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UDRUŽENJE KARDIOLOGA SRBIJE
CARDIOLOGY SOCIETY OF SERBIA

Srce i krvni sudovi 2025; 44(3) : 62-66

Case report

Treatment of acute myocardial infarction as an early postoperative event after total gastrectomy and distal oesophagectomy for invasive gastric adenocarcinoma

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Abstract Acute myocardial infarction (AMI) following major upper gastrointestinal surgery is rare yet associated with high mortality. Balancing timely revascularization with the risk of postoperative bleeding presents a significant clinical challenge, especially considering the altered pharmacokinetics of dual antiplatelet therapy after gastrectomy. The goal of our case report is to demonstrate the course of treating acute myocardial infarction in a patient with stable angina and arterial hypertension, previously surgically treated for aneurysm of the abdominal aorta, yet undergoing extensive radical surgery for locally advanced malignant disease. Interventional treatment decisions had been evolving and were in concordance with the patient's symptom status, ECG changes, repeated rhythm disorders, and extensive coronary artery disease. A multidisciplinary individual approach is essential to optimize outcomes and reduce the risk of haemorrhagic complications.

Key-words acute myocardial infarction, gastrectomy, bleeding, treatment

A 57-year-old male patient, a radiologist, was hospitalized at the Department of Abdominal Surgery at the University Clinical Center of Serbia at the Division for malignant diseases of the oesophagus in May 2023 for further diagnostic assessment of dysphagia. Namely, over the previous two months, the patient had reported progressive dysphagia for solid foods and an unintentional weight loss of approximately 5 kg. Pre-admission diagnostics included oesophagogastroduodenoscopy, with a biopsy description of Barrett adenocarcinoma with foci of high-grade dysplasia, and CT of the thorax and abdomen, which demonstrated a dilated esophagus of smooth walls without mucosal folds, with a differential diagnosis of scleroderma.

His past medical history included stable angina; he underwent an exercise stress echocardiogram and a coronary angiogram four years before his current admission and was only conservatively treated for the stenosis of up to 50% of the diameter of the medial segment of the left anterior descending artery (LAD). Fractional flow reserve (FFR) and repeated stress echocardiogram were suggested six months later but were not performed. Due to an asymptomatic infrarenal aneurysm of the abdominal aorta (7 cm in diameter) and aneurysms of the common iliac arteries (up to 3.5 cm in diameter each) in 2020, aortobiiliac bypass dacron graft was implanted. He has a long-standing history of arterial hypertension and has been an active smoker for several decades. Denies taking any medication prior admission, however, in discharge report from the Department of Vascular Surgery, he was advised to continue with Aspirin 100 mg qd (which he stopped taking in the spring of 2022), Atorvastatin 20 mg qd, and Omeprazole 40 mg bd.

Physical examination upon admission was unremarkable, and the patient was hemodynamically stable. ECG depicted sinus rhythm, HR 60 bpm, lower amplitude of the R notch in precordial leads V1-V3, without significant changes in ST-T segments. Lab analyses delineated markedly elevated CA 19-9 (1236 U/L), mildly decreased free iron with normal levels of haemoglobin, and preserved kidney function without electrolyte disturbances.

Initial evaluation

CT of the chest and abdomen was repeated upon hospitalization (**Figure 1**) with several findings corroborating the diagnosis of suspected neoplasm of the cardia (Siewert tip 2; T3 N+). The esophagus was dilated along its entire length in the thoracic part, up to 3.5 cm in diameter. In its distal, abdominal segment, the oesophagus had a concentric, unevenly thickened wall, as well as the cardia and subcardial segment of the body of the stomach along a lesser curvature, with a total length and a maximum diameter on the cross section of about 4 cm both. In the hepatogastric ligament along the lesser curvature, several small individual lymph nodes up to 8 mm in diameter were noted. Upper flexible endoscopic ex-

