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Title : CARDIAC RESUSCITABILITY AFTER CLOSED-CHEST, MAST-AUGMENTED AND OPEN-CHEST CARDIOPULMONARY RESUSCITATION (CPR)

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Introduction. Prolonged standard closed-chest CPR (CC-CPR) may be incapable of sustaining vital organ systems viability[1]. Manual abdominal restraint can augment blood flow[2]. Military anti-shock trousers (MAST) may be less traumatic[1]. Open-chest CPR (OC-CPR) produces even better blood flow[1]. These 3 methods have not been evaluated on the basis of restoration and maintenance of spontaneous circulation.

Methods. Broad-chested dogs (10-15 kg) were anesthetized with ketamine IM. Endotracheal anesthesia was maintained with halothane in N_2O/O_2 50%/50%. Monitored were $PETCO_2$, rectal temp. (38±1C); art. and central ven. blood gases, lactate and O_2 cont.; abdominal and aortic press. (MAP); inferior and superior vena cava press.(IVCP, SVCP); EKG; common carotid artery blood flow (CCABF)[3]; cardiac output (CO); and O_2 consumption ($\dot{V}O_2$). Ventric. fibrill. was induced with 120 V AC. After arrest of 5 min, CPR was started with 1 IPPV after every 5th compr. (60/min), with FIO_2 100%, using a "Thumper" for CC-CPR. After 30 min of CC-CPR (group I, n7); MAST-augmented CPR (group II, n6); or OC-CPR (group III, n6) restoration of spont. circ. was attempted by a standardized protocol of repeat administrations of epinephrine, DC shocks, bicarbonate and fluid load with max. limits. After restoration of spont. circ., standard IPPV and MAP control continued for 4 h. Differences between groups were compared by Students' t-test; significant p was < 0.05.

Results. During CPR (Table 1) OC-CPR produced better CCABF than the closed methods because of lower CVP and better perfusion press. MAST signif. improved flow but worsened PaO_2, $PaCO_2$, pHa and lact. and caused liver rupture with inability to restore spont. circ. Energy and drug requirements for restoration of spont. circ. were signif. lower for OC-CPR than CC-CPR (Table 2). Post-CPR (Table 3), CO and $\dot{V}O_2$ varied widely, CO around 50% of control, with no diff. between groups. Arterial O_2 transport, O_2 utilization coefficient (O_2 demand/supply ratio) and lact. were signif. better and O_2 debt lower after OC-CPR.

Conclusion. Optimal CC-CPR, producing borderline carotid flow (about 10% of control), can be augmented by MAST. This, however, hampers ventilation and oxygenation and can cause liver rupture, obviating restoration of spontaneous circulation. OC-CPR is superior to CC-CPR not only hemodynamically, but also in terms of ability to restore spont. circ. and physiol. variables post-CPR.

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References.

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Table 1
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)
Systemic perfusion press. (MAP-CVP), torr				
1)CC-CPR (n7)	100±13	19±8	25±15	24±13
2)MAST (n6)	115±11	13±16	26±12	15±19
3)OC-CPR (n7)	96±15	15±8	50±17*	48±20*
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 (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)

Table 2
REQUIREMENTS FOR RESTORATION OF SPONT. CIRC. (*$p < 0.05$)

Therapy	CC-CPR (n7)	OC-CPR (n6)
DC countershocks #	1.43±0.53	1.17±0.41
Epinephrine, mg	1.94±0.78	1.07±0.16*
Bicarb., mg/kg	7.11±2.75	3.79±0.65*
Norepinephr., mg/kg	0.29±0.36	0.06±0.05
Lidocaine, mg	11.7±18.45	3.33±5.16

Table 3
VARIABLES AFTER CPR (*$p < 0.05$)

CPR Method	Prearrest Control	Post CPR 30 min	90 min	180 min
Art. O_2 transport ($\dot{A}OT$) (O_2 cont. x CO) % control				
1)CC-CPR (n7)	100	62±30	51±18	34±9
3)OC-CPR (n5)	100	75±31	67±19	60±26
O_2 utiliz. coeff. (O_2 Cons:$\dot{A}OT$)				
1)CC-CPR (n7)	0.12±0.06	0.21±0.09	0.32±0.11	0.36±0.11
3)OC-CPR (n5)	0.12±0.04	0.17±0.05	0.18±0.08*	0.21±0.11
Art. lactate, ug/ml				
1)CC-CPR (n7)	3.3±1.7	16.2±3.5	12.0±4.4	11.6±8.3
3)OC-CPR (n6)	2.5±1.3	12.9±1.6*	10.4±1.7	10.2±4.0