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External Cardioversion-Defibrillation with Pushing Down on the Chest Wall to Increase the Success Rate in Obese Patients

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Data Interpretation D
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Case series
Patients: Female, 17-year-old • Male, 63-year-old • Male, 65-year-old
Final Diagnosis: Atrial fibrillation
Symptoms: Palpitations
Medication: —
Clinical Procedure: Cardioversion
Specialty: Cardiology • Pediatrics and Neonatology

Objective: Unusual clinical course

Background: The energy delivered by a defibrillator is expressed in joules (J). However, current is what actually defibrillates the heart and is related to the voltage-to-impedance ratio. With the same energy, the lower the transthoracic impedance, the higher the current delivered. In obese patients, pushing the chest wall toward the heart during electric shock can result in an improved outcome.

Case Reports: We report the cases of 3 obese patients with previously failed cardioversion/defibrillation who had an eventual shock success. (1) A 17-year-old girl failed multiple defibrillation efforts for her recurrent ventricular fibrillation. After ECMO, with the physician pushing down the chest wall, a 200-J defibrillation converted her VF. (2) A 63-year-old man with recurrent atrial fibrillation (AF) had an unsuccessful 150-J shock followed by a successful 200-J cardioversion. His AF recurred. After amiodarone bolus, a 200-J shock converted it to sinus. Another recurrent AF failed 150-J cardioversion. With chest pushing down, a 150-J cardioversion was successful. (3) A 65-year-old man underwent elective cardioversion for AF. A 200-J shock was unsuccessful. A 200-J shock with pressure on the chest successfully converted it.

Conclusions: We performed successful electrical cardioversion/defibrillation with this "pushing down the chest while shocking" method. Many clinicians are still unaware of this method, especially in obese patients. With the increasing prevalence of obesity, it is urgent to perform a randomized study to confirm the efficacy and safety of this method, and integrate it into advanced cardiac life support protocols.

MeSH Keywords: Atrial Fibrillation • Electric Countershock • Ventricular Fibrillation

Full-text PDF: https://www.amjcaserep.com/abstract/index/idArt/927009

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Background

The amount of energy delivered by a defibrillator is expressed in joules. However, current is what actually defibrillates the heart and is related to the voltage-to-impedance ratio. Thus, with the same energy delivered, the lower the transthoracic impedance, the higher the current delivered to the heart. In obese patients or in patients with barrel chest, previous studies showed pushing the chest wall toward the heart during electric shock could result in an improved outcome [1]. We present the cases of 3 obese patients (1 adolescent and 2 adults) with previous failed cardioversion/defibrillation who had an eventual shock success by the method of "pushing down the chest wall hard with both hands" during the procedure.

Case Reports

Case No. 1

A 17-year-old female patient with noncompaction cardiomyopathy and obesity (weight 100 kg, height 161 cm, and body mass index (BMI) 38.5 kg/m^2) developed an episode of cardiac arrest during sleep. Emergency Medical Service arrived 10 minutes later and found her in ventricular fibrillation (VF), which was successfully defibrillated at 200 J. She was intubated and taken to the hospital Intensive Care Unit.

After admission, she developed VF again. Using a Philips® defibrillator with placement of the adhesive electrical patches in the anterolateral position, biphasic defibrillation at the maximal dose of 200 J failed to convert the VF. Cardiopulmonary resuscitation (CPR) was started with intravenous amiodarone and epinephrine and she was placed on extracorporeal membrane oxygenation (ECMO). Five additional 200-J shocks all failed to convert the VF. At that time, the laboratory tests showed pH 7.32, PCO2 29 mmHg, PO2 168 mmHg, base excess –11, lactate 4.02 mmol/L, potassium 3.3 mmol/L, and ionized calcium 1.10 mmol/L.

Her VF persisted with ECMO running. With a linen blanket placed on the anterior chest wall as an insulator, and with the physician pushing down the chest wall hard with both hands, a 200-J defibrillation instantly converted the VF to sinus rhythm. However, due to the prolonged VF of >10 minutes, she suffered from brain damage, with only partial recovery on follow-up.