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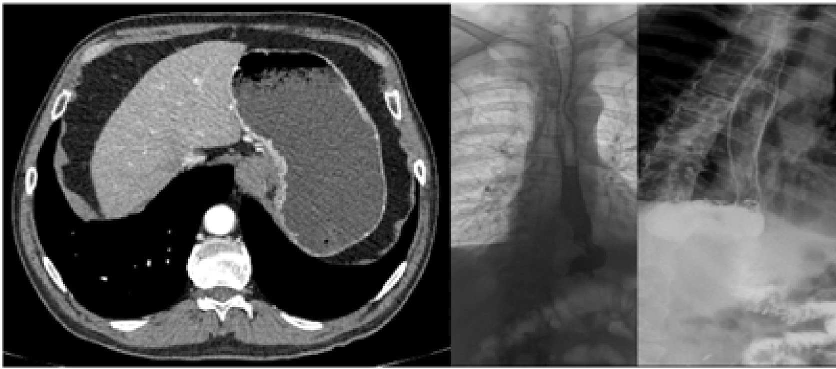

Figure 1. Preoperative CT of the abdomen (far left) and postoperative oesophageal radioscopy (right)

amination revealed that the infiltration of the cardia begins at the level of oesophago-gastric junction where the infiltration of the cardia begins.

Spirometry was ordered since CT report bilateral destructive lesions of the lung parenchyma - centriacinar and paraseptal emphysema, several micronodular lesions and basal fibroadhesions. Findings included FVC 126% (5.07 L), FEV_1 108% (3,46 L), and FEV_1/FVC 68,26. Considering prior major surgery, colour Doppler Scan of abdominal aorta was requested to confirm normal flow over the aortic graft. Consulted vascular surgeon, cardiologist, and pulmonologist confirmed that there were no absolute contraindications for the proposed surgical treatment. Surgical procedures performed include distal oesophagectomy, total gastrectomy, omentectomy, and radical D2 lymphadenectomy, with an oesophagojejunal and sec—Roux-en-Y entero-enteric anastomosis.

Diagnosis and Management

On the second evening after surgery (31.05.2023), in the intensive care unit (ICU), patient complains of shortness of breath (oxygen saturation rate 90%) and is excessively sweating.

ECG monitoring revealed episodes of non-sustained and sustained ventricular tachycardia with a heart rate up to 160 bpm, which reverted to sinus rhythm after medical therapy. Due to hypotension, intravenous crystalloids and colloids were intensified, and norepinephrine infusion was initiated. One hour later, laboratory testing showed elevated high-sensitivity troponin T (267 ng/mL), B-type natriuretic peptide (BNP) 286 pg/mL, and NT-proBNP 715 ng/mL. An hour afterward, the patient experienced predominantly left-sided chest pain radiating to the scapula, accompanied by nausea. ECG showed new T-wave inversion in lead aVL. A cardiology consultation was obtained, and dual antiplatelet therapy (DAPT) was recommended; however, due to the high postoperative bleeding risk, only 100 mg of aspirin was administered.

Repeated enzymes four hours later with rising Troponin T 1961 ng/mL and NT-proBNP 1006 ng/mL indicated that the reason for deterioration of his clinical condition may hide in previously known ischaemic heart disease accompanied by acute heart failure. ECG on the morning after depicts flat T waves in lead I and mild ST elevation in lead aVL with terminally inverted T waves.

Proceeding with FOCUS transthoracic echocardiographic (TTE) exam, left ventricular end-diastolic over end-systolic diameter (EDD/ESD) were 48/34 mm, with ormal wall dimensions. Segmental wall motion abnormalities included hypokinesia of the proximal 2/3 of the septum with LV ejection fraction (EF) around 50%. Right ventricle was of normal dimensions (2.4 mm). Trivial mitral regurgitation (MR) was noted in the dilated left atrium (LA).

After consulting with clinical and interventional cardiologists, the patient was transferred to the catheterization laboratory.

