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Title : CEREBRAL RECOVERY AFTER PROLONGED CLOSED-CHEST, MAST-AUGMENTED AND OPEN-CHEST CARDIOPULMONARY RESUSCITATION (CPR)

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Introduction. Neurologic recovery has been studied after prolonged periods of circulatory arrest, but not after prolonged periods of CPR. In a previous study, we confirmed others' reports on low blood flow values produced by standard closed-chest CPR (CC-CPR), and showed that it may be borderline for maintaining cerebral viability and thereby return of function[1]. CPR should not only lead to the ability to restore spontaneous circulation, but also cerebral function. Abdominal compression by hand or by pressure suit (military anti-shock trousers, MAST)[1] can augment blood flow during CPR. Open-chest CPR (OC-CPR) is hemodynamically superior to CC-CPR [1]. Therefore, we compared prolonged use of the above 3 methods in terms of their ability to sustain signs of cerebral function during CPR and after restoration of spontaneous circulation.

Methods. Broad-chested dogs were anesthetized with ketamine and maintained with halothane-N_2O/O_2-50%/50%. Monitored were $PETCO_2$; T(38°C); MAP; CVP; EKG; art; ven, and saggital sinus (SS) blood gases, lactate, and O_2 contents; common carotid blood flow (CCABF)[2]; and pupil size and reactivity.

The dogs were divided into group I, CC-CPR (n7); group II MAST-CPR (n6); and group III, OC-CPR (n6). Control values were obtained under light anesthesia during a steady state. After discontinuance of halothane, ventricular fibrillation (VF) was induced electrically with 100 V-AC.Circulatory arrest was allowed to persist for 5 min. CPR with one of the above methods was then carriedout with 1 IPPV (TV 10 ml/kg, FIO_2 100%) after every 5th cardiac compression (60/min) by Michigan Instr. "Thumper". During CPR in group II, the MAST applied over legs and abdomen was inflated to 100 torr. In group III, left thoracotomy was followed by heart compressions and non-synchronized IPPV. After 5 min arrest, 5 min CC-CPR and 30 min group I, II or III CPR (total 40 min), restoration of spontaneous circulation was attempted by standardized protocol. Post CPR, IPPV and MAP were controlled for 3 h. After weaning at 3 h, neurologic deficit score (NDS) (0%=normal,100%=brain death) was determined[3]. Differences between groups were compared by Students' t test; significant, p was <0.05.

Results. During CPR (Table I), CVP and ICP were lowest and CPP (MAP-ICP), CCABF and SS PO_2 highest during OC-CPR. MAST augmented CCABF, but group II post-CPR dropped out because of inability to restore spont.circ. due to acidemia, hypoxemia and liver rupture. During CPR, pupillary reaction returned in most dogs earlier during OC-CPR than during CC-CPR or MAST-CPR. OC-CPR gave better SS O_2 cont. and cerebral O_2 utilization coefficient. After CC-CPR, in 5/7, EEG returned at 60±28 min; after OC-CPR in 5/6 at 24±35. Final NDS was 85 ± 8% after CC-CPR, and 66 ± 11% for OC-CPR ($p<0.05$).

Conclusions. OC-CPR is not only hemodynamically superior to CC-CPR, but also results in better cerebral status during and early after CPR. MAST-CPR improved CCABF over CC-CPR, but not SS blood gas values or CPP and adds complications.

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References.

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TABLE I-CNS VARIABLES DURING CPR (*$p<0.05$)

CPR Method	Prearrest Control	After 5' CPR (1)	After 15' (1),(2) or (3)	After 30' (1),(2) or (3)
Cerebral perfusion press. (MAP-ICP), torr				
1)CC-CPR (n4)	85±18	24±15	27±28	41±9
2)MAST (n3)	105±10	7±18	22±27	11±22
3)OC-CPR (n4)	92±10	18±9	51±16	56±18
Comm. carotid blood flow, ml/min				
1)CC-CPR (n4)	64±20	10±3	11±3	9±3
% control	(100)	(16±3)	(17±6)	(15±6)
2)MAST-CPR (n3)	83±34	9±4	24±9*	33±22
% control	(100)	(11±1)	(30±3)	(38±15)
3)OC-CPR (n4)	69±28	13±3	24±5*	29±8*
% control	(100)	(23±8)	(41±17)	(54±32)
Saggital sinus PO_2, torr				
1)CC-CPR (n4)	65±12		32±12	40±6
2)MAST-CPR (n3)	69±5		23±10	21±8
3)OC-CPR (n4)	76±4		51±8*	47±1*

TABLE 2-CNS VARIABLES AFTER CPR (*$p<0.05$)

CPR Method	Prearrest Control	Post CPR 30 min	90 min	180 min
Comm. carotid blood flow, ml/min				
1)CC-CPR (n4)	64±20	70±52	51±13	
% control	(100)	(103±46)	(84±28)	
3)OC-CPR (n4)	69±28	55±34	69±31	
% control	(100)	(82±34)	(113±38)	
Saggital sinus O_2 content, ml/dl				
1)CC-CPR (n4)	20.9±0.6	13.2±1.6	12.5±3.7	11.2±1.8
2)OC-CPR (n3)	19.1±2.9	14.6±2.8	19.6±1.8*	17.3±2.7*
Cerebral O_2 utiliz. coeff.		$C(a-SS)O_2/CaO_2$		
1)CC-CPR (n4)	0.15±0.03	0.34±0.07	0.47±0.18	0.45±0.11
2)OC-CPR (n3)	0.13±0.03	0.27±0.16	0.18±0.04	0.20±0.15