Three minutes after the shock, arterial pressure had returned to near the initial value in all groups and there were no statistically significant differences between the groups.

In most of the patients in the diazepam and the thiopentone groups, the decreases in arterial pressure were less than 20%. Decreases of 20-30% were found group (P<0.001). The difference between the thiopentone and the diazepam groups was significant (P<0.05), whereas the difference between the propanidid and the thiopentone groups was not. Immediately after countershock, there were significant differences between the groups in the changes in arterial pressure (diazepam v. propanidid, P<0.001; diazepam v. thiopentone, P<0.05; thiopentone v. propanidid, P<0.01). Three minutes after the shock, arterial pressure had returned to near the initial value in all groups and there were no statistically significant differences between the groups.

In most of the patients in the diazepam and the thiopentone groups, the decreases in arterial pressure were less than 20%. Decreases of 20-30% were found

Table V. Arterial pressure and heart rate before the injection of anaesthetic (2 min after the injection of atropine 0.01 mg/kg). Mean values ± SEM

<table>
<thead>
<tr>
<th></th>
<th>Diazepam</th>
<th>Thiopentone</th>
<th>Propanidid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic pressure (mm Hg)</td>
<td>134 ± 3.9</td>
<td>146 ± 3.3</td>
<td>139 ± 2.1</td>
</tr>
<tr>
<td>Heart rate (beats/min)</td>
<td>114 ± 3.5</td>
<td>113 ± 2.9</td>
<td>116 ± 4.2</td>
</tr>
</tbody>
</table>

Table VI. Changes in arterial pressure and heart rate during the procedure. The values are per cent (mean ± SEM). 100 per cent is the value following atropine but before the administration of the anaesthetic

<table>
<thead>
<tr>
<th></th>
<th>Systolic pressure (mm Hg)</th>
<th>Heart rate (beats/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Diazepam</td>
<td>Thiopentone</td>
</tr>
<tr>
<td>2 min after start of anaesthesia</td>
<td>97 ± 1.7</td>
<td>89 ± 1.2†</td>
</tr>
<tr>
<td>After shock</td>
<td>101 ± 1.5</td>
<td>96 ± 1.5*</td>
</tr>
<tr>
<td>3 min after shock</td>
<td>99 ± 1.8</td>
<td>98 ± 1.5</td>
</tr>
</tbody>
</table>

† P<0.001; ‡ P<0.01; * P<0.05.
in none of the patients in the diazepam group, in four in the thiopentone group, and in 11 in the propanidid group. Decreases of more than 30% were seen in two patients in the thiopentone group and in seven in the propanidid group. However, in this respect, the differences between the groups were not statistically significant (hypergeometrical distribution).

The changes in heart rate throughout the procedure followed a similar pattern in all groups (table VI). No statistically significant differences were found between the groups.

**Side-effects**

The frequency of side-effects is shown in table VII. The incidence of apnoea exceeding 30 sec was significantly less in the diazepam group than in the propanidid group ($P < 0.01$) or in the thiopentone group ($P < 0.001$). The difference between the thiopentone and the propanidid groups was not significant.

| TABLE VII. Occurrence of side-effects during anaesthesia. Fifty patients in each group |
|---------------------------------|----------------|----------------|
|                                 | Apnoea | Excitation | Laryngeal irritation |
| Diazepam                        | 2      | 0           | 0                    |
| Thiopentone                     | 25     | 4           | 1                    |
| Propanidid                      | 15     | 19          | 1                    |

Excitatory side-effects, such as muscular tension or involuntary movements, or both, were observed most commonly in the propanidid group. The difference, as compared with either the thiopentone or the diazepam group, was statistically significant ($P < 0.001$), whereas the difference between the thiopentone and the diazepam groups was not significant. The electric countershock seemed to worsen the excitatory side-effects.

Signs of laryngeal irritation were observed in one patient in the thiopentone group and in one in the propanidid group. No other side-effects, such as hiccup, retching, vomiting or sweating were observed during anaesthesia or the immediate recovery period.

In the diazepam group 15 patients, out of 41 interviewed, recalled the electric countershock, compared with one out of 40 in the thiopentone group and three out of 38 in the propanidid group (diazepam vs. thiopentone, $P < 0.001$; diazepam vs. propanidid, $P < 0.01$ (hypergeometrical distribution)).

