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# Comparison of propofol and etomidate anaesthesia for elective electrical cardioversion

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## Abstract

**Background:** Propofol has been previously shown to be superior to etomidate during electrical cardioversion (EC) of atrial tachyarrhythmias. However, literature on this topic is scarce and the optimal anaesthetic technique for EC has not yet been firmly established.

**Aim:** To compare anaesthetic management with propofol against a mixture of etomidate and low-dose fentanyl for EC.

**Methods:** One hundred patients, aged 32 to 87, underwent elective EC for various atrial arrhythmias. All patients were haemodynamically stable before the procedure and were randomly allocated into one of two groups. Group I (n = 50) was given propofol (bolus 1 mg/kg, followed by increments containing 20% of the initial dose). Group II (n = 50) received 1 $\mu$g/kg of fentanyl i.v. (single dose) and etomidate (bolus 0.15 mg/kg, followed by increments containing 20% of the initial dose). Heart rate and non-invasive blood pressure values were taken before induction of anaesthesia (T1), before EC (T2), after EC (T3) and when awake (T4). The number of shocks, the total amount of energy, the number of patients in whom EC failed to restore sinus rhythm, and the time taken to achieve maximal Aldrette score, as well as side effects, were all noted.

**Results:** Heart rate values were similar in both groups. Blood pressure was significantly lower at T2, T3 and T4 in patients who received propofol. Anaesthesia time was similar; however, maximal Aldrette score was achieved quicker in group I than in group II (4.7 ± 2.2 *vs* 6.7 ± 4.9 min, $p < 0.01$). Overall, the efficacy of EC was similar in both groups: 41 (82%) patients from group I and 46 (92%) patients from group II regained sinus rhythm (NS). Significantly more side effects, such as pain at the time of injection, muscle tremor, nausea and vomiting, were noted in group II.

**Conclusions:** In terms of side effects, propofol is superior to etomidate with fentanyl for elective EC of atrial tachyarrhythmias.

**Key words:** cardioversion, anaesthesia, propofol, etomidate

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## INTRODUCTION

Electrical cardioversion (EC) of cardiac arrhythmias is a frequently performed, standard procedure, and may be considered as a day case if a patient is in good clinical condition. Cardioversion may be performed as an emergency procedure if the arrhythmia impairs haemodynamics and therefore is life-threatening, but it may also be done electively. The risk remains very low [1, 2], but the procedure is painful and requires short-term general anaesthesia, usually via intravenous agents [3, 4]. The most popular anaesthetic agents for this purpose are etomidate and propofol [5].

There is not enough literature on this topic and therefore the optimal anaesthetic technique for EC has yet to be firmly established. Some authors have compared the use of etomidate against propofol for this procedure [6–10]. There is one study where etomidate was combined with fentanyl, but no comparison with propofol was performed [11]. Anaesthetic techniques using a volatile agent, sevoflurane [12], and the

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most modern short-acting opioid, remifentanil [13], have also been described.

The choice of anaesthetic agent for EC is therefore still an important clinical issue. The aim of this study was to compare anaesthetic management with the use of propofol and etomidate with fentanyl for EC of atrial tachyarrhythmias.

## METHODS

### *Patients*

This prospective study was performed on 100 consecutive patients (32 to 87 years) scheduled for elective EC in three cardiology departments, all located in one cardiology centre, meaning that all patients were treated by the same anaesthesia team. Patients were randomised to group I (propofol) or group II (etomidate with fentanyl). Randomisation was performed when a new patient scheduled for EC was reported to the anaesthetic team.

Patients from group I (n = 50) received a bolus of propofol 1 mg/kg (Propofol, Fresenius), followed by increments (0.2 mg/kg each) to achieve general anaesthesia. Patients from group II (n = 50) received 1 $\mu$g/kg of fentanyl and then a bolus dose of etomidate 0.15 mg/kg (Hypnomidate, Janssen Pharmaceutica), followed by additional etomidate doses (0.03 mg/kg each). Inability to open the eyes when commanded and a lack of eyelid reflex were considered as indications of effective general anaesthesia. Patients were allowed to breathe with room air spontaneously during the procedure. Temporary respiratory support was provided if apnea > 30 s was observed or if oxygen saturation dropped below 90%.

