Predicting postoperative cardiac complications using automated endothelial function test

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KEY MESSAGE

For patients undergoing non-cardiac surgery, non-invasive assessment of endothelial function provides additional predictive value, beyond clinical variables, for preoperative risk stratification of postoperative myocardial ischaemia and major cardiac complications.

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Background

Perioperative myocardial ischaemia is a common complication after non-cardiac surgery,[1] and is associated with severe morbidity and mortality.[2,3] The vascular endothelium is an important component in coronary artery disease.[4] Endothelial dysfunction may play an important role in perioperative myocardial injury, and its rapid assessment may enable cardiac risk stratification prior to surgery.[4] Based on an automated, non-invasive test to quantify reactive hyperaemia in response to brief upper limb ischaemia, a prospective observational cohort study was performed to determine the performance of preoperative endothelial function testing in predicting cardiac complications after non-cardiac surgery. Results of the study have been published.[5,6]

A representative sample of patients, at intermediate-to-high risk for postoperative cardiac complications, scheduled to undergo non-cardiac surgery were recruited.[5,6] Endothelial function was measured using an EndoPAT device (Itamar Medical, Caesarea, Israel). A reactive hyperaemia index (RHI) was calculated to indicate endothelial dysfunction (Fig). Blood samples were collected on the first 3 days after surgery for the measurement of plasma concentration of cardiac troponin T.

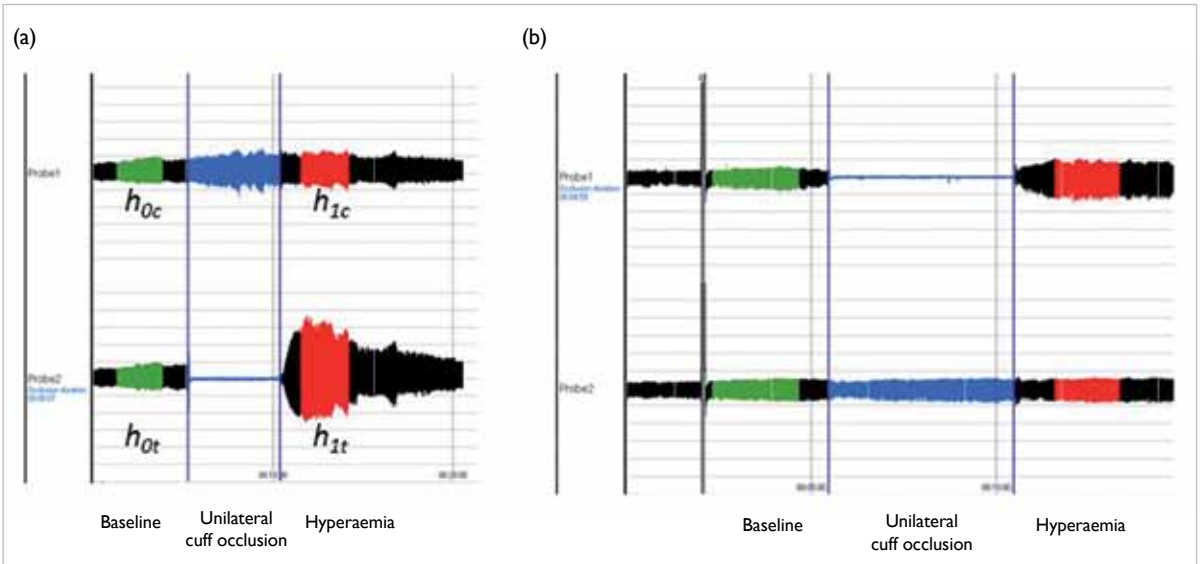

FIG. (a) Pulse amplitude tracing with normal endothelial function: during hyperaemia of a finger, baseline pulse amplitude is recorded. During cuff inflation, arterial flow is occluded and rapidly rises after release during the hyperaemic period. In the contralateral control finger, flow continues throughout, and pulse amplitude change is minimal. The reactive hyperaemic index (RHI) is a ratio of mean amplitude in the test finger during hyperaemia and that in baseline after adjusting for the change in the control finger, ie RHI=$(h_{1t}/h_{0t})/(h_{1c}/h_{0c})$. The calculated RHI for this tracing is 2.41. (b) In a patient with endothelial dysfunction, change in pulse amplitude is little in both the test and control fingers (RHI=1.15).

