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Acute mesenteric ischemia following cardiovascular surgery – A nested case-control study

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HIGHLIGHTS

- This study focusses on acute mesenteric ischemia following cardiovascular surgery.
- Preoperative versus perioperative risk factors were compared to predict mesenteric ischemia.
- Early postoperative parameters are superior to facilitate early diagnosis of mesenteric ischemia.
- Liver cirrhosis and emergency operation remain preoperative key factors.
- Serum lactate and use of catecholamines are most important perioperative indicators.

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ABSTRACT

Introduction: Acute mesenteric ischemia is a rare but often fatal complication following cardiovascular surgery. Early suspicion may reduce overall mortality. This retrospective study aims to identify predictors and risk factors that may determine the onset and evolution of acute mesenteric ischemia.
Methods: In a retrospective case-control study, we compared co-morbidities and peri-operative risk factors of patients with or without mesenteric ischemia following cardiac surgery using univariate and logistic regression analyses.
Results: Of 9385 patients, 108 (1.15%) were diagnosed with acute mesenteric ischemia within two weeks after cardiac surgery. In-hospital mortality was 68% for this group. Patients with ischemia and controls were matched in regard to patient's age and type of surgical intervention and showed similar pre-operative parameters. Only liver cirrhosis (OR 13.3, CI95% 3.6–49.3), and emergency operation (OR 2.6, CI95% 1.3–5.2) remained independent pre-operative predictors for acute mesenteric ischemia in multivariate analysis. In contrast, early postoperative parameters revealed a higher correlation with the occurrence of mesenteric ischemia including the use of norepinephrine (OR 3.5 CI95% 1.6–7.8), epinephrine (OR 2.0, CI95% 1.1–3.7), and serum lactate levels >3 mmol/L (OR 2.9, CI95% 1.5–5.6). A set of key markers of regression analysis was evaluated in a ROC curve analysis. The area under curve was 0.835, which indicates moderate to good prognostic accuracy.

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Conclusion: Early identification of pre- and post-operative predictors including liver cirrhosis, emergency operation, serum lactate >3 mmol/L, and the use of norepinephrine and epinephrine may help facilitate early diagnosis of acute mesenteric ischemia following cardiac surgery, and thus may allow immediate adequate treatment, leading to a reduction in mortality rates.

1. Introduction

Acute mesenteric ischemia is a rare, often fatal complication following cardiovascular surgery. It occurs between 1% and 10% [1–4], but varies with study design, definition of mesenteric ischemia and selection of patient population. It may result from embolic or thrombotic events or occur as non-occlusive disease affecting small or large bowel or both. There is a non-gangrenous and a gangrenous type [5]. It may be self-limiting, can be treated conservatively, or might even occur silent. The gangrenous form will lead to organ failure or death, if not diagnosed and surgically treated in time. Its mortality is reported to reach up to 70% [6,7].

A limited number of clinical studies have detected “patients at risk” for developing mesenteric ischemia following cardiovascular surgery to allow early diagnosis. In fact, many conditions predispose patients to mesenteric ischemia from either pre-existing or perioperative factors. Different types of recent shock, hypotension, diabetes mellitus, chronic kidney disease, age and different types of medication are widely accepted as pre-existing risk factors for mesenteric ischemia [8]. Perioperative surgical characteristics (e.g. type of operation, emergency situation, cardiopulmonary bypass, intra-aortic balloon pump, cross-clamp time, transfusion, complications) and medical factors (vasopressors, renal failure, fluid intake) may play an important role although they have been reported only infrequently [1–3,9,10].

However, a high number of patients undergoing cardiac surgery suffer from co-morbidities and other risk factors, resulting in a low positive predictive value of each of them. Therefore, the question arises, whether a combination of predisposing conditions and perioperative data may yield a higher prognostic accuracy. Mesenteric ischemia may be suspected, if a patient's condition does not improve during the postoperative course.

The aim of this study was to identify predictors of acute mesenteric ischemia and to define a set of factors and conditions that determine the onset and evolution of fatal mesenteric ischemia in patients following cardiac surgery. This may lead to an individualized postoperative management of patients at risk including parameter triggered colonoscopy or early laparotomy in cases of high suspicion for acute mesenteric ischemia.

2. Material and methods

2.1. Patient population

We conducted a case control study to identify consecutive patients with a diagnosis of mesenteric ischemia following cardiac surgery who were treated at our hospital from January 2005 through December 2012, and who had been prospectively enrolled in the hospital's database.

From patients undergoing cardiac surgery during this time period, we selected only patients who had undergone 1) coronary bypass with cardiopulmonary bypass (CPB), 2) coronary bypass without CPB, 3) valve replacement, 4) the combination of bypass and valve surgery, or 5) ascending aortic repair with CPB (n = 9385). In this subgroup we first looked at patients who were diagnosed with acute mesenteric ischemia (n = 120) and in a second step who subsequently had laparotomy within two weeks after cardiac surgery (n = 108). Mesenteric ischemia was diagnosed by CT-scanning, endoscopic or macroscopic findings of bowel ischemia, and/or was confirmed histologically.

The 108 study patients were then matched using the PROC SQL procedure (SAS software package) to patients without mesenteric ischemia at a ratio of 1:3 (one patient with mesenteric ischemia matched to three controls). Our software algorithm looked at: 1) similar age (<5.5 year difference), 2) identical type of surgical procedure (one of the five mentioned above), and 3) comparable period of surgery (matched pairs operated within 12 months or less).

2.2. Data collection

Clinical, surgical and laboratory data had been collected on all patients in our quality-information-management-system (QIMS) and COPRA (Copra System GmbH, Sasbachwalden, Germany). Preoperative data determined the SAPS II- and Euroscore including age, gender, body mass index (BMI), ASA physical status classification, history of smoking, comorbidities (arterial hypertension, pulmonary hypertension, Diabetes mellitus, atrial arrhythmia, peripheral arterial occlusive disease, coronary heart disease, symptomatic angina (grade 1–4), chronic cardiac failure (NYHA 1-4), chronic obstructive airway disease, liver cirrhosis, chronic renal failure), ejection fraction (EF), emergency admission/operation, presence of shock or cardiopulmonary resuscitation (CPR) within three weeks, myocardial infarction within 90 days, and mechanical ventilation. The vital sign “shock within 3 weeks” was defined as systolic blood pressure below 90 mmHg within 3 weeks prior to admission and chronic renal failure with hemodialysis or raised serum creatinine levels >110 μmol/L [11]. The diagnosis of liver cirrhosis was confirmed using the labMELD score (laboratory Model of End Stage Liver Disease). The patient's history provided other comorbidities.

Postoperative data (length of stay, mortality, myocardial infarction, need for cardiopulmonary resuscitation and cardioversion, respiratory failure, pleural and pericardial effusion, pneumothorax, redo-operation, use of intra aortic balloon pump (IABP) or extracorporal membrane oxygenation (ECMO), hemodialysis) were also collected from the patient management systems.

Additional intraoperative (cardiopulmonary bypass time, aortic clamp time) and perioperative data on laboratory results, fluid management, transfusion, blood pressure (MAP), mechanical ventilation, medications and interventions were obtained through the COPRA system. The data were collected by trained research nurses and reviewed by an experienced intensivist (O.B.).

Vital signs, fluid management, and the rate of vasopressor therapy were determined at hourly intervals. The amount of administered catecholamines (norepinephrine, epinephrine) was calculated from the concentration (μg/L) and the perfusor flow rate (mL/hour) and calculated as the daily average (μg/day). Biochemical tests were conducted on admission, immediately after surgery and at least twice daily during ICU stay. The postoperative results were