Exclusion criteria were: age < 18 years; if patients were classified ASA V (moribund and not expected to survive more than 24 h with or without an operation); ejection fraction of the left ventricle < 30%; and when EC was done on an emergency basis. Patients were also not included in the study if they were haemodynamically unstable, had unstable angina or severe circulatory failure (NYHA IV), and also when they received intravenous medications (vasodilators, inotropic agents), were in cardiogenic shock or were mechanically ventilated when the procedure was planned.

The research protocol used during this study did not include additional procedures apart from standard anaesthetic technique and standard, non-invasive measurements and observations. All patients gave written informed consent for the administration of general anaesthesia for EC.

All patients were routinely treated. The last dose of a patient's usual oral medication was given in the morning of the day when the procedure was done. Premedication was not used. Basic vital signs (heart rate, non-invasive blood pressure (BP), oxygen saturation) were noted before the induction of anaesthesia (T1), before EC (T2), after EC (T3) and after awakening (T4). Anaesthesia and recovery times were recorded for each patient. An awakened state was diagnosed when the patient was able to open his or her eyes on being asked to do so. Anaesthesia duration was calculated from the moment the patient lost consciousness to the moment of awakening. Recovery time was measured from the moment of awakening to the moment a patient was fully conscious, able to move all limbs, breathe deeply and to maintain BP ± 20% compared to baseline values.

### *Electrical cardioversion*

A monophasic EC cardioverter (Medtronic Lifepak Physio-Control type 9P or 10) was used. Electrical current was used up to four times in a standard sequence: 100 J, 200 J, 360 J (classical location of the pads) and 360 J (antero-posterior location of the pads). For the purpose of this study, a scale to describe a degree of motor response to EC was invented and the strongest reaction for each patient was noted: 1° — no reaction, 2° — raising of the forearms, 3° — raising of the forearms and arms, 4° — raising of all limbs, without awakening, 5° — awakening as a response to cardioversion.

Side effects were defined as pain on injection of the study drug, nausea, vomiting, muscle tremor, or apnea with the need for respiratory support. Complications were defined as cardiac arrest, severe bradycardia, tracheal intubation, emergency medication or other serious adverse events with the need for any form of emergency medical management.

### *Statistical analysis*

Numerical data are presented as mean and standard deviation. The student t-test, Mann-Whitney test, or ANOVA with post-hoc Sheffe comparisons and Fischer exact tests were used, where appropriate. A p value < 0.05 was considered significant.

## RESULTS

Baseline demographic data and the form of cardiac arrhythmia leading to EC were similar in both study groups. No differences were noted in the haemodynamic status and oxygen saturation before anaesthesia induction (Table 1).

During and after anaesthesia, the mean values of heart rate were similar in both groups; however the mean values of BP were significantly lower in the propofol group. Oxygen saturation was lower during anaesthesia in patients receiving etomidate; however no differences were observed after a patient's awakening. Most haemodynamic parameters significantly decreased during anaesthesia (Table 2).

The anaesthesia duration was 10.7 ± 3.0 min for the propofol group and 10.1 ± 3.9 min for the etomidate group (NS). Awakening time (from opening eyes on verbal command to the moment a patient achieved an Aldrette score of 10) was significantly shorter in the propofol group compared to the etomidate group (4.7 ± 2.2 min *vs* 6.7 ± 4.0 min, p < < 0.01). Mean dose of propofol was 1.68 ± 0.63 mg/kg and of etomidate 0.21 ± 0.05 mg/kg. A mean of 3.5 additional