Coronary angiogram was conducted less than one day after onset if chest pain. The left main was without angiographically significant stenoses. LAD in the medial segment had a short stenosis of 70%, and more distally, a long stenosis of 70-90%, TIMI 3. The first diagonal branch had an ostial stenosis of 80-90%. The left circumflex (LCx) artery had a stenosis in the proximal segment of 50-70% in diameter, TIMI 3. The obtuse marginal (OM) branch had an ostial stenosis of 70-90%. The right coronary artery (RCA) in the proximal segment has a stenosis of 70-90%. In the distal segment of the RCA, diffuse disease with stenosis 50-70% before the crux, TIMI 3. The initial conclusion was to defer intervention pending discussion at the cardiology-cardiac surgery Board meeting, where the revascularisation strategy (coronary artery bypass grafting (CABG) vs. percutaneous coronary intervention (PCI)) would be discussed.

Follow-up

The patient was transferred to the Coronary Care Unit. Several hours after returning to the CICU, the patient reported mild chest discomfort that later worsened, accompanied by recurrent non-sustained ventricular tachycardia. The ECG showed ST elevation in leads I, aVL, and aVR, with reciprocal ST depression in leads II, III, aVF, and the anterior precordial leads (**Figure 2**). After clearance from the abdominal surgical team, DAPT was administered via jejunostomy (aspirin 300 mg and ticagrelor 180 mg), and the patient was returned to the cath lab.

Although the angiographic findings remained unchanged, considering the ECG changes and symptoms, balloon angioplasty of the ostial obtuse marginal branch was performed. On the morning after, the decision from the Division of interventional cardiology was to perform PCI of the LAD and RCA. The patient received two drug-eluting stents in the medial LAD and one at the proximal segment of the RCA (**Figure 3**). In the following days, the patient was haemodynamically stable, without chest pain, symptoms and/or signs of heart failure.

Despite receiving a total of 450 mL of contrast during three procedures, renal function remained intact. C-reactive protein (CRP) levels increased to 115.5 mg/L due to presumed bacterial bronchopneumonia, which resolved with triple antibiotic therapy. Multiplate ag-

gregometry showed adequate platelet inhibition with ticagrelor but suboptimal response to aspirin. Comprehensive TTE exam (**Figure 4**) confirmed hypokinesia of the basal 1/2 of the inferior and anterior wall and the basal third of the lateral wall, EF of the LV of 45% and diastolic dysfunction type 2.

Discharge and outcome

On the seventh day of treatment in the Cardiac Intensive Care Unit (CCU) the patient was transferred to the Cardiology Ward. Oesophageal radioscopy verified normal contrast passage through the oesophago-jejunal and enteric anastomoses without extraluminal leakage. CT of the endocranium, performed due to diminished dorsiflexion and tingling in the right foot, showed only mild cortical reductive changes. The patient was discharged on June 15th, 2023, with the subsequent treatment regimen: aspirin 100 mg qd, ticagrelor 90 mg bd, pantoprazole 40 mg qd, bisoprolol 2.5 mg qd, trimetazidine MR 35 mg bd, rosuvastatin 20 mg qd, spironolactone 50 mg qd, nitroglycerin spray (only if needed).

Pathology report confirmed invasive adenocarcinoma of the cardia infiltrating the distal esophagus—Grade 3, Stage IIIC (pTNM8: T4a N3a [14/27] Mx L1 V1 PN1, R0).

The case was presented to the Oncology Advisory Board in June and July 2023. At follow-up (19 July 2023), the patient was asymptomatic, actively participating in cardiac rehabilitation, and able to walk up to 4 km daily, though he continued smoking. Blood pressure was 110/70 mmHg, heart rate 64 bpm, ECG showed sinus rhythm with T-wave inversion in lead aVL, and TTE demonstrated LVEF 55% with hypokinetic basal segments of the inferior and inferolateral walls. There were no contraindications for chemotherapy.

Unfortunately, the patient did not continue follow-up at our institution and passed away on January 11, 2024. The cause of death remains unknown, as electronic medical records did not provide access to the death certificate.

