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TITLE: PREDICTORS OF ISCHEMIA DURING CABG WITH HALOTHANE

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INTRODUCTION:

Considerable interest surrounds the question of which routinely monitored determinant--or combination of determinants--of myocardial oxygen supply and demand best predicts myocardial ischemia. Since prevention of ischemia by early treatment of a supply-demand imbalance is presumably preferable to treatment of overt (electrocardiographic) ischemia, it would be helpful to know which determinants, when abnormal, are the most accurate indicators of imminent ischemia. It would also be helpful to know at which point a determinant becomes "abnormal". We therefore designed a study to ascertain which determinants of myocardial oxygen supply and demand are most frequently associated with ischemia during halothane anesthesia for coronary artery bypass grafting (CABG).

MATERIALS AND METHODS:

Thirty patients (21 males) undergoing CABG were studied. Monitoring was established prior to anesthetic induction with an EKG lead (II or V_5) which had demonstrated ischemic EKG changes previously during stress testing or spontaneous angina, a radial arterial cannula, and a triple-lumen pulmonary artery catheter. The study period was from anesthetic induction until 5 minutes after sternotomy, and for the first 10 minutes following cardiopulmonary bypass. EKG (10 mm= 1mV), arterial systolic blood pressure (BPs), central venous pressure (CVP), and pulmonary artery-occluded pressure (PAOP) were recorded every 60 seconds for 3 consecutive respiratory cycles, allowing for 40 sets of measurements per patient (1200 total measurements). We defined ischemia as ST-segment depression of at least 1 mm, measuring the ST-segments 80 msec. after the J-point. CVP and PAOP were taken as the average of 3 consecutive end-expiratory values, as read from strip recordings. We defined rate-pressure product (RPP) as (BPs x HR), and coronary perfusion pressure (CPP) as (mean arterial BP-PAOP).

Following morphine-scopolamine premedication, anesthesia was induced by mask with halothane-nitrous oxide in 50% oxygen. Anesthesia was maintained with the same gas mixture, pancuronium was used for muscle relaxation, and ventilation was controlled mechanically.

Values for each determinant during ischemia were compared with those during non-ischemia using analysis of variance; $p < .05$ was considered statistically significant. For each determinant we used chi-square analysis to select a single point e.g. HR = 80 such that values on one side of the point (HR > 80) correlated best with ischemia, and values on the other side of that point (HR < 80) correlated best with non-ischemia.[1] Using discriminant analysis, we then evaluated the ability of these cut-off points, singly or in combination, to predict the presence or absence of ischemia.

RESULTS:

1. Ischemia was present during 230 of the 1200 measurement periods (in 20 of 30 patients). 2. Table I shows that ischemia is associated with a highly significant difference ($p < 0.0001$) in the mean values of all variables except RPP ($p = 0.88$). 3. Table II displays the cut-off points for each variable, above which (for HR, CVP, PAOP) or below which (CPP, MAP, BPs) ischemia is more likely to, but will not necessarily, occur. 4. Table II also shows the relative accuracy with which the "abnormal" determinant (based on the cut-off point, e.g., CPP < 50) predicts ischemia, and the "normal" determinant predicts non-ischemia. Interestingly, neither PAOP nor CVP is a strong predictor of ischemia, and the use of PAOP to derive CPP adds virtually no predictive power to MAP. 5. Using paired determinants, however, ↑CVP and ↑PAOP both improve the predictive accuracy of ↓BPs.

CONCLUSIONS:

During CABG under halothane anesthesia: 1. Low values of CPP and MAP are the best single predictors of ischemia, and their predictive accuracy is not improved when paired with any single variable. 2. The pairs (↓BPs, ↑CVP) and (↓BPs, ↑PAOP) are also strong predictors, although CVP and PAOP are weak predictors by themselves. 3. Low BPs and high HR are good predictors of ischemia. Even markedly elevated BPs (200 torr) was not associated with ischemia. 4. RPP is not a predictor of ischemia; this may be related to the fact that high BPs is also not a predictor.

Table I

Determinant	Mean Value (95% limits) No Ischemia	Mean Value (95% limits) Ischemia
CPP (torr)	75 (74-77)	*64 (61-67)
MAP (torr)	91 (89-92)	*81 (78-85)
HR (bpm)	68 (67-69)	*77 (74-79)
RPP (bpm x torr)	9170 (8984-9355)	*9205 (8734-9675)
BPs (torr)	135 (133-137)	*121 (110-121)
PAOP (torr)	15.2 (14.9-15.5)	*18.3 (17.4-19.1)
CVP (torr)	10.6 (10.2-10.9)	*13.6 (12-15.2

* $p < .0001$ ¶ $p = .88$

Table II

Determinant	Value	%Correct Classification +/- ischemia
CPP	< 50*	83
MAP	< 65*	82
HR	> 80*	72
BPs	< 90*	72
PAOP	> 15*	52
CVP	> 10*	46
	* = $p < .00001$	
MAP, PAOP	-	82
MAP, CVP	-	82
HR, BPs	-	72
HR, PAOP	-	72
HR, CVP	-	72
BPs, PAOP	-	84
PBs, CVP	-	84

1. Armitage R. Statistical methods for identification of prognostic factors, Int. J. Cancer 13: 16-36, 1974

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