**Table 1.** Demographic data and the form of cardiac arrhythmia leading to cardioversion

| Parameter | Propofol group (n = 50) | Etomidate (+ fentanyl) group (n = 50) |
|---|---|---|
| Age [years] | 63.3 ± 10.9 | 60.1 ± 10.7 |
| Body weight [kg] | 84.5 ± 14.5 | 84.2 ± 17.1 |
| Height [cm] | 171.3 ± 9.1 | 171.8 ± 9.5 |
| Body mass index [kg/m$^2$] | 28.8 ± 4.1 | 28.4 ± 4.4 |
| Left ventricular ejection fraction [%] | 51.9 ± 8.2 | 52.0 ± 10.4 |
| Female sex | 13 (26%) | 15 (30%) |
| NYHA class I | 37 (74%) | 31 (62%) |
| NYHA class II | 11 (22%) | 12 (24%) |
| NYHA class III | 2 (4%) | 7 (14%) |
| Arterial hypertension | 34 (68%) | 35 (70%) |
| Coronary artery disease | 37 (74%) | 40 (80%) |
| Severity of coronary symptoms (Canadian Coronary Score): | | |
| 0 | 13 (26%) | 10 (20%) |
| 1 | 24 (48%) | 26 (52%) |
| 2 | 13 (26%) | 11 (22%) |
| 3 | 0 (0%) | 3 (6%) |
| Anaesthesia risk (ASA): | | |
| 2 | 15 (30%) | 19 (38%) |
| 3 | 34 (68%) | 29 (58%) |
| 4 | 1 (2%) | 2 (4%) |
| Atrial fibrillation | 46 (92%) | 45 (90%) |
| Arrhythmia lasting < 48 h | 7 (14%) | 4 (8%) |
| Previous use of amiodarone | 15 (30%) | 18 (36%) |
| Previous use of $\beta$-blocking agents | 37 (74%) | 32 (64%) |

All differences non significant.

**Table 2.** Haemodynamic data and oxygen saturation during anaesthesia

| Parameter | | Propofol group (n = 50) | Etomidate (+ fentanyl) group (n = 50) | P |
|---|---|---|---|---|
| Heart rate [bpm] | T1 | 94.0 ± 22.6 | 93.0 ± 22.9 | NS |
| | T2 | 93.9 ± 22.3 | 95.4 ± 24.9 | NS |
| | T3 | *67.5 ± 22.9 | *68.8 ± 18.0 | NS |
| | T4 | *68.1 ± 17.6 | *71.9 ± 14.0 | NS |
| Systolic blood pressure [mm Hg] | T1 | 129.5 ± 16.2 | 134.5 ± 17.4 | NS |
| | T2 | *116.5 ± 15.1 | *128.4 ± 17.8 | < 0.01 |
| | T3 | *118.3 ± 19.0 | *127.6 ± 24.7 | < 0.05 |
| | T4 | *115.4 ± 23.4 | 131.8 ± 23.5 | < 0.01 |
| Diastolic blood pressure [mm Hg] | T1 | 82.8 ± 8.2 | 83.7 ± 10.1 | NS |
| | T2 | *76.5 ± 10.1 | 81.6 ± 10.6 | < 0.05 |
| | T3 | *78.9 ± 13.5 | 81.4 ± 16.4 | NS |
| | T4 | *75.6 ± 10.1 | 82.5 ± 13.9 | < 0.01 |
| Oxygen saturation [%] | T1 | 97.3 ± 0.8 | 97.3 ± 0.9 | NS |
| | T2 | 97.0 ± 1.9 | *95.9 ± 2.8 | < 0.05 |
| | T3 | *94.1 ± 5.6 | *92.5 ± 5.6 | < 0.05 |
| | T4 | *96.7 ± 1.6 | *96.3 ± 1.8 | NS |

*test for repeated measurements, comparison within the group, values significantly different to baseline

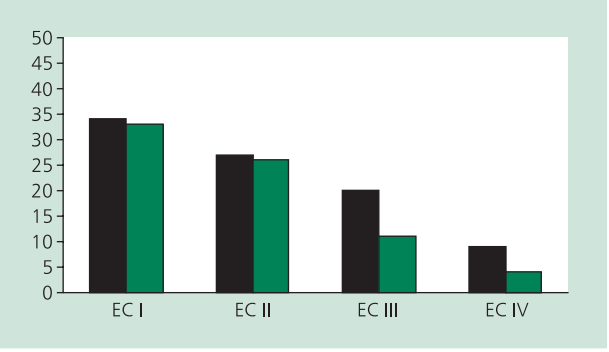


**Figure 1.** Patients remaining in atrial arrhythmia after consecutive cardioversions; EC — electrical cardioversion; black bars — propofol group; green bars — etomidate (+ fentanyl) group. Differences at each stage were NS

