Systematic Review of the Role of New ECG Changes in Predicting Major Cardiac Events after Non-Cardiac Surgeries

Essay

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Contents

List of Abbreviations

Abb.	Full term
95% CI	95% Confidence interval
ACC	American College of Cardiology
AHA	American Heart Association
BP	Blood pressure
CABG	Coronary artery bypass graft
CAD	Coronary artery disease
CHF	Congestive heart failure
ECG	Electrocardiogram
FN	False negative
FP	False positive
HB	Heart block
IHD	Ischemic heart disease
KATP	ATP-sensitive potassium channels
LVH	Left ventricular hypertrophy
MACE	Major cardiac events
MI	Myocardial infarction
NSTEMI	Non ST-segment elevation myocardial infarction
NTG	Nitroglycerin
OR	Odds ratio
PMI	Perioperative myocardial infarction
POISE	PeriOperative Ischemic Evaluation

Abb.	Full term
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analysis
PTCA	Percutaneous transluminal coronary angioplasty
RR	Relative risk
STEMI	ST-segment elevation myocardial infarction
TEE	Transoesophageal echocardiography
TN	True negative
TP	True positive
VF	Ventricular fibrillation
VT	Ventricular tachycardia

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Introduction

Throughout the last few decades non-cardiac surgery has made substantial advances in treating diseases and improving patient quality of life. As a result, the number of patients undergoing non-cardiac surgery is growing worldwide. However, such surgery is associated with significant cardiac morbidity, mortality and consequent cost ***(Mangano et al., 1999).***

Surgical care is nowadays a determinant part of health care all around the world, with an estimated number of 234 million adults undergo major non-cardiac surgeries annually, equivalent to roughly 4% of the global population per year ***(Weiser et al., 2008).***

Changes in demographics, with the ageing of the population, threaten to increase this problem in the near future. Elderly requires surgery approximately four times as often as the rest of the people ***(Naughton et al., 2007).***

Millions of these patients will have a major cardiac event (MACE) (cardiac death, nonfatal myocardial infarction [MI], nonfatal cardiac arrest) within 30 days after surgery. Myocardial infarction is the most common major peri-operative cardiac complication. For example, in the original POISE (PeriOperative ISchemic Evaluation) study 1.6% died of vascular causes, 0.5% had a non-fatal cardiac arrest, and 5.0% had an MI in the first 30 days. These major cardiac events prolong hospitalization, increase medical costs and account for at least 30% of perioperative mortality ***(Devereaux et al., 2008).***

In patients who have or are at risk for coronary artery disease (CAD), the most significant risks are perioperative myocardial ischemia and nonfatal myocardial infarction. Early postoperative myocardial ischemia (i.e. within 48 h), as defined by new ST segment changes, is associated with a nine-fold increase in the odds of suffering major cardiac events (cardiac death, nonfatal myocardial infarction or nonfatal cardiac arrest) which makes it the most important predictor of these events after non-cardiac surgeries ***(Mangano et al., 1990).***

Based on that evidence, American College of Cardiology (ACC) and the American Heart Association (AHA) task forces, focusing on perioperative cardiac surveillance recommend the following for detecting ischemia in high risk cardiac patients in non-cardiac surgery: a preoperative 12-lead electrocardiogram (ECG), an electrocardiogram immediately after the surgical procedure, and a computerized ST segment analysis on the first two days following the operation ***(Mason et al., 2007).***

New ECG changes indicative of myocardial ischemia (i.e. new ST segment changes) can predict major cardiac events after non-cardiac surgeries. A few previous studies have suggested that. An accurate understanding of this potential association requires a comprehensive, systematic, and an unbiased assessment of the literature. We therefore undertook a systematic review to address the following: the role of new ECG changes in predicting major cardiac events after non-cardiac surgeries.

Aim of the Work

The aim of the current study is to conduct a systematic review of the literature regarding the role of new ECG changes in predicting major cardiac events after non-cardiac surgeries.

