

特集 (special edition)

Detection of Myocardial Ischemia by Electrocardiography and Transesophageal Echocardiography

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Introduction

Recent studies¹⁾²⁾³⁾ have suggested that intraoperative transesophageal echocardiography (TEE) provides useful information of hemodynamics during both cardiac and non-cardiac surgery. Despite apparent importance of perioperative ischemia, diagnosis of myocardial ischemia during anesthesia is not easy. Electrocardiography is one of the most popular monitoring and usually II and V₅ lead are monitored during anesthesia. Rate pressure product (RPP) and triple index (TI) might suggest myocardial ischemia due to increase of myocardial oxygen consumption. But recent studies reveal RPP and TI are not a good indicator of myocardial ischemia. V wave by PCWP pressure trace is also not enough to detect myocardial ischemia.

Method

We studied fifteen patients scheduled for elective coronary bypass graft surgery before cardiopulmonary bypass. Left ventricular ejection fraction of the patients were more than 50%. Fifteen patients were divided into three groups:

single vessel disease (n=5), double vessel disease (n=5), triple vessel disease (n=5). Anesthesia was induced fentanyl 10 µg/kg with diazepam and maintained with isoflurane, nitrous oxide, and oxygen. Muscle relaxants included pancuronium 0.1 mg/kg at induction and additional dose was administered. TEE was performed with single plane probe with 64 elements (ALOKA, Inc, Tokyo, Japan). We monitored ST depression of II and V₅ lead by ST trend monitor (Marquette, Inc). We measured 9 points at each patient: ECG ischemia was defined with ST depression more than 1 mm compared with control level at J plus 90 msec points. Regional wall motion abnormality (RWMA) is divided into four classes: mild hypokeinesis, severe hypokeinesis, akinesis and dyskeinesis. TEE ischemia was defined with new or worsened RWMA.

Results (Table 1 & 2)

single vessel disease

RWMA was observed 4 points (9%) during anesthesia. RWMA with ST depression was 2 points, and RWMA without ST change also 2 points. The sensitivity is 50% and the specificity

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Table 1 Relationship between RWMA and ST changes

single vessel disease		
	RWMA(+)	RWMA(-)
ST(+)	2	2
ST(-)	2	39
TOTAL	4	41
double vessel disease		
	RWMA(+)	RWMA(-)
ST(+)	1	3
ST(-)	4	37
TOTAL	5	40
triple vessel disease		
	RWMA(+)	RWMA(-)
ST(+)	6	3
ST(-)	14	22
TOTAL	20	25

RWMA(+) : new or worsened regional wall motion abnormalities

RWMA(-) : no regional wall motion abnormality

ST(+) : ST depression more than 1 mm than control level

ST(-) : no ST change compared with control level

Table 2 Sensitivity and Specificity of ECG ischemia compared with TEE ischemia

	sensitivity	specificity
single vessel disease	50%	91%
double vessel disease	25%	90%
triple vessel disease	67%	61%

ty is 91%.

double vessel disease

RWMA were observed 5 points (11%) during anesthesia. RWMA with ST depression was 1 points, and RWMA without ST change also 4 points. The sensitivity is 25% and the specificity is 90%.

triple vessel disease

RWMA were observed 20 points (45%) during anesthesia. RWMA with ST depression

were only 6 points, and RWMA without ST change also 14 points. The sensitivity is 67% and the specificity is 61%.

Discussion

TEE is confirmed to be valid and reliable technique for the evaluation of cardiac function, that includes systolic function (ejection fraction by M mode), diastolic function⁴⁾⁵⁾ (mitral valve flow velocity by doppler mode), preload,

measurement of cardiac output and degree of valve regurgitation. So we could understand the global and regional cardiac function at real time by TEE. Batler⁶⁾ showed dissociation between regional myocardial dysfunction and ECG changes in conscious dogs and suggested that RWMA is more sensitive than ECG.

