Cardiac Ultrasound has the Potential to Detect Tension Pneumothorax as a Reversible Cause of Cardiac Arrest – An Experimental Porcine Study

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Introduction
Survival from cardiac arrest (CA) with a non-shockable rhythm is unlikely unless a reversible cause is identified and treated. Tension pneumothorax (tPTX) is a potentially reversible cause of CA, however the diagnosis can easily be missed. Cardiac ultrasound has the potential to detect reversible causes of CA. tPTX is believed to compress the heart and great vessels, causing the diameter of the right ventricle (RV) to decrease. In ventricular fibrillation and hypoxia induced CA blood accumulates on the right side of the heart causing RV distension, however the cardiac ultrasonographic characteristics of tPTX before and during CA are unknown.

Hypotheses
1) In the period up to CA tPTX will decrease RV diameter compared to hypoxia induced CA.
2) At the onset of CA and start of CPR the RV diameter will increase, abolishing group difference.

Methods
Pigs were randomized to CA induced by either unilateral tPTX (n=9) or hypoxia (n=9). tPTX was induced by injecting increments of air into the intrapleural cavity to a total volume of 50 ml/kg (90% of total lung capacity), while hypoxia was induced by gradually reducing the tidal volume over 30 min. tPTX was decompressed after 7 cycles of CPR. Subcostal 5chamber ultrasound images of the RV were obtained during induction of CA and CPR. The primary endpoints were RV diameter at the onset CA and after 3 cycles of CPR.

Results
At baseline the RV diameter was (mean (95%CI)): 24.2 (21.127.4) mm in the tPTX group and 24.2 (20.627.8) mm in the hypoxia group. Induction of CA, elicited a decrease in RV diameter in the tPTX group to 16.8 (13.020.6) mm and an increase in the hypoxia group to 36.2 (32.540.0) mm (p-value for comparison to baseline and between groups at CA; p<0.01). After three cycles of CPR RV diameter was significantly smaller in the tPTX group at 11.8 (7.316.2) mm when compared to the hypoxia group of 28.2 (24.531.9) mm (p<0.01). Immediately after decompression no difference existed between groups: tPTX 28.9 (23.434.3) mm vs. hypoxia 29.2 (20.138.2) mm (p = 0.94).

Conclusion
tPTX causes a significantly smaller diameter of the RV compared to hypoxia prior to CA. This difference persisted during CPR, enabling cardiac ultrasound to detect tPTX as a reversible cause of CA. There was no RV difference after tPTX decompression.