Head and thorax elevation cardiopulmonary resuscitation versus flat cardiopulmonary resuscitation with extracorporeal membrane oxygenation as salvage therapy in a severe porcine model of cardiac arrest

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Background

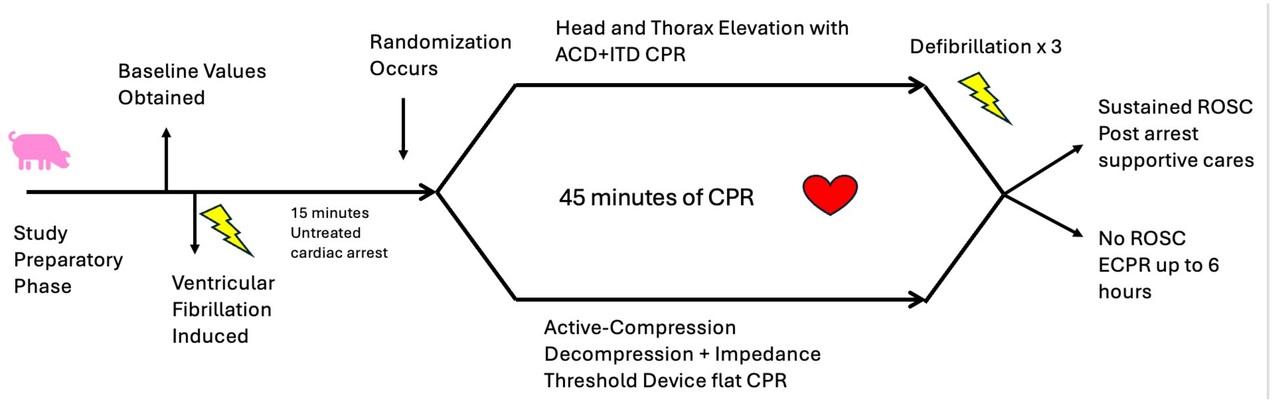
Elevation of the head and thorax (HUP), in combination with active compression decompression (ACD) cardiopulmonary resuscitation (CPR) and an impedance threshold device (ITD), is starting to be used clinically by first responders. Pre-clinical studies have shown decreased intracranial pressure, improved cerebral blood flow, and improved survival at 24 hours with HUP CPR.[1,2] Observational clinical studies suggest an association between survival to hospital discharge and rapid use of HUP CPR.[3,4] Extracorporeal membrane oxygenation in cardiac arrest (ECPR) for refractory cardiac arrest is also increasingly used and evolving with randomized trials showing mixed results.[5,6] The potential benefit of ACD+ITD HUP CPR in a prolonged period of CPR with ECPR as a salvage therapy is unclear.

Aim

Demonstrate superior incidence of survival with ACD+ITD HUP CPR versus ACD+ITD CPR flat in an animal model that includes salvage with ECPR.

Methods

- Female and male Yorkshire-hybrid swine (~40 kg) were sedated, intubated, and anesthetized.
- Bilateral percutaneous venous and arterial access were obtained.
- High fidelity micromanometer tipped catheters were placed under fluoroscopy to continuously measure arterial and venous pressures.
- Regional cerebral tissue oxygenation (rSO2) was continuously monitored.
- Ventricular fibrillation was induced and left untreated for 15 minutes.
- Animals were randomized to 1) HUP CPR or 2) flat CPR and ACD+ITD
- CPR was then performed for 45 minutes.
- At 44 minutes, epinephrine and amiodarone were given and defibrillation attempted up to 3 times.
- If return of spontaneous circulation (ROSC) was not obtained, ECPR was then performed for up to 6 hours.
- Neurological assessment was performed at 24 hours post arrest
- Fisher's exact test was used to compare outcomes between groups and an unpaired t-test for continuous data



Intervention	ECMO (n)	Sustained ROSC	24-Hour Survival	24-Hour CPC
Head and Thorax Elevation CPR (n = 10)	5	4	3	1
ACD+ITD flat CPR (n = 10)	4	5	0	0

Results

- 10 animals were randomized to HUP and 10 animals to the flat position
- At 44 minutes of ACD + ITD CPR, mean ± SD rSO2 (%) was 63 ± 7.7 for HUP and 54.7 ± 6.6 for flat (p = 0.04)
- ROSC without ECMO was in 4/10 (40%) for HUP and 5/10 (50%) for flat (p = 1.0).
- Salvage ECPR was performed at similar frequency in each group
- Most animals (9/10, 90%) had ECPR performed successfully.
- ROSC was not obtained and ECPR deemed futile in one HUP animal.
- At 24 hours, 3/10 (30.0%) of the HUP animals and 0/10 (0%) of the flat animals survived (p= 0.21).
- One HUP animal (10%) survived without any neurologic deficit.
- None of the animals that required ECPR survived to 24 hours.

Limitations

This was a severe animal model of cardiac arrest with few survivors. The control group in the flat position received ACD + ITD CPR, not conventional CPR, which is what most patients receive as care. It is likely survival would be even lower with conventional CPR based on previous studies. We were unable to continue ICU care and ECPR overnight.

Conclusions

In this severe model of cardiac arrest with a small number of animals, all the survivors received ACD+ITD HUP CPR. There was no additional survival benefit from ECPR.

References

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