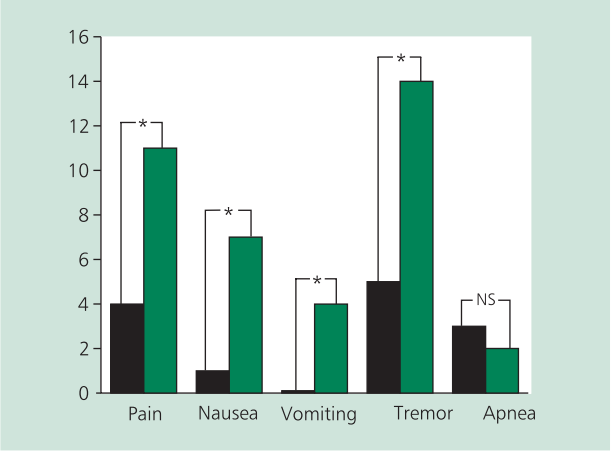


**Figure 2.** Comparison of side-effects in both study groups; black bars — propofol group; green bars — etomidate (+ fentanyl) group; *p < 0.05

injections of propofol and 1.7 additional injections of etomidate were needed.

We also studied the efficacy of all consecutive attempts of EC and the overall efficacy of EC. The mean number of ECs to restore sinus rhythm was 2.6 ± 1.3 impulses in the propofol group and 2.3 ± 1.1 impulses in the etomidate group (NS). Mean cumulative energy was 552 ± 392 J for the propofol group and 469 ± 345 J for the etomidate group (NS). Overall, EC was successful in 41 (82%) patients receiving propofol and in 46 (92%) patients receiving etomidate (NS) (Fig. 1). The degree of maximal motor response to consecutive EC was also similar in both groups (Table 3).

Special attention was paid to those patients who required four consecutive ECs, and thus the antero-posterior positioning of electrodes during the fourth attempt. The number and percentage of these patients was slightly higher in the propofol group (20 patients; 40%) compared to patients receiving etomidate (11 patients; 22%), but this difference did not reach statistical significance (p = 0.08). Patients requiring four ECs were not different when compared to the remaining patients except for significantly higher body mass index (BMI) (30.8 ± 4.2 *vs* 27.7 ± 4.0, p = 0.0008). In a subgroup analysis, the significant difference in BMI remained in patients anaesthetised with propofol (31.2 ± 3.7 *vs* 27.4 ± 3.7, p = = 0.001), but did not reach statistical significance in patients receiving etomidate (30.1 ± 5.0 *vs* 27.9 ± 4.2, p = 0.17).

Side-effects during and after anaesthesia were noted significantly more frequently in patients receiving etomidate. These included pain on injection, tremor during anaesthesia, as well as nausea and vomiting after awakening (Fig. 2). Asystolic cardiac arrest occurred in one patient in the etomidate group, but spontaneous circulation was restored immediately after a few seconds of cardiopulmonary resuscitation. No intubation or interventional drugs were necessary, the patient recovered from anaesthesia and the further course was uneventful. In another patient in the etomidate group, insertion of temporary endocavital electrical pacing was necessary due to severe sinus bradycardia after EC. In five patients, three from the propofol group and two from the etomidate group, apnea was noted and temporary respiratory support was needed during anaesthesia (NS) (Fig. 2). None of the patients was intubated or mechanically ventilated. In one patient in each study group, a low dose

**Table 3.** Maximal motor response to cardioversion

| Maximal motor response to consecutive electrical impulses | Propofol group (n = 50) | Etomidate (+ fentanyl) group (n = 50) |
|---|---|---|
| I degree | 16 (32%) | 10 (20%) |
| II degree | 22 (44%) | 32 (64%) |
| III degree | 8 (16%) | 6 (12%) |
| IV degree | 4 (8%) | 2 (4%) |
| V degree | 0 (0%) | 0 (0%) |

All differences non significant.

of midazolam (2.5 mg) was given to reduce severe involuntary muscle movements or muscle tremor.

