

Anterior–posterior *versus* anterior–lateral electrode position for biphasic cardioversion of atrial fibrillation

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Key words: atrial fibrillation; electrical cardioversion.

Summary. *Objective.* The aim of the study was to assess if the anterior–posterior electrode position for the conversion of atrial fibrillation using biphasic waveform shocks is more effective and needs less energy compared with the anterior–lateral position.

Background. In several studies, anterior–posterior electrode position has been demonstrated to be superior to anterior–lateral position for the termination of atrial fibrillation using monophasic waveform shocks, but data regarding biphasic shocks are still emerging.

Patients and methods. Our prospective, randomized study enrolled 103 consecutive patients with atrial fibrillation who were referred for elective cardioversion. The electrode position was randomly selected to be anterior–lateral ($n=55$) and anterior–posterior ($n=48$). A step-up protocol of 100, 150, 200, and 300 J biphasic truncated exponential waveform shocks was used.

Results. Two groups with different paddle position were compared. There was no difference in age, gender, body mass index, ejection fraction, or left atrial size between the groups. Sinus rhythm restoration failed only in one patient in each group. Energy of 100 J was sufficiently effective in most patients in both groups.

Conclusions. The anterior–posterior electrode position during transthoracic cardioversion using biphasic waveform shocks has no advantages compared with more comfortable and common anterior–lateral position.

Introduction

Atrial fibrillation (AF) is the most common cardiac arrhythmia. It causes considerable disability, impairs quality of life, and is difficult to treat. Electrical direct-current (DC) cardioversion has become a routine technique for the conversion of AF since its introduction in the 1960s (1). It is frequently a safe and effective procedure for the restoration of the sinus rhythm. In most series, DC cardioversion has an initial success rate of 80–90% (2). Successful cardioversion of AF depends on many factors: underlying heart disease, the duration of AF, the output waveform, the size and position of the electrode paddles, and others (3). Biphasic waveform shocks are more effective and require lower energy levels than monophasic waveform (4–6). Lower energy levels required for cardioversion result in lesser postcardioversion skin injury and pain (7). Several studies have suggested that the success rate is higher with the anterior–posterior electrode position for the termination of AF using monophasic waveform shocks (8, 9), but data regarding biphasic shocks are still emerging. The aim of our study was to compare anterior–posterior and anterior–lateral

electrode positions for the termination of AF using biphasic waveform shocks.

Patients and methods

This study enrolled 103 consecutive patients who underwent elective cardioversion of atrial fibrillation at the Kaunas University of Medicine Hospital. Written informed consent was obtained from all patients. Patients enrolled were older than 18 years and were hemodynamically stable. If the duration of AF was more than 48 h, all patients underwent therapeutic anticoagulation (international normalized ratio ≥ 2 for at least 3 weeks before cardioversion). Patients had already been treated with antiarrhythmic drugs. Hypertensive patients had good control of blood pressure. The duration of AF was determined as the time from the first Electrocardiographic (ECG) documentation. All patients underwent echocardiography within 3 months.

ECG data were obtained from a 12-lead ECG before the procedure. All cardioversion procedures were performed under ECG monitoring and with full equipment for cardiopulmonary resuscitation.

The electrode position was randomly selected to

be anterior–lateral or anterior–posterior. For the anterior–lateral position, the paddles were placed at the right sternal edge and on the midaxillary line at the fourth to the sixth intercostal spaces. For the anterior–posterior position, the paddles were placed to the left of the sternum with its upper edge at the level of the fourth intercostal space and at the inferior angle of the left scapula. Fifty-five patients were randomly attributed to the group where anterior–lateral electrode paddle position was used, and 48 patients – to the group where anterior–posterior electrode paddle position was used.

Cardioversion was performed by delivering R-wave synchronized biphasic truncated exponential waveform shocks using a step-up protocol of 100, 150, 200, and 300 J. If these four shock sessions were ineffective, we changed the electrode position and used the maximum energy output (300 J). Successful car-

dioversion was defined as the presence of at least one clearly visible P wave within 30 seconds after the administration of the shock.

All patients were sedated with thiopental or propofol.

