EPICARDIAL POTENTIALS DERIVED FROM THE BODY SURFACE POTENTIAL MAP USING INVERSE ELECTROCARDIOGRAPHY IMPROVE DIAGNOSIS OF ACUTE MYOCARDIAL INFARCTION: A PROSPECTIVE STUDY

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Background Epicardial potentials (EP) derived from body surface potentials using a thoracic volume conductor model (TVCM) improve acute myocardial infarction (AMI) diagnosis. In this study, we compared EP derived from the 80-lead body surface potential map (BSPM) using a TVCM developed from CT imaging with other electrocardiographic techniques in AMI diagnosis.

Methods In this prospective study, consecutive patients presenting to both the ED and pre-hospital coronary care unit between August 2009 and August 2011 with acute ischaemic-type chest pain at rest were enrolled. At first medical contact a 12-lead electrocardiogram (ECG) and BSPM were recorded. Cardiac troponin-T (cTnT) was sampled 12 h after symptom onset. AMI was diagnosed when cTnT $\geq 0.1 \mu\text{g/l}$. Patients were excluded from analysis if they had bundle branch block, permanent pacemaker, left ventricular hypertrophy by voltage criteria or concomitant digitalis therapy. A cardiologist assessed the 12-lead ECG for STEMI by Minnesota criteria and the BSPM. BSPM ST-elevation (STE) was $\geq 0.2 \text{ mV}$ in anterior, $\geq 0.1 \text{ mV}$ in lateral, inferior, right ventricular (RV) or high right anterior and $\geq 0.05 \text{ mV}$ in posterior territories indicating AMI. To derive EP, the 80-lead BSPM data were interpolated (Laplacian method) to yield values at 352-nodes of a Dalhousie torso. Using an inverse solution based on the boundary element method employing Tikhonov regularisation, EP at 98 cardiac nodes positioned within a standard TVCM were estimated. EP $\geq 0.3 \text{ mV}$ defined STE. A cardiologist blinded to both the 12-lead ECG and BSPM interpreted the EP map.

Results Enrolled were 400 patients (age 62 ± 13 years; 57% male): 80 patients had exclusion criteria. Of the remaining 320 patients, 180 (56%) had AMI. Of these 180 patients, 117 had STEMI by Minnesota criteria (sensitivity 65%, specificity 89%) and 146 had BSPM STE (sensitivity 81%, specificity 90%). EP STE occurred in 158 patients (sensitivity 88%, specificity 95%, $p < 0.001$). Of those with non-STEMI by Minnesota criteria on 12-lead ECG and AMI ($n=63$), 29 (46%) patients had STE detected by BSPM with a further 12 (19%) patients having STE detected only using EP derived from the BSPM using a TVCM. Overall, 41 (65%) patients with both a non-diagnostic 12-lead ECG at presentation and AMI had STE detected only by BSPM or derived EP. In 32/41 (78%) patients, STE was detected in the posterior or RV territories. All 41 patients had AMI diagnosed by EP.

Conclusions Among those with an initial non-diagnostic 12-lead ECG, EP derived from BSPM using a TVCM significantly improves AMI diagnosis.