## DISCUSSION

Anaesthesia for EC should provide haemodynamic stability and retrograde amnesia. In addition, the choice of anaesthetic agent should not negatively influence the efficacy of the procedure [4, 11]. The results of our study confirm that both anaesthetic agents fulfilled these criteria.

No standard anaesthetic technique has been indicated in the literature for EC. Both propofol and etomidate are commonly used and recommended to provide short general anaesthesia and the cost of both agents is very similar. In our study, etomidate was combined with a low dose of fentanyl, although most authors have used an opioid-free anaesthetic technique [5, 7, 8, 12, 14, 15, 16].

Our study showed that the use of both propofol and etomidate provided haemodynamic stability during anaesthesia for EC, and even if BP was found to be significantly lower in the propofol group, this difference was not clinically important. These results are consistent with the results of other authors who have also described the use of propofol and etomidate for EC [6, 8, 9, 17, 18]. In our study, both anaesthetic drugs on induction were used very carefully, their doses were rather low, and as a result we achieved a high level of haemodynamic stability. Gale et al. [17] indicated that titrating of drug dosages increases haemodynamic stability and decreases the total dose of the drugs given to a patient during anaesthesia.

Decrease of BP values in our study was almost negligible — it decreased by 9 mm Hg in the propofol group and by only 3 mm Hg in patients receiving etomidate. These results are similar to data presented by other investigators, who also titrated propofol for EC and observed a minimal decrease in BP values (only 2% on average) [18]. It has been found that the speed of injection of intravenous anaesthetics may influence haemodynamic response. Billotta et al. [19] injected 2.5 mg/kg propofol with the rate of 2 mg/s and 10 mg/s and found that a higher rate of injection was associated with a marked decrease of the arterial BP.

Differences in recovery times between etomidate and propofol have already been confirmed in the literature. Kick et al. [8] found that the recovery after propofol is faster than after etomidate, but no difference in psychomotoric tests were found 15 min post-operatively. In another study, recovery time after propofol was also faster, and in addition 20% of patients receiving etomidate had some recall of the moment when the electrical impulse was delivered [10].

Our study found no differences in the efficacy of EC. Biphasic cardioverters were not available in all cardiology departments when the study was conducted, therefore only monophasic cardioverters were used for the purpose of the study. In the literature one may find a few anecdotal reports suggesting that the use of general anaesthetic agent alone may stop cardiac arrhythmia even without EC [20, 21]. We did not confirm these findings.

A comparison of the side-effects of propofol and etomidate had already been made by Hullander et al. [7]. Both drugs were given by continuous infusion, so the rate of injection was much lower when compared to our study. Etomidate was administered without fentanyl. Involuntary muscle movements or tremor were observed in 45% of patients receiving etomidate and in none of those receiving propofol. This effect of etomidate is already well known from other studies [11, 15, 22, 23] and therefore in our study a low dose of fentanyl was administered before etomidate. This could in turn result in more patients with incidents of nausea and vomiting in the etomidate-fentanyl group. In a recent study published by Hüter et al. [15], a low dose of midazolam was given prior to etomidate during EC to reduce etomidate-induced myoclonus.

Using the etomidate-fentanyl technique, we observed muscle movements in only 28% of our patients, but still they were more frequent when compared to only 10% in the propofol group. Apnea was noted in 4% of all patients receiving etomidate and in 6% of patients receiving propofol. These results are better than those obtained by Hagemeijer et al. [11], where, after the injection of etomidate and fentanyl, apnea was observed in more than 10% of patients. A higher incidence of apnea has also been suggested for propofol [8].

Our study also attempted to measure the motor response to a strong and relatively standardised stimulus that is delivered during EC. No similar data has been presented in the literature, so a proposed simple scale to measure motor response may be recommended to further researchers in this area.

## CONCLUSIONS

Both propofol and etomidate with fentanyl are safe agents for EC. Recovery time is faster and side-effects are fewer after propofol. Anaesthetic management with propofol is superior to management with etomidate and fentanyl, and should therefore be preferred for EC.

