Rapid Intranasal Cooling Initiated Coincident with CPR Improves Success of Defibrillation and Post-Resuscitation Myocardial Function in a Porcine Model of Prolonged Cardiac Arrest

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INTRODUCTION

Systemic hypothermia initiated after resuscitation has been shown to improve long-term neurologic outcome.[1-4] In addition to neuroprotection, hypothermia has also been documented to decrease ischemia/reperfusion injury of the heart and improve resuscitation outcome.[5-7] In a porcine cardiac arrest model, systemic hypothermia established before cardiac arrest improved the defibrillation success and resuscitation outcome.[7] Intra-arrest systemic cooling has also been shown to reduce mortality rates in mice[6].

In the present study, we hypothesized that rapid intranasal cooling during CPR followed by systemic cooling reduces the severity of post-resuscitation myocardial dysfunction after prolonged cardiac arrest. We sought to investigate the effect of preferential intranasal head cooling initiated at the start of CPR on success of resuscitation, and on post-resuscitation myocardial function and survival.

METHODS

Sixteen pigs, weighing 40.6±1.41kg, were randomized to cooling (n=8) or control (n=8). VF was induced and untreated for 10 minutes. CPR was then initiated for 5 minutes before defibrillation with a biphasic 150J electric shock (Figure 1).

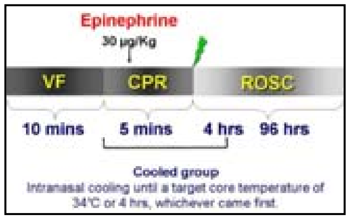


Figure 1. Experimental protocol

Coincident with starting CPR, the cooling group was cooled by spraying a volatile perfluorochemical in the nasal cavity (Figure 2). The cooling was continued for 4 hours or until core temperature reached 34ºC, whichever occurred first. During the 4 hours following resuscitation, the cooling was stopped after the core temperature reached 34ºC and restarted when the core temperature increased to 34.5ºC. Rewarming was passive.

The temperature of the control group was not disrupted after VF was induced. Echocardiographic measurements including systolic and diastolic functions were performed hourly during the 4 hours following ROSC and repeated at 96 hours post-resuscitation.

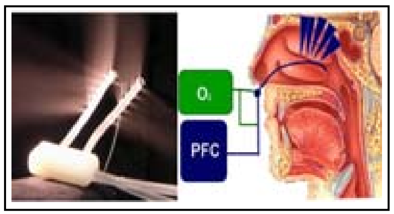


Figure 2. Evaporative perfluorochemical – spray catheter and system schematic

RESULTS

Fewer defibrillation shocks were required to achieve ROSC in the cooled group (8.1±4.6 vs. 14.6±8.6, P= 0.08) and CPR duration was shorter (364.6±42.4 sec vs. 600.4±243.2 sec, P=0.01) (Table 1).

Five minutes after starting CPR, jugular bulb temperature was 4ºC below baseline in the cooled group but core temperature (Pa) was unchanged from baseline (Figure 3).

Post-resuscitation myocardial function measured by transthoracic echocardiography was significantly better in the cooled animals when compared with control animals (Figures 4-7). All cooled animals survived for 96 hours after ROSC. However, only 2 of 8 control animals survived to 96 hours (100% vs. 25%, P=0.003).

Table 1. Resuscitation data

	Control	Cooled	
	N=8	N=8	P
Weight (kg)	40.8±1.9	40.4±0.7	0.613
CPP before initial electric shock (mm Hg)	17.7±5.6	21.3±9.6	0. 370
No. of electric shock	14.6±8.6	8.1±4.6	0.08
Initial electric shock success (%)	38%	75%	0.315
Total electric shock success (%)	66±19%	88±18%	0.034
CPR duration (sec)	612.9±227.3	364.6±42.4	0.009
Epinephrine dosage (μg/kg)	60±32.1	30±0	0.01
ROSC	7(88%)	8(100%)	1

Figure 3. Temperatures

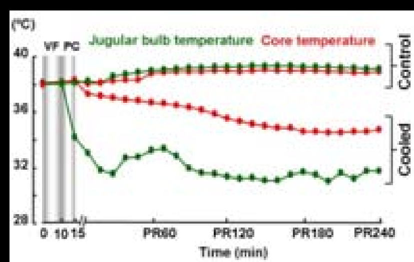


Figure 4. Left ventricular ejection fraction (%)

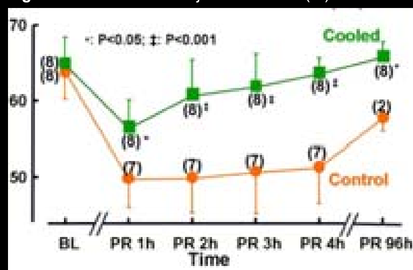


Figure 5. Fractional area change (%)

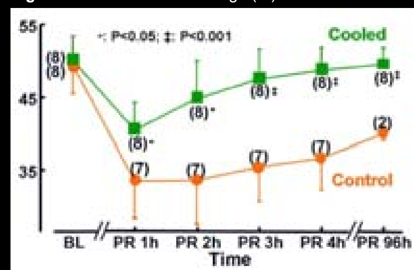


Figure 6. Isovolumic relaxation time (sec)

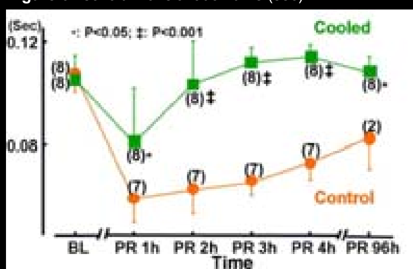
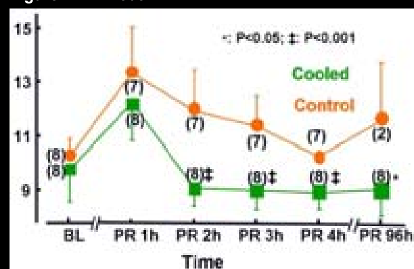


Figure 7. E/E' ratio



CONCLUSIONS

1) Intranasal cooling for 5 minutes during cardiac arrest with minimal core temperature change facilitates and improves the success of the resuscitation effort.

2) Intranasal cooling for 4 hours reduces post-resuscitation myocardial dysfunction and markedly improves survival following cardiac arrest.

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