Definition, Incidence and Significance of New ECG Changes after Non-Cardiac Surgeries

Definition:

New Q-wave changes (≥ 30 ms) present in any 2 contiguous leads fulfill the definition of the development of pathological Q waves. We define electrocardiogram (ECG) changes indicative of ischemia as ST-segment elevation (≥ 2 mm in leads V1, V2 or V3 and ≥ 1 mm in the other leads) or ST-segment depression (≥ 1 mm) in at least 2 contiguous leads, or symmetric inversion of T waves (≥ 1 mm) in at least 2 contiguous leads ***(Devereaux et al., 2005).***

ST segment abnormality is most specific. The basis of ST segment changes is due to repolarisation. ATP-sensitive potassium channels (KATP channels), a subtype of potassium channels present in cardiac myocytes regulate cellular response to hypoxia and ischemia. When there is an insult, these channels open up and cells begin losing potassium. This alters electrochemical potential which is recorded on surface ECG as ST segment alteration. Horizontal or down sloping ST depression of more than 1 mm at 60 msec from the ‘J’ point lasting for at least 60 seconds is suggestive of ischemia. This has been accepted by American college of cardiology. ST segment depression indicates subendocardial ischemia and elevation indicates transmural ischemia. Up sloping ST depression of at least 1.5mm and measured 80msec after 'J' point is also a marker of ischemia, but with shorter duration, it loses its validity ***(Dash, 2002).***

Incidence:

Two different mechanisms lead to perioperative myocardial infarction (PMI): PMI type1 is caused by severe coronary vasospasm, leading to platelet aggregation, occlusive (ST-segment elevation, STEMI) or non-occlusive (ST-segment depression, NSTEMI) thrombus formation and prolonged myocardial ischemia resulting in cell death. Plaque disruption is demonstrated in autopsy studies in approximately 50% of patients who died of PMI. PMI type 2 usually results from a sustained imbalance between myocardial oxygen supply (decreased) and demand (increased) combined with the presence of significant, obstructive, but not occlusive, CAD. Most patients with PMI type 2 have ST-segment depression (NSTEMI) ***(Mathis et al., 2013).***

Patients undergoing major operations are particularly prone to ischemic adverse events because of the surgery associated inflammation and hypercoagulable state, as well as preoperative factors that increase the risk of plaque rapture (pain, hypertension, elevated levels of catecholamines), increase myocardial oxygen demand (hypertension, tachycardia, elevated left ventricular diastolic pressure), or decrease myocardial oxygen supply (blood loss, anemia, hypotension, hypoxia , tachycardia , coronary vasoconstriction) ***(Pearse et al., 2011).***

NSTEMI is the most common type of PMI. Compared with patients with STEMI, patients with NSTEMI are generally older have multivessel and\or left main CAD more frequently, and often have multiple risk factors and comorbidities. ST- segment depression is quite common, occurring in approximately 30% of patients, whereas 20% of patients have T-wave inversion, and 10% have ST- segment elevation. Conversely, ECG changes may be only minor or transient in approximately 40% of patients ***(Haeck et al., 2009).***

Significance:

Electrocardiography was invented more than 100 years ago. ECG has since then been part of perioperative cardiac assessment and ECG changes have been recognized for their help in determining intraoperative or postoperative cardiac events. However, ECG has lost ground in detection of ischemia in the operating room due to the introduction of invasive hemodynamic monitoring and echocardiography procedures such as transoesophageal echocardiography (TEE). Although the scientific community has focused extensively on these newer methods, several recent studies have highlighted the significance of perioperative ECG monitoring in preoperative risk stratification, as well as in intraoperative and postoperative ischemia detection. Accumulating evidence clearly indicates that preoperative, intraoperative and postoperative ischemia monitoring with ECG significantly contributes to patient safety and by allowing an early diagnosis of cardiac complications reduces length of hospital stay ***(Roizen et al., 2010).***

Wright and Hunt (2008) showed that the significance of ST-segment depression that is incidentally picked up in the general patient depends on the clinical probability that the patient has coronary artery disease. This viewpoint is as