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# Porównanie znieczulenia propofolem i etomidatem w planowej kardiowersji elektrycznej

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## Streszczenie

**Wstęp:** Arytmie nadkomorowe, zwłaszcza napadowe migotanie przedsionków, to zaburzenia rytmu serca często spotykane w codziennej praktyce lekarskiej. Ponieważ obecność arytmii istotnie zwiększa ryzyko wystąpienia powikłań, należy zawsze dążyć do jak najszybszego jej przerwania za pomocą kardiowersji elektrycznej (EC). Jednak zabieg ten jest bolesny i wymaga zastosowania krótkotrwałego znieczulenia ogólnego z powodu wystąpienia chwilowego, przemijającego bólu związanego z wyzwolonym impulsem elektrycznym. Propofol i etomidat to dwa najpopularniejsze środki znieczulenia ogólnego stosowane podczas EC. Udowodniono, że propofol ma pewną przewagę nad etomidatem w EC, jednak wciąż brakuje dostatecznej liczby danych dotyczących tego zagadnienia. Dotychczas nie ustalono, jaka jest optymalna technika znieczulenia w przypadku EC.

**Cel:** Celem pracy było porównanie postępowania anestezjologicznego z użyciem propofolu lub etomidatu połączonego z małą dawką fentatylu podczas kardiowersji elektrycznej.

**Metody:** Planową kardiowersję elektryczną z powodu arytmii przedsionkowych wykonano u 100 pacjentów w wieku 32–87 lat. Wszyscy chorzy byli hemodynamicznie stabilni przed zabiegiem. Pacjentów przydzielono losowo do dwóch grup. W grupie I (n = 50) stosowano propofol (Propofol firmy Fresenius) w dawce 1 mg/kg, a kolejne dawki miareczkowano po 0,2 mg/kg w zależności od reakcji chorego. W grupie II (n = 50) podawano najpierw fentanyl w dawce 1 $\mu$g/kg, a następnie po 30 s stosowano etomidat (Hypnomidate firmy Janssen Pharmaceutica) w dawce 0,15 mg/kg, natomiast kolejne dawki miareczkowano po 0,03 mg/kg w zależności od reakcji chorego. Brak otwierania oczu na polecenie słowne oraz brak odruchu rzęsowego stanowiły kryteria wprowadzenia do znieczulenia, a następnie utrzymywania pacjenta w stanie znieczulenia ogólnego. Rejestrację wartości wysycenia hemoglobiny krwi włośniczkowej tlenem, częstości akcji serca oraz ciśnienia skurczowego, rozkurczowego i średniego prowadzono w 4 punktach pomiarowych: przed wprowadzeniem do znieczulenia (T1), po wprowadzeniu do znieczulenia — przed EC (T2), po EC (T3), po wybudzeniu chorego (T4). W obu grupach rejestrowano liczbę wyładowań elektrycznych, łączną dawkę zastosowanej energii elektrycznej, liczbę chorych, u których EC nie przywróciła rytmu zatokowego po zastosowaniu kolejnych impulsów, a także czas wybudzenia się ze znieczulenia (skala Aldretta) oraz objawy uboczne. Wyniki poddano analizie statystycznej; przyjęto, że znamienność statystyczna występuje przy wartości $p < 0,05$.

**Wyniki:** Częstość akcji serca była zbliżona w obu grupach. W grupie I ciśnienie tętnicze było istotnie niższe w punktach T2, T3 i T4. Czas znieczulenia był podobny, jednak czas do uzyskania pełnego wybudzenia (maksymalna punktacja w skali Aldretta) był krótszy w grupie I (4,7 ± 2,2 v. 6,7 ± 4,9 min; $p < 0,01$). Skuteczność EC okazała się zbliżona — rytm zatokowy przywrócono u 41 (82%) chorych w grupie I i u 46 (92%) chorych w grupie II. W grupie II zanotowano znamiennie więcej działań niepożądanych, takich jak ból podczas wstrzykiwania leku, drżenia mięśniowe, nudności i wymioty.

**Wnioski:** Propofol ma istotną przewagę nad mieszaniną etomidatu z fentanylem podczas znieczulenia w przypadku planowej EC.

**Słowa kluczowe:** kardiowersja elektryczna, znieczulenie, propofol, etomidat

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