Early Selective Trans-nasal Cooling during CPR Improves Success Of Resuscitation In A Porcine Model Of Pulseless Electrical Activity Cardiac Arrest

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INTRODUCTION

Patients in cardiac arrest presenting with pulseless electrical activity (PEA) or asystole typically have a dismal chance of survival. The outcomes of those patients are much worse than those of patients presenting with ventricular fibrillation (VF).

We have previously reported that early and selective trans-nasal cooling during CPR improves outcomes after prolonged VF. Early induced hypothermia during CPR improves not only cerebral outcomes but also defibrillation success and resuscitability from VF. However, the efficiency of early trans-nasal cooling during CPR in a PEA model of cardiac arrest has not been studied. In the present study, we investigated the effect of trans-nasal cooling during CPR on the outcomes in a porcine model of PEA.

HYPOTHESIS

Early trans-nasal cooling during CPR improves outcomes in cardiac arrest associated with PEA.

METHODS

VF was electrically induced in 16 domestic male pigs weighing 40±3 kg. After 14 minutes of untreated VF, PEA was induced following delivery of one or more electrical shocks. One minute after onset of PEA, CPR including chest compression and ventilation with oxygen was initiated. CPR was continued for 5 minutes prior to attempted defibrillation if needed.

If defibrillation was not successful, CPR was continued until return of spontaneous circulation (ROSC) or for a total of 15 minutes. In 8 animals, selective trans-nasal cooling was begun coincident with start of CPR and 8 randomized controls were identically treated except for trans-nasal cooling. Aortic pressure and right atrial pressure were concurrently measured together with nasal, body and right jugular vein temperatures. Coronary perfusion pressure (CPP) was computed from aortic diastolic and simultaneous right atrial pressures.

RESULTS

Six of eight animals were resuscitated after early trans-nasal cooling and only one in the untreated control (p=0.012). No baseline differences in body weight, heart rate, mean arterial pressure, pulmonary arterial pressure, right atrial pressure, ejection fraction (EF), cardiac output and $EtCO_2$ were observed (Table 1). Nasal, core and jugular baseline temperatures were 37.7±0.2ºC, 38.1±0.1ºC and 37.9±0.2ºC in the cooling group compared to 37.7±0.2ºC, 38.0±0.0ºC and 37.8±0.2ºC in the non-cooling group (p=0.921, p=0.224 and p=0.365). There were no differences in numbers of shocks delivered to convert VF to PEA between the groups (2.3±0.7 in the cooling group vs 2.4±0.7 in non-cooling group, p=0.736). All animals returned to VF in the first 3.4±1.5 minutes in cooling group compared to 2.6±2.2 minutes in non-cooling group (p=0.439). After 5 minutes of CPR, CPP was 25±5 mmHg in the cooling group compared to 15±4 mmHg in non-cooling group. Trans-nasal cooling was associated with greater CPP (p=0.001).

Table 1. Baseline characteristics

	Cooling (n=8)	Non-Cooling (n=8)	p-value
Body weight, kg	41±2	40±3	0.460
Heart rate, beat/min	132±25	143±36	0.499
Mean aortic pressure, mmHg	112±16	113±13	0.837
Mean right atrial pressure, mmHg	7±2	7±1	0.764
Mean pulmonary artery pressure, mmHg	22±4	24±6	0.566
Ejection Fraction, %	69.8.±3.3	66.6±2.8	0.056
Cardiac output, l/min	7±1	7±1	0.995
End-tidal CO_2	37±2	36±2	0.550
Baseline temperature, ºC			
Nasal	37.7±0.3	37.7±0.2	0.921
Blood	38.0±0.1	38.0±0.1	0.289
Jugular	37.9±0.2	37.8±0.2	0.365

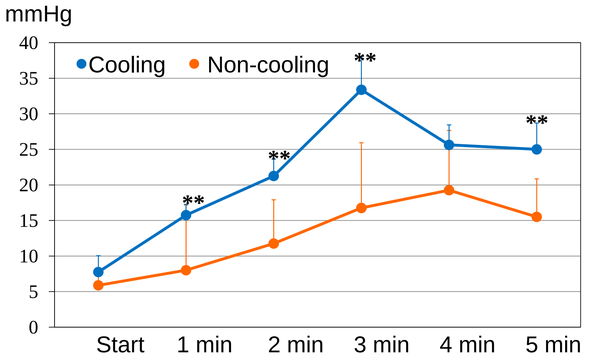

Figure 1. Figure showed CPP differences between two groups during CPR. *indicates statistically significant difference between groups. (*; *P*<0.05 **; P<0.01).

Table 2. Outcome variables

	Cooling (n=8)	Non-Cooling (n=8)	p-value
ROSC	6	1	0.012
No. of shock to induce PEA	2.3±0.7	2.4±0.70.	0.736
Time returned to VF	3.4±1.5	2.6±2.2	0.439
No. of shock to ROSC	5±5	5±3	0.901
Survival time. hour	9.3±10.7	0.1±0.1	0.028
Ejection fraction, %			
Baseline	69.8±3.3	66.6±2.8	0.056
PR 1 hour	59.7±7.3	-	-
PR 2 hours	60.6±7.9	-	-
PR 3 hours	60.0±11.4	-	-
PR 4 hours	59.6±10.4	-	-
PR 24 hours	65.2± -	-	-

The mean ROSC time was 5.2±0.4 minutes after CPR in the cooling group compared to 9 minutes in non-cooling group. The rhythm conversion rates from PEA to VF were 100% in both groups.

CONCLUSIONS

When selective trans-nasal cooling was initiated during CPR in settings of PEA, the likelihood of successful resuscitation was improved.