Intra-arrest Rapid Head Cooling Improves Cardiac Arrest Outcomes Over Delayed Post-resuscitation Systemic Cooling In A Porcine Model of Prolonged Ventricular Fibrillation

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Background: Therapeutic hypothermia reduces neurological deficits and myocardial injury after cardiac arrest, and improves survival.

Hypothesis: Rapid head cooling initiated at the beginning of cardiopulmonary resuscitation yielded lesser severity of post-resuscitation myocardial dysfunction than delayed post-resuscitation systemic cooling after prolonged cardiac arrest.

Methods: Ventricular fibrillation was induced in 24 domestic pigs and left untreated for 10 minutes. Animals were equally divided into 3 treatment groups: (1) intra-arrest head cooling, (2) post-resuscitation systemic cooling, and (3) control. The intra-arrest head cooling group was cooled by utilizing the Rhinochill device producing evaporative cooling through the nostrils of the pigs. Cooling was begun 5 minutes prior to attempted defibrillation and continued for 4 hours or until core temperature was 34℃. The post-resuscitation systemic cooling group was cooled by a water-filled blanket (Blanketrol ® II, Cincinnati Sub-Zero Medical Products) begun 2 hours following return of spontaneous circulation (ROSC), and continued for 8. No hypothermia was administrated to the control animals. Transthoracic echocardiography was performed prior to onset of cardiac arrest, hourly for 4 hours after ROSC, and repeated at 96 hours.

Results: Myocardial systolic function measured by ejection fraction and diastolic function measured by isovolumic relaxation time (IRT) were significantly greater in the intra-arrest cooled animals when compared with both delayed cooling and control animals (Table). All intra-arrest head cooling animals survived for more than 96 hours after ROSC. This contrasted with 6 of 8 survivors among delayed cooling animals and only 2 of 8 survivors among control animals.

Conclusion: Both intra-arrest head cooling and delayed post-resuscitation systemic cooling improved myocardial function after cardiac arrest, and the beneficial effect was more significant when cooling was initiated at the beginning of cardiopulmonary resuscitation.

Table

LVEF (%)						
	Baseline	**PR 1h**	**PR 2h**	**PR 3h**	**PR 4h**	**PR 96h**
Intra-arrest cooling	**64.8±3.6**	**56.3±3.8*ξ**	**60.6±4.8‡ψ**	**61.8±4.5‡ψ**	**63.5±2.2‡ψ**	**65.7±2.2‡ψ**
Post-resuscitation cooling	**62.6±2.3**	**50.8±3.4**	**50.9±1.9**	**51.6±1.9**	**52.4±3.3**	**60.0±2.7**
Control	**63.9±3.7**	**49.7±3.7**	**49.8±4.5**	**50.6±5.4**	**51.2±4.7**	**57.6±1.6**
IRT(msec)						
Intra-arrest cooling	**1.1±0.1**	**0.8±0.2***	**1±0.2‡ξ**	**1.1±0.1‡ψ**	**1.1±0.0‡ψ**	**1.1±0.1‡**
Post-resuscitation cooling	**1.1±0.1**	**0.8±0.1***	**0.8±0.1***	**0.8±0.1***	**0.8±0.1***	**1.1±0.0***
Control	**1.1±0.1**	**0.6±0.1**	**0.6±0.1**	**0.7±0**	**0.7±0.1**	**0.8±0.1**

***: P<0.05, ‡: P<0.001 when compared with control group**

ξ: P<0.05, ψ: P<0.001 when compared with delayed post-resuscitation cooling group