Statistical analysis. Data were expressed as mean±SD. The clinical characteristics of the two patients' groups were compared using Pearson's chi-square (χ^2) test for categorical variables. The independent sample t-test was used to compare continuous variables. All reported P values are two-sided. Standard levels of statistical significance ($P<0.05$) were used. Data were analyzed using the SPSS software package, version 12.0.

Results

Patients' characteristics and demographic data were similar between both groups (Table 1). There was no difference in age, gender, body mass index,

Table 1. Patients' characteristics and clinical demographic data

| Characteristic | Anterior–lateral position (n=55) | Anterior–posterior position (n=48) | P value |
|--------------------------------------|----------------------------------|------------------------------------|---------|
| Age (y) | 63.84±11.67 | 62.31±10.37 | 0.488 |
| Gender | | | 0.597 |
| female | 19 (34.5%) | 19 (39.6%) | |
| male | 36 (65.5%) | 29 (60.4%) | |
| Body mass index (kg/m ²) | 29.55±4.78 | 29.91±5.16 | 0.721 |
| Systolic blood pressure (mmHg) | 147.85±20.14 | 145.83±17.93 | 0.594 |
| Heart rate (beats/min) | 89.11±21.17 | 83.27±17.04 | 0.131 |
| Heart disease | | | 0.432 |
| coronary artery disease | 26 (47.3%) | 16 (33.3%) | |
| hypertension | 20 (36.4%) | 19 (39.6%) | |
| valvular disease | 8 (14.5%) | 11 (22.9%) | |
| others | 1 (1.8%) | 2 (4.2%) | |
| Ejection fraction (%) | 48.6±9.45 | 48.8±6.08 | 0.912 |
| Left atrial size (mm) | | | |
| length | 65.45±6.32 | 66.96±6.29 | 0.230 |
| width | 45.87±5.35 | 45.81±5.08 | 0.954 |
| Antiarrhythmic drugs | | | 0.479 |
| amiodarone | 22 (40%) | 24 (50%) | |
| beta-blocker | 17 (30.9%) | 8 (16.7%) | |
| propafenone | 8 (14.5%) | 10 (20.8%) | |
| digoxin | 2 (3.6%) | 2 (4.2%) | |
| none | 6 (10.9%) | 4 (8.3%) | |
| Atrial fibrillation duration | | | 0.284 |
| 1–48 h | 22 (40%) | 12 (25%) | |
| 48 h – 1 month | 9 (16.4%) | 6 (12.5%) | |
| 1–6 months | 19 (34.5%) | 23 (47.9%) | |
| >6 months | 5 (9.1%) | 7 (14.6%) | |

Values expressed as mean±SD or number (%) of patients.

left ventricular ejection fraction, or left atrial size between the groups. The patients were predominantly hypertensive men. They had moderate atrial dilatation: 65.45×45.87 mm in the anterior–lateral group vs. 66.96×45.81 mm in the anterior–posterior group. Left ventricular ejection fraction was about 49% (48.6% in the anterior–lateral group vs. 48.8% in the anterior–posterior group, $p=0.912$). Less than half of the patients (40.8%) had a history of coronary artery disease. The use of cardiac medications was similarly distributed. Nearly half of the patients (44.7%) were treated with class III antiarrhythmic drugs (amiodarone). In 33% of patients, the duration of AF was less than 48 h.

Sinus rhythm restoration failed only in one patient in each group. There were no significant differences in the overall efficacy of the cardioversion or in atrial defibrillation threshold when the anterior–lateral and the anterior–posterior electrode positions were compared. The overall success rate of cardioversion was 98.18%, with a mean of 1.35 ± 0.7 shock sessions, and effective energy being 159.45 ± 146.65 J for the an-

terior–lateral electrode position compared to the success rate of 97.92%, with 1.58 ± 0.85 shock sessions and effective energy being 202.08 ± 164.04 J for the anterior–posterior position ($P>0.05$) (Table 2). The cumulative success rates were 72.7% at 100 J, 94.6% at 250 J, and 96.4% at 450 J using the anterior–lateral electrode position compared to success rates of 60.4%, 85.4%, and 95.8% at the respective energy levels using the anterior–posterior position. The cumulative cardioversion success rates at each shock energy level are presented in Fig.