**DISCUSSION**

The mean doses of diazepam and thiopentone were similar to the amounts given by Fox, Wynands and Bhambhiami (1968) in their comparison of these drugs as induction agents. Nutter and Massumi (1965) and Muenster and colleagues (1967) have used diazepam in doses of 5–20 mg and 15–20 mg, respectively, for cardioversion. These doses are smaller than in the present study: thiopentone 3.7 mg/kg; propanidid 4.6 mg/kg: a potency ratio of 1.2 : 1. This ratio is similar to that found by Wynands and Fox (1966). The potency ratio for thiopentone and propanidid is 1.1 : 1 (Clarke et al., 1968).

The incidences of ventricular extrasystoles in the present series differ from those reported by Muenster and others (1967), who found that ventricular extrasystoles appeared in 11 of 18 patients anaesthetized with thiopentone, but in none of 19 patients anaesthetized with diazepam. When results from the patients in the present study who showed no extrasystoles before the procedure were analysed, there were no significant differences between the groups in the appearances of ventricular extrasystoles during the procedure. The patients in the present study received oxygen and atropine (Orko, 1974), whereas Muenster's patients did not.

Johnstone and Barron (1968) reported that propanidid has an anti-arrhythmic effect. This was seen in the present study, although there was no statistically significant difference between the propanidid and the other two groups.

The success rate of conversion was not very high in this series. There were no statistically significant differences between the groups. It is probable that the choice of anaesthetic agent has no significant influence upon the success rate of conversion of arrhythmia (Muenster et al., 1967; Heinonen, Orko and Louhija, 1973).

The arterial pressure in the diazepam group was almost unchanged, which is in accordance with previous observations (Nutter and Massumi, 1965; McClish, 1966; Brown and Dundee, 1968; Winters et al., 1968; Knapp and Dubow, 1970; Wyant and Studney, 1970; Somers et al., 1971). In this respect diazepam may be considered a safe agent for patients with cardiac disease. However, relatively small doses have been used in all the studies, including the present study, and it is evident that diazepam in larger doses may have some depressant effect on the circulatory function (Rao et al., 1973).

The decreases in arterial pressure in the thiopentone and the propanidid groups are comparable with the
findings of Wynands and Fox (1966), but not with those of Dundee and Clarke (1964), who used smaller doses of propanidid. The periods of hypotension after propanidid in the present study were brief and unlikely to be dangerous. No signs of hypersensitivity were observed in any of the patients.

The different frequency of apnoea in the thiopentone and the propanidid groups might be because only apnoea exceeding 30 sec was considered. There were shorter periods of apnoea immediately after the hyperventilation in some of the patients in the propanidid group. There was significantly less apnoea in the diazepam group than in the other two groups and the same observation has been made by Fox, Wynands and Bhambhami (1968). However, diazepam may depress breathing occasionally (Dalen et al., 1969; Rao et al., 1973) and it should be given by anaesthetists preferably (Dundee and Wyatt, 1974), although some authors (Glassman, 1971; Somers et al., 1971) are of the opinion that an anaesthetist is not necessary when diazepam is used for cardioversion.

Amnesia produced by diazepam has been reported frequently (McClish, 1966; Brown and Dundee, 1968). In the present study 37% of the patients anaesthetized with diazepam recalled the electric countershock. This is unacceptable in elective cardioversion. The lack of sufficient amnesia did not seem to be related to the given dose per kg. No patient in the series of Muenster and others (1967) recalled the electric countershock although some authors (McClish, 1966; Brown and Dundee, 1968) believed that amnesia produced by diazepam was great, and it was difficult to find the optimal dosage for every patient.

Diazepam may be considered the drug of choice for cardioversion in poor-risk patients and in emergency situations, because it does not seem to depress the circulation. However, patients anaesthetized with diazepam may recall the unpleasant procedure. For patients in better physical condition thiopentone would seem to be preferable. Hypotension and excitatory side-effects produced by propanidid make it less suitable.

ACKNOWLEDGEMENT
I wish to thank Laakin touni Oy of F. Hoffmann-La Roche & Co. A.G. for supplies of Valium.

REFERENCES


**ANESTHESIE POUR CHOC ELECTRIQUE EXTERNE: COMPARAISON DU DIAZEPAM, DU THIOPENTONE ET DE LA PROPANIDIDE**

**RESUME**

On a anesthesié pour choc électrique externe à froid, trois groupes de 50 patients à l’aide de diazepam (0,32 mg/kg), de thiopentone (3,7 mg/kg) ou de propanidide (4,6 mg/kg). La propanidide a provoqué une hypotension plus grande que le diazepam ou le thiopentone. L’apnée a été plus fréquente après l’administration de thiopentone et les effets secondaires excitatoires ont été plus prononcés après la propanidide; le contrechoc électrique a aggravé le phénomène excitatoire. Le taux de réussite de la conversion a été plus élevé dans le groupe traité au diazepam que dans les autres groupes, mais la différence n’a pas été d’une importance statistique conséquente. Dans 33% des cas, le diazepam n’a produit aucune amnésie. Le thiopentone convient bien et est plaisant dans les cas de chocs électriques externes. Le diazepam est recommandé pour les patients présentant peu de risques et pour les cas d’urgence.