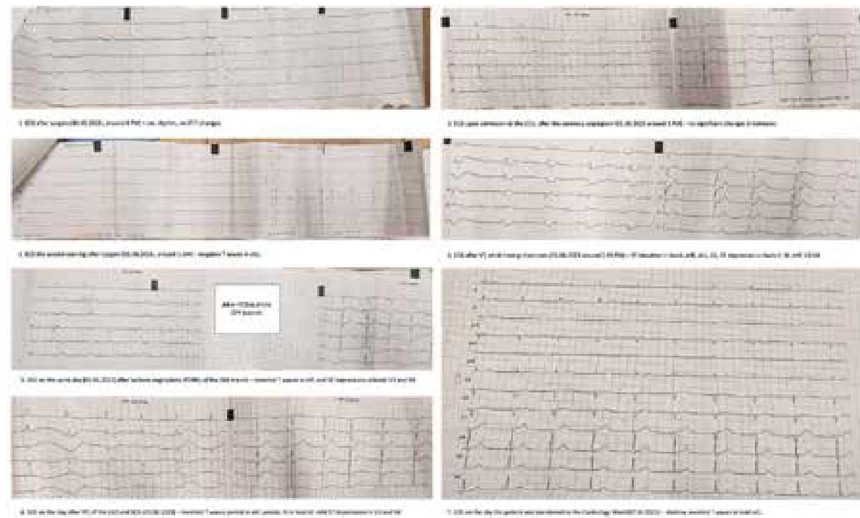

Figure 2. ECGs from May 30th to June 07th 2023

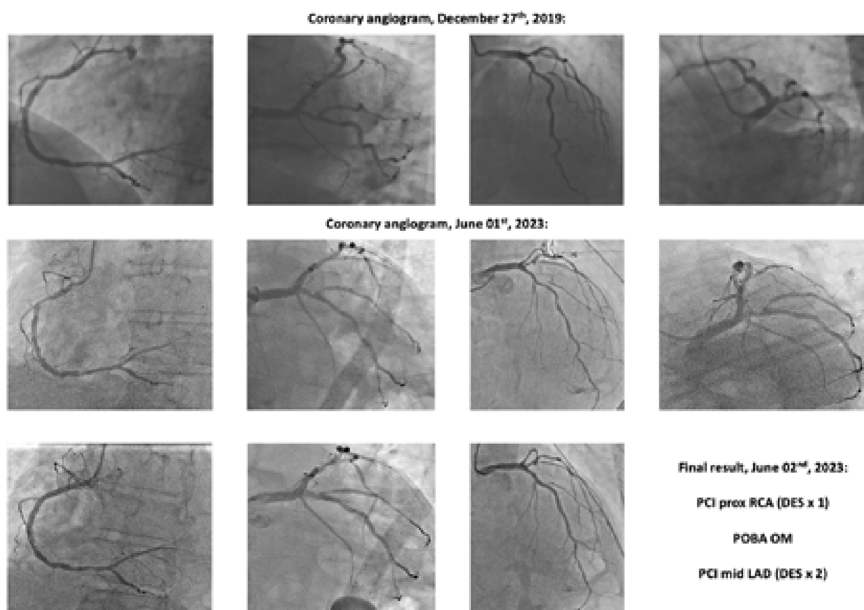

Figure 3. Coronary angiograms (2019 - 2023)

Discussion

It is estimated that the prevalence of active cancer in patients with acute coronary syndrome is around 3% and they are regarded as a subset with a high-bleeding risk, weighing the choice and duration of DAPT[1]. Incidence of AMI in the first year after gastric surgery from Swedish healthcare databases is 1.33% with the highest probability to occur in the first 30 days after surgery[2]. Due to advances in gastric cancer treatment, mortality rates due to cardiovascular diseases in this patient population steadily increase over the last decades[3].