We reported clinical usefulness of TEE during coronary artery bypass grafting⁷⁾. Anesthesia was induced fentanyl and diazepam and maintained with enflurane or isoflurane, nitrous oxide, and oxygen. TEE was performed with biplane probe. We monitored the 7-lead ECG (I, II, III, aVR, aVL, aVF, V₅) and recorded ST changes before and after cardiopulmonary bypass (CPB). We obtained various view by biplane probe and observed 24 points at pre CPB and 37 points at post CPB. During pre CPB, incidences of RWMA with ST depression were only 12.5%, otherwise RWMA without ST depression (false negative) 33%, ST depression without RWMA (false positive) 12.5%. During post CPB, incidences of RWMA with ST depression were only 8%, RWMA without ST depression (false negative) 8%, and ST depression without RWMA (false positive) 30%. The result indicates ECG is not a good indicator of myocardial ischemia both before and after CPB. The incidences of RWMA by TEE were more than that of ST depression before CPB⁸⁾. This result suggests that ECG ischemia has a false negative after CPB. And our study also suggested that heart rate more than 100 per minutes or RPP more than 12,000 did not suggest myocardial ischemia¹⁾. Leung²⁾ reports that perioperative TEE episodes are infrequently triggered by changes in hemodynamics and suggests that primary decrease in myocardial oxygen supply may be an important mechanism for most perioperative RWMA.

Our results suggest that the patients with triple vessel disease cause high incidences of RWMA (45%) compared with single (9%) or

double (11%) vessel disease. The detection rate of ischemia by ECG is 50%, 20% and 30% by single, double and triple vessel disease and is not enough in clinical situation. And false positive rate of ECG ischemia is almost the same between the groups, but false negative rate at triple vessel group is much higher than single and double vessel group. As far as the sensitivity of ECG is concerned, the sensitivity of triple vessel group is much better than single and double vessel disease, but is not enough to detect TEE ischemia. The specificity with single and double vessel group, is not too bad but low in case of triple vessel group. This means TEE monitoring is mandatory to detect myocardial ischemia especially in case of triple vessel disease.

ECG is very simple method to detect myocardial ischemia, but sometimes shows false positive and false negative of ischemia. On the other hand, TEE is reliable technique to early detection of myocardial ischemia. Several methods are used to analyze wall motion and wall thickening⁹⁾¹⁰⁾, but they were usually off line analysis, not real time one. Soon new technology will provide anesthesiologists with informative wall motion analysis, for example, wall motion auto-tracing, three dimensional viewing of the heart by multi-plane probe, and combination with ST trend monitoring.

But we are not able to use TEE probes with all of the patients undergoing general surgery. TEE still has a few clinical limitations in clinical situation. And RWMA obtained by TEE is not always a "gold standard" for myocardial ischemia. TEE itself has false positive and negative to detect myocardial ischemia. It is very important that we must know clinical limitations and usefulness with TEE.

It is too fast to conclude that TEE is useful to protect myocardial ischemia perioperatively and decrease mortality and morbidity. We have to deal with much larger number of patients

and we think that it is impossible to study myocardial ischemia during anesthesia at one institution. Therefore we hope multi-center study in the same protocol in our country.

In conclusion, the patients with triple vessel disease showed high incidences of RWMA without ST-T changes compared with single and double vessel disease. We recommend that TEE should be monitored with severe ischemic heart disease, like triple vessel disease¹⁰⁾ during both cardiac and non-cardiac surgery. But to validate myocardial ischemia, further study of relationship between ST-T changes by ECG and RWMA by TEE will be necessary.

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心電図と経食道エコーによる心筋虚血の診断

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左心機能良好な冠動脈再建術患者を対象に、人工心肺前の心筋虚血の発生頻度を、食道エコー(TEE)の壁運動異常(RWMA)で診断し、心電図のST変化と比較検討した。対象患者を、冠動脈の覆患病変枝別に、1枝病変群、2枝病変群、3枝病変群に分けた。3枝病変群のRWMAは45%と、1枝病変群9%、2枝病変群11%と比較して、高い発生頻度であった。また、心電図による心筋虚血の発生頻度は、1枝病変群50%、2枝病変群20%、3枝病変群30%と低い検出率であり、特に、3枝病変群においては、心電図のST変化

は、感度、特異度とも低く、心電図による心筋虚血の診断の限界が示唆された。我々の、以前の報告と総合すると、重度の冠動脈病変を合併する患者においては、心電図や血圧、心拍数、Rate Pressure Product等のパラメーターは心筋虚血の指標とはならず、TEEによる壁運動異常の観察が重要である。しかし、TEEにもreal timeの解析等の問題があり、今後の技術的、臨床的使用法の検討が必要である。

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