The primary endpoint was perioperative myocardial necrosis indicated by an elevation of cardiac troponin concentration of >0.03 μg/L.[2] The occurence of major adverse cardiac complications (including myocardial infarction, non-fatal cardiac arrest, stroke, pulmonary embolism, congestive heart failure, and new clinically significant atrial fibrillation), coronary intervention, and all-cause mortality within 30 days after surgery were recorded.

In this cohort, the mean duration of surgery was 3.8 (standard deviation, 1.7) hours. The median RHI was 1.51 (interquartile range, 1.34-2.08). By postoperative day 3, 10.6% of patients had a peak cTnT concentration of >0.03 μg/L, indicating occurrence of perioperative myocardial injury. At day 30, 8.2% had major cardiac complications. Taking RHI of ≤1.22 as the threshold, the area under receiver operating characteristic (ROC) curve was 0.89 (95% confidence interval [CI], 0.81-0.96), with sensitivity and specificity of 65% and 95%, respectively. Using the revised cardiac risk index of ≥2, the area under the ROC curve was 0.75 (95% CI, 0.64-0.86), with sensitivity and specificity of 82% and 65%, respectively.

Patients with endothelial dysfunction reported higher rates of perioperative myocardial injury (P=0.001) and 30-day postoperative cardiac complications (P=0.001). After adjustment for age, clinical risk score, and extent of surgery, endothelial dysfunction remained a significant risk factor for adverse cardiac outcomes. The population attributable risk analysis suggested that 41.8% of perioperative myocardial necrosis and 45.3% of postoperative cardiac complications were related to the presence of endothelial dysfunction. After adjustment for age, clinical risk factors, and extent of surgery, patients with endothelial dysfunction were less likely to be discharged from hospital on any given day after surgery than those with preserved endothelial function (hazard ratio=2.56; 95% CI, 1.53-4.17; P=0.001). Interestingly, RHI did not predict the development of acute kidney injury (odds ratio=1.60; 95% CI, 0.40-1.70; P=0.530).[5]

Conclusions

The study demonstrated the potential utility of non-invasive automated measure of endothelial dysfunction to provide rapid preoperative risk stratification (when used alone or combined with clinical risk score) for perioperative myocardial ischaemic injury in patients undergoing non-cardiac surgery. The RHI, however, did not predict postoperative acute kidney injury.

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McIlroy DR, Chan MT, Wallace SK, et al. Automated preoperative assessment of endothelial dysfunction and risk stratification for perioperative myocardial injury in patients undergoing non-cardiac surgery. Br J Anaesth 2014;112:47-56.

References

1. Vascular Events In Noncardiac Surgery Patients Cohort Evaluation (VISION) Study Investigators, Devereaux PJ, Chan MT, et al. Association between postoperative troponin levels and 30-day mortality among patients undergoing noncardiac surgery. JAMA 2012;307:2295-304.
2. Botto F, Alonso-Coello P, Chan MT, et al. Myocardial injury after noncardiac surgery: a large, international, prospective cohort study establishing diagnostic criteria, characteristics, predictors, and 30-day outcomes. Anesthesiology 2014;120:564-78.
3. Devereaux PJ, Chan MT, Eikelboom J. Major vascular complications in patients undergoing non-cardiac surgery: magnitude of the problem, risk prediction, surveillance, and prevention. In: Yusuf S, Cairns JA, Camm AJ, Fallen EL, Gersh BJ, editors. Evidence-based cardiology. 3rd edition. West Sussex: Wiley-Blackwell; 2010:47-62.
4. Bonetti PO, Lerman LO, Lerman A. Endothelial dysfunction: a marker of atherosclerotic risk. Arterioscler Thromb Vasc Biol 2003;23:168-75.
5. McIlroy DR, Chan MT, Wallace SK, et al. Is preoperative endothelial dysfunction a potentially modifiable risk factor for renal injury associated with noncardiac surgery? J Cardiothorac Vasc Anesth 2015;29:1220-8.
6. McIlroy DR, Chan MT, Wallace SK, et al. Automated preoperative assessment of endothelial dysfunction and risk stratification for perioperative myocardial injury in patients undergoing non-cardiac surgery. Br J Anaesth 2014;112:47-56.