Effect of Dermal Contact with Cold on the Coronary Circulation.* (20572)

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It is well-known that patients with arteriosclerotic heart disease and angina pectoris frequently experience precordial pain upon exposure to cold. The interpretation given this observation is that dermal contact with cold elicits a reflex constriction of the coronary arteries, and that the resulting myocardial ischemia is responsible for the chest pain and electrocardiographic changes(1,2). The existence of such reflexes has not been established. The following study was initiated to determine the presence or absence of such reflex effects of cold on coronary blood flow (CBF) in the dog.

Methods. Experiments were performed on pentobarbitalized open-chested dogs with respiration maintained artificially. A small segment of the circumflex branch of the left coronary artery was dissected free, cannulated near its origin, and perfused via the subclavian artery. Care was taken to maintain the integrity of the sheath of the artery. A blood reservoir and pump perfusion system were placed in parallel with the arterial perfusion system in order to permit a selection of perfusion pressures, regardless of the dog's mean aortic pressure(3). Coronary inflow was measured by an optically recording rotameter(4). Aortic and mean coronary inflow pressures were registered by modified Gregg manometers. Temperatures, recorded from the right atrium and the coronary inflow cannula, remained constant throughout the experiments.

Results. In 5 out of 6 preliminary experiments in which ice was placed in contact with one hind limb, no change in CBF, heart rate or arterial blood pressure was detected. In the 6th experiment, CBF, aortic pressure, and heart rate increased while coronary perfusion pressure was held constant. In 10 subsequent experiments the strength of the cold stimulus was increased by immersing 1/3 to 2/3 of the body surface in ice water. In all these experiments, contact with cold in the absence of changes in heart blood temperature produced an increase in CBF which was associated with an increase in aortic pressure and/or heart rate. Fig. 1 is a plot of a representative experiment in which CBF, perfusion pressure, aortic pressure, and heart rate are plotted against time. Following immersion in ice water, CBF increased, and was associated with an increase in mean aortic pressure and pulse pressure. Adjustment of coronary perfusion pressure to control levels at 5½ and 8½ minutes resulted in a moderate reduction in CBF, but not to pre-immersion values. Heart rate showed no significant change in this experiment. In Table I are presented data on all 10 experiments. In the first 5 experiments perfusion pressure was kept constant, yet CBF increased concomitantly with mean blood pressure and pulse pressure. In the last 5 experiments in Table I, either no attempt was made to regulate perfusion pressure or, for technical reasons perfusion pressure could not be held at control levels. Therefore, part of the increase in CBF in these experiments may be attributed to the

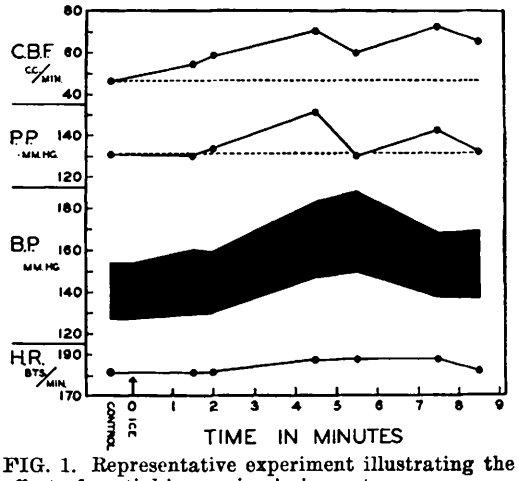

FIG. 1. Representative experiment illustrating the effect of partial immersion in ice water on coronary blood flow (CBF), perfusion pressure (PP), arterial blood pressure (BP), and heart rate (HR).

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TABLE I. Cardiovascular Effect of Dermal Contact with Cold, 10 Experiments.

	Aortic pressure, mm/Hg	Heart rate, beats/min.	Perfusion pressure, mm/Hg	CBF, cc/min.
Cont.	145/121	150	121	38
Exp.	158/130	158	122	45
Cont.	140/120	214	128	32
Exp.	156/125	214	130	51
Cont.	145/126	160	124	46
Exp.	170/147	154	124	57
Cont.	154/127	182	131	46
Exp.	187/149	187	129	59
Cont.	134/119	158	126	35
Exp.	146/126	171	128	48
Cont.	116/ 87	187	98	39
Exp.	123/ 95	193	103	48
Cont.	140/119	158	123	45
Exp.	177/147	194	145	100
Cont.	141/126	200	129	48
Exp.	161/138	200	140	66
Cont.	147/113	158	125	59
Exp.	162/122	157	132	65
Cont.	134/103	154	117	31
Exp.	148/117	158	129	35

rise in perfusion pressure.

It should be noted that in 8 experiments pulse pressure increased, whereas heart rate was significantly altered in only 2 experiments. Stimulation of the accelerator nerves following coronary artery cannulation produced an immediate increase in CBF in the cannulated vessel.

Discussion. The increase in CBF observed upon immersion of the anesthetized dogs in ice water was associated with an increase in cardiac work as judged from the increase in aortic pressure, pulse pressure, and/or heart rate. With less intense stimulation (contact of hind leg with ice), CBF was unchanged, but cardiac work was also unchanged. In no instance did CBF decrease. Therefore, no evidence could be uncovered for reflex coronary constriction and the increase in CBF observed appeared to be related to the increase in cardiac work.

Criticism may be leveled at these experiments because of the depressant effect of anesthesia upon reflexes and the possible severance of sympathetic nerves in cannulation of the coronary artery. However, anesthesia was light; tendon and corneal reflexes were active; autonomic reflexes were also active, as evidenced by the reflex rise in blood pressure and increase in heart rate upon contact with ice water. That sympathetic nerves were intact is suggested by the prompt increase in CBF obtained upon stimulation of the accelerator nerves.

Our results are at variance with those of Gilbert *et al.*(5) who reported small decreases in CBF upon irrigation of the nasal mucous membranes with ice water. These investigators used the thermostromuhr and coronary sinus outflow technic to measure CBF in the decerebrate dog. Gregg(6) has pointed out that the thermostromuhr and the coronary sinus outflow technic are not accurate enough to attach significance to changes of the order of magnitude observed by Gilbert and coworkers.

Application of our data to man must be made with caution. However, our findings offer no support for the clinical interpretation that chest pain and ECG changes appearing upon dermal contact with cold in patients with angina pectoris are due to reflex coronary artery constriction. The possibility of the failure of the sclerosed vessels to dilate in response to an increase in cardiac work has not been excluded.

Summary. Dermal contact with ice water in the anesthetized dog failed to produce a reflex constriction of the coronary arteries. Exposure of small areas of body surface to ice water resulted in no changes in CBF, whereas immersion of 1/3 to 2/3 of the body surface in ice water produced an increase in CBF associated with an increase in cardiac work.

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