Without firm data to support treatment decisions, approaches after PCI are often case-dependent and require close in-patient adverse events monitoring and more frequent follow-up visits after discharge. When total gastrectomy was performed in our patient, the findings on the first coronary angiogram where no obstructive disease or angiographically unstable plaques were noted, interventional cardiologists were cautious in terms of potential stent implantation, which was performed on the third procedure in less than a 24-hour time span. Pharmacokinetics of aspirin and P2Y12 inhibitors is significantly impeded after gastrectomy, especially since early drug administration occurs via jejunostomy. In the setting where the risk of stent thrombosis is the highest, DAPT efficacy is paramount for stent patency, especially in patients with myocardial infarction (MI) as a clinical presentation[4]. Absorption of acetyl-salicylic acid occurs

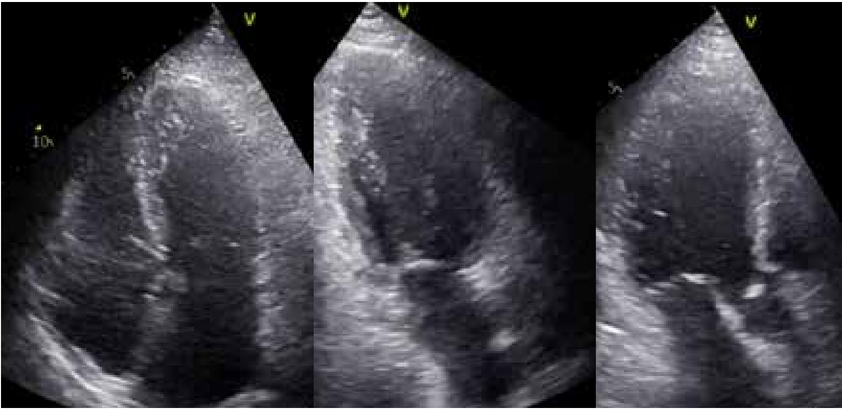

Figure 4. FoCUS TTE 02.06.2023 – apical views

in the stomach, small, and large intestines[5], and it has been shown that bioavailability of ticagrelor oral suspension decreases as distally it is released up to the ascending colon[6]. A study evaluating 10 cases demonstrated reduction of on-aspirin platelet reactivity in eight patients after bariatric surgery[7]. However, in our case multiplate aggregometry showed better therapeutic response from ticagrelor than from aspirin. Cytochrome P450 enzymes in enterocytes and hepatocytes remain of key importance for enabling P2Y12 inhibitor active metabolites to exhibit their effects in systemic circulation[8]. To the best of our knowledge, there are no peer-reviewed publications assessing DAPT efficacy in the setting of gastrectomy in locally advanced malignancy.

Diagnostic algorithm proposed by the 2022 ESC Guidelines on cardiovascular assessment and management of patients undergoing non-cardiac surgery underlines key steps in addressing ventricular arrythmias in patients with either functionally normal heart or with established structural cardiac disease[9]. Causal treatment of nsVT together with amiodarone or beta blockers did suffice in our case, yet burden of malignant arrhythmias may persist in patients with extensive myocardial scars, prompting catheter ablation.

In the BASEL-PMI study, about 16% of patients aged over 65 years with pre-existing coronary or peripheral artery disease undergoing major non-cardiac surgery developed perioperative myocardial injury (PMI) with up to six times higher 30-day mortality than the ones who remained PMI-event free[10] PMI usually is missed in the absence of systematic screening.\nMETHODS: We performed a prospective diagnostic study enrolling consecutive patients undergoing noncardiac surgery who had a planned postoperative stay of ≥24 hours and were considered at increased cardiovascular risk. All patients received a systematic screening using serial measurements of high-sensitivity cardiac troponin T in clinical routine. PMI was defined as an absolute high-sensitivity cardiac troponin T increase of ≥14 ng/L from preoperative to postoperative measurements. Furthermore, mortality was compared among patients with PMI not fulfilling additional criteria (ischemic symptoms, new ECG changes, or imaging evidence of loss of viable myocardium. Although occurring in a non-severe anaemia setting, our patient's case can be understood as type II MI, with postoperative blood loss and ventricular tachycardia contributing to the ECG changes and clinical presentation rather than plaque rupture itself[11] tachycardia, and anemia. Diagnosis of perioperative myocardial injury after noncardiac surgery is based on elevated cardiac troponin levels, greater than the 99th percentile of the assay's upper reference limit within 30 days of surgery. Perioperative myocardial injury is further classified into non-ischemic and ischemic based on the underlying pathophysiology. Ischemic injury, also called myocardial injury after noncardiac surgery (MINS. Perioperative MI, in addition, prolongs in-hospital stay and increases the probability of readmission and the risk of developing congestive heart failure and stroke(10,11)PMI usually is missed in the absence of systematic screening.\nMETHODS: We performed a prospective diagnostic study enrolling consecutive patients undergoing non-cardiac surgery who had a planned postoperative stay of ≥24 hours and were considered at increased cardiovascular risk. All patients received a systematic screening using serial measurements of high-sensitivity cardiac troponin T in clinical routine. PMI was defined as an absolute high-sensitivity cardiac troponin T increase of ≥14 ng/L from preoperative to postoperative measurements. Furthermore, mortality was compared among patients with PMI not fulfilling additional criteria (ischemic symptoms, new ECG changes, or imaging evidence of loss of viable myocardium.