Case No. 2

A 63-year-old man with hypertension and hyperlipidemia presented to the Emergency Department with chest pain and was found to have a non-ST elevation myocardial infarction. His weight was 82 kg, height 165 cm, with a BMI of 30 kg/m^2 and a large transthoracic diameter. A cardiac catheterization showed 4-vessel coronary artery disease. He required an intra-arterial balloon pump during catheterization and received a coronary artery bypass graft afterward.

He developed atrial fibrillation (AF) 2 days later and had an unsuccessful synchronized biphasic 150-J biphasic wave DC cardioversion with electrode patches placed in the anteroposterior position. A repeat cardioversion at 200 J was successful. His AF recurred 3 hours later. After administration of an amiodarone bolus (5 mg/kg), a 200-J cardioversion converted it to sinus. However, his AF recurred 6 hours later, and a 200 J cardioversion after a repeat bolus of amiodarone returned it to sinus. The next morning, another AF recurred and a 150-J cardioversion failed. At this time, using the method of pushing the chest wall down with both hands and a linen blanket placed on the anterior chest wall, a 150-J cardioversion successfully converted the AF. He was started on metoprolol 25 mg bid, amiodarone 200 mg daily, and warfarin 1 mg daily 4 times a week and 2 mg daily on alternating days 3 times a week.

Case No. 3

A 65-year-old man with a BMI of 42 underwent elective cardioversion for atrial fibrillation. Pads were placed anterior-posterior. A 200-J shock was unsuccessful. A repeat 200-J shock with the same pad position with pressure on the chest using a dry towel as an insulator successfully converted to sinus rhythm.

Discussion

The amount of energy delivered by a defibrillator is expressed in watt-seconds or joules. This energy (in joules) is a function of voltage (in volts), current (in amperes), and time (in seconds). Of these parameters, current is what actually defibrillates the heart and is related to the voltage-to-impedance ratio. The lower the impedance (i.e., resistance to electrical flow) the higher the current delivered to the heart ($\text{Current}=\{\text{Energy}/(\text{Resistance}\times\text{time})\}^{1/2}$). Resistance can rise due to poor pads-to-skin contact, diaphoresis, and increased chest size or body mass [2]. In obese patients and in patients with large anteroposterior thoracic diameter, higher transthoracic impedance occurs because the heart is insulated from the delivered energy by fatty tissue and by increased interelectrode distance. Therefore, pushing the anterior chest wall toward the heart can reduce the thoracic impedance. Thus, with the same energy delivered, the amount of current delivered to the myocardium can be increased, increasing the chance of defibrillation success.

Our Case No. 1 had refractory VF and severe obesity. Her BMI of 38.5 may have played a role in the repeated shock failures despite using maximally available defibrillation energy. After recognizing the factor of obesity, success defibrillation was achieved

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by pushing her chest wall down during the shock. Our Case No. 2 also was obese, with a large transthoracic diameter. He had 2 failed lower-energy (150 J) shocks and 3 successful higher-energy (200 J) shocks for his AF. Using the method of pushing the chest wall down and the operator insulated by a linen blanket, the recurrent AF was successfully converted by the same-dose DC cardioversion. In Case No. 3, the variables were the same, and successful cardioversion occurred with pushing down on the chest.

For unsuccessful cardioversion/defibrillation, repeated attempts may be made following administration of an antiarrhythmic medication [3], with increased paddle size [2], changing the shock vector [4], or applying pressure over the electrodes [5]. In patients with increased transthoracic diameter, fluoroscopic-guided placement of electrode patches may be useful for AF cardioversion [6,7]. Double-sequential defibrillation delivering nearly simultaneous defibrillation shocks may also work, possibly due to optimization of the electrical vector direction, increased myocardial surface area affected, and increased power delivered [8,9]. However, a high-intensity shock can cause myocardial injury [10]. This method also requires a second defibrillator, which may take precious time to arrange. Internal cardioversion via an implantable cardioverter-defibrillator can also be tried in selected patients [11].

Obese patients were known to have higher cardioversion failure rates [12]. By using manual pressure augmentation technique (with either 1 or 2 operators wearing latex gloves providing manual pressure augmentation on each patch placed at either anterolateral or anteroposterior position, then charging and delivering energy by another rescuer during the expiratory phase of respiration), cardioversion was successful in 80% of AF patients who failed both adhesive patch and hand-held paddle methods [1]. This manual pressure augmentation method can be safely applied with up to 360-J biphasic shock. Similar to the manual pressure augmentation technique using latex gloves, we used a blanket or dry towel placed over the chest serving as an insulator during electrical conversion to ensure the safety of the procedure. We usually designate the biggest person in the rescue team to push down the chest wall, utilizing body weight and both hands during the shock delivery.