**ANESTESIA PARA LA CARDIOVERSION: UNA COMPARACION DEL DIAZEPAM, LA TIOPENTONA Y LA PROPANIDIDA**

**SUMARIO**

Se anestesió a tres grupos de 50 pacientes con diazepam (0,32 mg/kg), tiopentona (3,7 mg/kg) o propanidida (4,6 mg/kg) para una cardioversion electiva. La propanidida produjo más hipotensión que el diazepam y la tiopentona. La apnea fue más frecuente después del diazepam o la tiopentona y los efectos secundarios excitables fueron más prominentes después de la propanidida; el contrachoque eléctrico empeoró los fenómenos excitables. El porcentaje de logro de conversión fue más alto en el grupo del diazepam que en los otros grupos, pero la diferencia no fue significante estadísticamente. El diazepam falló en provocar la amnesia en alrededor del 33% de los pacientes. La tiopentona es adecuada y agradable para la cardioversion. Se recomienda el diazepam en pacientes de exiguo riesgo y en situaciones de emergencia.

**ANESTESIA PARA LA CARDIOVERSION: COMPARACIÓN DEL DIAZEPAM, LA TIOPENTONA Y LA PROPANIDIDA**

**ZUSAMMENFASSUNG**

Drei 50-Patientengruppen wurden zwecks Herzwendungsschirurgie mit Diazepam (0,32 mg/kg), Thiopentone (3,7 mg/kg) und Propanidid (4,6 mg/kg) narkotisiert. Es wurde festgestellt, dass Propanidid ein grösseres Ausmass von Hypotonic auslöste, als Diazepam, oder Thiopentone. Nach Anwendung von Thiopentone ergab sich Apnoe am häufigsten; Reizwirkungen als Komplikation waren auffällend nach Propanidid; elektrisch ausgelöster Gegen- schock verschlimmerte die Reizwirkungen. Die Ergebnisergebnisse bei der Herzwendungsschirurgie waren bei Patienten, denen Diazepam verabreicht worden war, besser als bei denen der anderen zwei Gruppen angehörigen. Jedoch war der Unterschied nicht von statistischer Bedeutung. Bei ungefähr 33% der Patienten verursachte Diazepam keinerlei Amnesie. Thiopentone erwies sich als erfolgreiches und angenehmes Mittel zum Gebrauch in der Herzwendungsschirurgie. Diazepam wird für Patienten mit schlechtem Risiko, sowie für Notfälle empfohlen.
Liberate Julia

- So simple to operate it's like having one more technician.
- Provides complete blood gas analysis in 1½–2 minutes.
- Sample size only 40 microlitres.
- Built-in gas mixer; supply gases being air and CO₂ only.
- Direct digital read-out of pO₂, pCO₂, pH and base excess. In addition built-in calculator gives digital read-out of buffer base, actual bicarbonate and total CO₂.
- sO₂ calculator and data printer available as optional extras.
- Simple adjustments for calibration.
- Vertical heparinised capillary fill system or syringe-luer fitting introduces blood directly into measuring chamber.
- Sample visible at all times.

Electrode and membrane replacement in a simple 1-minute operation.
Documented by clinical trials and usage throughout Europe.

AVL blood gas analyser – the Liberator from Sandoz.

Sandoz Products Ltd.,
Medical Equipment Division,
42 Somers Road, Rugby, Warwickshire. Phone Rugby (0788) 78121. Telex 31424.
2001
The Disposable circuit for less than £1

Cuffs at 15” intervals to allow circuit to be cut to convenient size.
Fits most popular ventilators.
British Standard fittings.
Fully swivelling Y piece.
Reduces infection risk.
High Quality. Low Cost.
Reduces work load.
Kink resistant.
Lightweight.

2001 Disposable Ventilator circuit complete with swivel Y connector and B.S. fitting.
2002 Disposable Ventilator circuit complete with swivel Y connector and B.S. fitting plus extra length for Humidifier.

medical equipment division
Sandoz Products Ltd. (Medical Equipment Division) 42, Somers Road, Rugby, Warwickshire. Telephone: (0788) 78121.
PROCEEDINGS OF THE ANAESTHETIC RESEARCH SOCIETY

LONDON MEETING

OCTOBER 31, 1975