Evidence and experiences of long-term prognosis after PCI in patients who are in T4 stage of gastric cancer are sparse. A retrospective cohort study from South Korea, one of the regions where screening programs contribute to one of the highest incidences and survival rates in the world, encompassing over 37,000 gastrectomy patients, reported a one-year incidence of acute MI, revascularization, or ischemic stroke of 2.9%, lower than in patients undergoing endoscopic resection (5.4%) or the general population over a seven-year follow--up[12]. However, most cases (>63%) involved early-stage gastric cancer, and cancer stage was not specified. In a U.S. database of over 29,000 gastric cancer cases (2000–2015), only 4.9% were classified as T4/N3, and cardiovascular deaths occurred in 0.9% of patients, with the highest risk in the first year post-diagnosisa[3].

Conclusion

Our case illustrates the complexity of managing acute coronary syndromes in patients with untreated cardiovascular risk factors undergoing extensive surgery for locally advanced malignancy. Early signs of hemodynamic deterioration, including ventricular tachycardia and hypotension, heralded the development of acute MI. Continuous ECG monitoring and transthoracic echocardiography, together with elevated cardiac biomarkers, guided the clinical decision to transfer the patient to the coronary care unit. Despite recent major surgery

for advanced malignancy, it was recognized that his acute, life-threatening condition was primarily driven by myocardial infarction and its complications.
In the setting of total gastrectomy, therapeutic strategies must carefully balance the competing risks of bleeding and ischemia. This case underscores the need for individualized, multidisciplinary management involving surgical, cardiology, and critical care teams to achieve optimal outcomes in such complex clinical scenarios.

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Sažetak

Lečenje akutnog infarkta miokarda kao ranog postoperativnog događaja nakon totalne gastrektomije i distalne ezofagektomije zbog invazivnog adenokarcinoma želuca

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Akutni infarkt miokarda (AIM) nakon velike operacije gornjeg dela gastrointestinalnog trakta je redak, ali je povezan sa visokom smrtnošću. Balansiranje blagovremene revaskularizacije sa rizikom od postoperativnog krvarenja predstavlja značajan klinički izazov, posebno imajući u vidu izmenjenu farmakokinetiku dvostruke antitrombocitne terapije nakon gastrektomije. Cilj našeg prikaza slučaja je da se demonstrira tok lečenja akutnog infarkta miokarda kod pacijenta sa stabilnom anginom i arterijskom hipertenzijom, prethodno hirurški lečenog zbog aneurizme abdominalne aorte, a koji se podvrgava opsežnoj radikalnoj operaciji zbog lokalno uznapredovale maligne bolesti. Odluke o interventnom lečenju su se razvijale i bile su u skladu sa stanjem simptoma pacijenta, EKG promenama, ponovljenim poremećajima ritma i opsežnom koronarnom arterijskom bolešću. Multidisciplinarni individualni pristup je neophodan za optimizaciju ishoda i smanjenje rizika od hemoragičnih komplikacija.

Ključne reči: *Akutni infarkt miokarda, gastrektomija, krvarenje, lečenje*