Application of ultrasound in pulseless electrical activity (PEA) cardiac arrest

Helaleh Rabiei¹, Vafa Rahimi-Movaghar*²

Received: 9 September 2015 Accepted: 24 February 2016 Published: 18 May 2016

While substantial efforts on an understanding of ventricular fibrillation (VF) pathophysiology have reduced deaths from ventricular fibrillation and ventricular tachycardia (1), pulseless electrical activity (PEA) during years have been associated with poor outcome. The focus of treatment in ventricular fibrillation is delivering shock; treatment of underlying etiology comes in the next stage, whereas in PEA, primary and timely diagnosis of the underlying cause is acknowledged. Meanwhile, CPR is ongoing. Therefore, studies and trials focusing on performing echocardiography alongside ACLS to access this goal were conducted to assay the utility of echocardiography in cardiac arrest. Echocardiography could help the definite diagnosis of an underlying cause in some PEA cases and lead to appropriate intervention but it failed as a targeted intervention in a subset of patients and no study showed improvement in the outcome of these patients (2-5).

As an important result, these studies revealed that in a noticeable proportion of patients with the diagnosis of PEA or asystole, the echocardiography demonstrates cardiac motion (pseudo-PEA) and these patients have higher survival rates (4,6-8). Pseudo-PEA patients have a higher potential of ROSC compared to true PEA while therapeutic strategies in both cases are similar. Some studies focused on the terminating prolonged resuscitation in true PEA subjects. Another approach is application of additional therapeutic strategies for pseudo-PEA patients when echocardiography does not determine specific causes of arrest and does not guide us to more effective key procedures.

PEA underlying causes are separated into primary and secondary forms. The secondary form includes the causes that result from an abrupt cessation of cardiac venous return, such as massive pulmonary embolism, acute malfunction of prosthetic valves, exsanguinations, and cardiac tamponade. Echocardiography during CPR is beneficial to detect secondary causes that include easily treatable, reversible pathologies associated with PEA (9). In primary PEA, none of those obvious mechanical factors is present, and ventricular muscle fails to produce an effective contraction despite continued electrical activity. The proximate mechanism for failure of electromechanical coupling is abnormal intracellular calcium metabolism, intracellular acidosis and adenosine triphosphate depletion that can occur because of acute myocardial ischemia, which is the major cause of cardiac arrest, toxins, and electrolyte imbalance. 70% of all cardiac arrests are caused by acute myocardial ischemia or massive pulmonary embolism (10). Diag-

¹. MD, Researcher, Sina Trauma and Surgery Research Center, Tehran University of Medical Sciences, Tehran, Iran. helale.rabiee@gmail.com
². (Corresponding author) MD, Professor of Neurosurgery, Research Vice Chancellor of Sina Trauma and Surgery Research Center, Department of Neurosurgery, Shariati Hospital, Tehran University of Medical Sciences, Tehran, Iran, & AOSpine research officer of Middle East, & Director of national spinal cord injury in Iran . v_rahimi@sina.tums.ac.ir, v_rahimi@yahoo.com
Pulseless electrical activity (PEA) arrest and ultrasound findings of ineffective cardiac arrest rather than coronary occlusion, calcium probably has a benefit, especially in PEA patients with ventricular contractions.

"Occult" ventricular fibrillation and difficulties with distinguishing between fine ventricular fibrillation and asystole may lead to delays of possibly lifesaving shocks (17). Pulseless electrical activity, occult VF and asystole are similar on EKG but require different treatments. The application of echo during CPR has been used as a diagnostic aid in this issue, too. Case reports indicated the benefit of ultrasound to detect occult VF that appeared asystole on EKG and allowed proper treatment with defibrillation (18,19). Now the questions are: Are there specific diagnostic ultrasound features to differentiate pseudo PEA vs. occult VF while both of them do not generate cardiac output? How could we be sure that patients diagnosed with pseudo-PEA are not occult VF? Do pseudo-PEA patients benefit from performing shock? In further researches, it is important to draw a sharp distinction between ultrasound findings of ineffective cardiac motion in PEA vs. cardiac fibrillation in occult VF. The American Heart Association's Guidelines do not recommend shocking in asystole or PEA but applying electrical defibrillation in PEA arrest patients in the compensatory stage, when an ultrasound shows cardiac motion, might be a point for further research.

References
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