Discussion

Initially, in 1960 B. Lown *et al.* used an anterior–lateral position of electrodes to apply a cardioversion shock (1). Recent pathophysiological studies have shown that atrial fibrillation is maintained by functional re-entry circuits anchored in the left atrium. By depolarizing all excitable tissue of the circuit and making the tissue refractory, the circuit is no longer able to propagate or sustain re-entry. As the left atrium is

Table 2. Success for progressive energy of shocks

| Delivered energy | Shock success | |
|---------------------------------|----------------------------------|------------------------------------|
| | anterior–lateral position (n=55) | anterior–posterior position (n=48) |
| Overall success rates | 54/55 (98.18%) | 47/48 (97.92%) |
| 1 shock (100 J) | 40/55 (72.7%) | 29/48 (60.4%) |
| 2 shocks (100, 150 J) | 12/15 (80%) | 12/19 (63.2%) |
| 3 shocks (100, 150, 200 J) | 1/3 (33.3%) | 5/7 (71.4%) |
| 4 shocks (100, 150, 200, 300 J) | 1/2 (50%) | 1/2 (50%) |

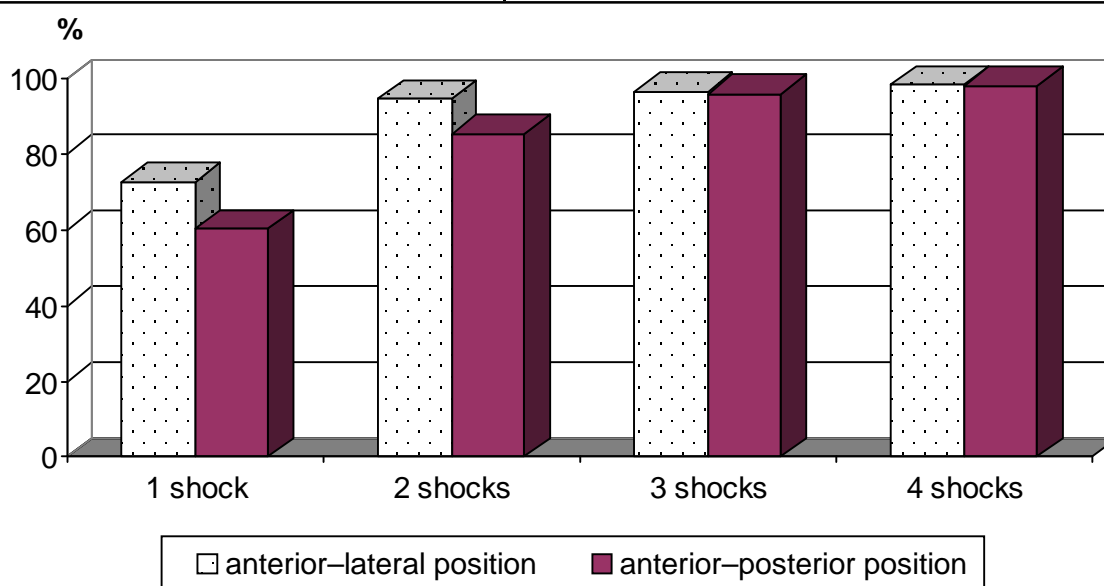


Fig. Cumulative success rates in the conversion of atrial fibrillation according to the number of shocks

located posteriorly in the thorax, an anterior–posterior electrode position may be more efficient for the external cardioversion of atrial fibrillation. Studies have demonstrated lower transthoracic impedance with the anterior–posterior position, theoretically increasing the success rate of cardioversion (10), but at present, available clinical data on the optimal electrode position for cardioversion are controversial. The differences in outcomes reported by various studies may be explained by divergent patients' demographic data, cardioversion energy levels, gel pads (adhesive or not), or standard manual paddles. Several studies have confirmed that an anterior–posterior electrode position is superior to an anterior–lateral electrode position. In a randomized controlled study of 301 patients, the energy requirement was lower, and overall success was greater with the anterior–posterior position (87%) compared to the anterior–lateral position (76%) (9). In another study of 108 patients, the success rate was 96% in the anterior–posterior group vs. 78% in the anterior–lateral group (8). N. J. Alp *et al.* conclude that the anterior–lateral paddle position appears to be more effective for DC cardioversion of persistent atrial fibrillation (2). They used a 360-J shock, and thus it is impossible to compare the results of their study with ours as we used a step-up protocol. However, two recent studies found no difference in the success rate comparing two paddle positions (11, 12). Our study found no difference either, but we used standard defibrillator paddles (in others studies, self-adhesive electrodes were used), and this may have made anterior–posterior cardioversion technically more difficult and may have contributed to the lower success rates in this position. We used biphasic waveform shock that was also different from those used in others studies. P. Ricard *et al.* (5) and S. Mittal *et al.* (6) have published reports of improved cardioversion of atrial fibrillation with biphasic waveform shocks, but