In our Case No. 1, since the successful defibrillation shock was done after ECMO and amiodarone IV push, we cannot rule out that ECMO and amiodarone might have contributed to the defibrillation success. Had this method of "pushing down the chest while shocking" been done in the first place, her VF might have been converted by the first 200-J shock, without needing ECMO and avoiding the brain injury sequelae. In our Case No. 2, administration of amiodarone might also have contributed to the cardioversion success.

Conclusions

We have been performing electrical cardioversion/defibrillation with this "pushing down the chest while shocking" method in our electrophysiological laboratory with biphasic wave energy shock up to 200 J in the last decade without encountering any safety issue. Although this method is not novel, we encounter many clinicians or rescuers who are still unaware of this method, especially in obese patients, to increase shock success. With the consistently rising obesity prevalence, and the prediction that nearly 50% of adults, 33% of children aged 6–11, and 50% aged 12–19 will be obese/overweight by 2030 [13], a randomized study is urgently needed do to confirm the efficacy and safety of this method, and possibly integrate it into advanced cardiac life support protocols.

References:

1. Voskoboinik A, Moskovitch J, Plunkett G et al: Cardioversion of atrial fibrillation in obese patients: Results from the Cardioversion-BMI randomized controlled trial. J Cardiovasc Electrophysiol, 2019; 30: 155–61
2. Kerber RE, Grayzel J, Hoyt R et al: Transthoracic resistance in human defibrillation. Influence of body weight, chest size, serial shocks, paddle size and paddle contact pressure. Circulation, 1981; 63: 676–82
3. Oral H, Souza JJ, Michaud GF et al: Facilitating transthoracic cardioversion of atrial fibrillation with ibutilide pretreatment. N Engl J Med, 1999; 340: 1849–54
4. Kirkland S, Stiell I, AlShawabkeh T et al: The efficacy of pad placement for electrical cardioversion of atrial fibrillation/flutter: A systematic review. Acad Emerg Med, 2014; 21: 717–26
5. January CT, Wann LS, Alpert JS et al: AHA/ACC/HRS guideline for the management of patients with atrial fibrillation: A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines and the Heart Rhythm Society. J Am Coll Cardiol, 2014; 64: e1–76
6. Mehdirad AA, Clem KL, Love CJ et al: Improved clinical efficacy of external cardioversion by fluoroscopic electrode positioning and comparison to internal cardioversion in patients with atrial fibrillation. Pacing Clin Electrophysiol, 1999; 22: 233–37
7. Khalighi K, Talebian A, Toor RS, Mirabbasi SA: Successful external cardioversion via fluoroscopic electrode positioning in patients with enlarged transthoracic diameter. Am J Case Rep, 2018; 19: 171–75
8. Chang MS, Inoue H, Kallock MJ, Zipes DP: Double and triple sequential shocks reduce ventricular defibrillation threshold in dogs with and without myocardial infarction. J Am Coll Cardiol, 1986; 8: 1393–405
9. Ross EM, Redman TT, Harper SA et al: Dual defibrillation in out-of-hospital cardiac arrest: A retrospective cohort analysis. Resuscitation, 2016; 106: 14–17
10. Walcott GP, Killingsworth CR, Ideker RE: Do clinically relevant transthoracic defibrillation energies cause myocardial damage and dysfunction? Resuscitation, 2003; 59: 59–70
11. Lüker J, Kuhr K, Sultan A et al: Internal versus external electrical cardioversion of atrial arrhythmia in patients with implantable cardioverter-defibrillator: A randomized clinical trial. Circulation, 2019; 140: 1061–69
12. Lévy S, Lauribe P, Dolla E et al: A randomised comparison of external and internal cardioversion of chronic atrial fibrillation. Circulation, 1992; 86: 1415–20
13. Wang Y, Beydoun MA, Min J et al: Has the prevalence of overweight, obesity and central obesity levelled off in the United States? Trends, patterns, disparities, and future projections for the obesity epidemic. Int J Epidemiol, 2020; 49(3): 810–23