they did not compare paddle positions and used only the anterior–lateral electrode paddle position. We could not find any data about the influence of electrode paddle position on the success rate when using biphasic shock. Biphasic shock is supposed to have higher cardioversion success rates with lower energy requirements. The selection of the energy level for the initial shock for the treatment of AF remains a matter of debate. Many guidelines have proposed an initial monophasic waveform shock of 200 J for the cardioversion of persistent AF. We used the initial shock of 100 J, and it was sufficiently effective in most patients in both groups. In some studies, according to logistic regression analysis, the significant independent predictor of success at low-energy shock was a shorter duration of AF (4, 13, 14). In our study, the duration of AF was less than 48 h in 33% of patients, and we did not investigate the influence of the duration of AF on the success of cardioversion. DC cardioversion had a success rate of 80–90% (2). The overall rate of successful cardioversion in our study was high (around 98% in both groups) because of our limited definition of success. Successful cardioversion was defined as the presence of at least one clearly visible P wave. We chose this definition because it is important to distinguish between failure to restore sinus rhythm and failure to maintain that rhythm for a long period.

The results of our study suggest that the anterior–lateral electrode paddle position can be used for cardioversion with biphasic shocks, since this position is more comfortable.

Conclusion

Our study demonstrated that the anterior–posterior electrode position during transthoracic cardioversion using biphasic waveform shock had no advantages compared to the anterior–lateral position. Cumulative success rate was similar in both groups ($p=0.167$).

Priekinės–nugarinės ir priekinės–šoninės elektrodų pozicijos palyginimas atliekant elektrinę kardioversiją prieširdžių virpėjimui nutraukti

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Raktažodžiai: prieširdžių virpėjimas, elektrinė kardioversija.

Santrauka. Darbo tikslas. Nustatyti, ar priekinė–nugarinė elektrodų pozicija efektyvesnė nei priekinė–šoninė ir ar pakanka mažesnės energijos atliekant elektrinę bifazinę kardioversiją prieširdžių virpėjimui nutraukti.

Kelių studijų duomenimis, taikant priekinę–nugarinę elektrodų poziciją, monofazinė kardioversija buvo dažniau sėkminga, tačiau neradome duomenų apie elektrodų pozicijos įtaką bifazinės kardioversijos efektyvumui.

Darbo metodai. Į prospektyvųjį randomizuotą tyrimą įtraukti 103 pacientai, kuriems prieširdžių virpėjimą nuspręsta nutraukti elektrinės kardioversijos būdu. 55 pacientams taikyta priekinė–šoninė elektrodų pozicija, 48 pacientams – priekinė–nugarinė. Pradinis elektros impulsas buvo 100 J. Jei prieširdžių virpėjimas nenutraukiamas, pagal tyrimo protokolą toliau naudoti 150, 200 ir 300 J bifaziniai nupjautiniai eksponentiniai elektros impulsai.

Rezultatai. Lyginamos dvi grupės pacientų, kuriems taikytos skirtingos elektrodų pozicijos. Šių grupių pacientai nesiskyrė pagal amžių, lytį, kūno masės indeksą, širdies išstūmimo frakciją, kairiojo prieširdžio dydį. Sinusinis ritmas neatkurtas dviem pacientams, po vieną iš grupės. 100 J elektros impulsas buvo pakankamai efektyvus abiejų grupių pacientams.

Išvada. Priekinė–nugarinė elektrodų pozicija neefektyvesnė už labiau įprastą ir patogesnę priekinę–šoninę atliekant bifazinę kardioversiją prieširdžių virpėjimo metu.

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