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Case Report

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A Novel Method for Detecting Coronary Artery Involvement Through Intravascular Injection of Fluorescein: A Case Report

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Abstract

Introduction: Fluorescein angiography is considered a diagnostic imaging technique that involves injecting fluorescein into the patient's bloodstream and then capturing images of the dye as it passes through the patient's blood vessels.

Case Report: The present study is a case report of a 62-year-old male with type II diabetes who was admitted due to an infectious diabetic foot and signs of gangrene. The patient underwent angiography for the preparation of amputation. However, the angiography revealed a severe three-vessel disease, making him a candidate for coronary artery bypass graft. In this surgery, before initiating grafting and during thoracoscopy, fluorescein was injected into the intravascular arteries to locate the graft sites and for real-time visualization of coronary arteries. After the procedure, the patient's hemodynamic status was stabilized, and he was discharged in a desirable condition.

Conclusion: The importance of intraoperative fluorescence imaging in increasing the success rate of minimally invasive coronary artery bypass graft outcomes and reducing the patient's complications after discharge.

Keywords: Coronary vessels, Fluorescein angiography, Coronary artery bypass

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Introduction

Coronary heart disease represents a significant global public health concern, with profound implications on quality of life, disability, and mortality rates. Cardiac catheterization serves as a prevalent medical intervention for both diagnostic and therapeutic purposes in addressing this ailment. Another commonly employed therapeutic approach, on a global scale, for managing coronary disease is coronary artery bypass grafting (CABG). Progressions in this surgical procedure have resulted in enhanced postoperative and long-term prognoses for individuals undergoing this intervention (1).

Fluorescein angiography is considered a diagnostic imaging technique that involves injecting fluorescein into the patient's bloodstream and then capturing images of the dye as it passes through the patient's blood vessels. The dye fluoresces when exposed to a specific wavelength of light, allowing the physician to identify the location of any abnormalities or vascular blockages (2). Near-infrared-II fluorescence imaging is utilized by surgeons for real-time identification of precise tissues and structures. This technique involves the molecular and cellular labeling of tissues, enabling enhanced resolution and sensitivity in comparison to traditional preoperative radiolabeled imaging methods. Presently, the Food and Drug Administration (FDA) has approved various NIR fluorescent dyes such as indocyanine green (ICG) and methylene blue, along with imaging systems, for clinical use (3).

Given the continuous advancements in medical science, it is imperative for healthcare professionals, including

physicians and other members of the healthcare team, to remain abreast of the latest developments in the field of medicine. Consequently, the objective of this study was to propose a novel diagnostic methodology involving the intravascular administration of fluorescein for visualizing the coronary arteries in a patient who had undergone CABG.

Case Report

A 62-year-old man with a 26-year history of type 2 diabetes presented with infection and discharge from his left big toe. Eight months earlier, he was hospitalized for a wound on his right big toe, which resulted in amputation. Three months ago, a blister formed on his left big toe, which became infected and also required amputation. He subsequently developed infection, foul-smelling discharge, and pain at the amputation site, leading to referral to the infectious disease department. Additionally, he experienced pleural effusion one month ago.

The patient's medical history includes diabetic nephropathy, retinopathy, and severe dyspnea classified as Class 4 by the New York Heart Association (NYHA), indicating an inability to perform any physical activity without discomfort. Symptoms of heart failure such as shortness of breath, fatigue, or chest pain are present even at rest. He has a history of ischemic heart disease with previous hospitalizations where balloon angioplasty was recommended but not performed. Family history of diabetes and heart disease is also not noted.

During a recent admission at Firoozgar Hospital in Tehran, comprehensive clinical and paraclinical evaluations revealed an ejection fraction of 30-35% and severe three-vessel coronary artery disease on angiography. Electrocardiogram showed ischemic changes, including inverted T waves in leads V4-V6 and ST depression in V5-V6, indicating the need for CABG due to extensive vascular involvement (Figure 1).

Laboratory results

Laboratory findings included: Blood sugar: 315 mg/dL, HbA1C: 7.5 g/dl, Albumin: 2.8 g/dl, urea: 54 mg/dL, Creatinine: 1.7, Na: 140 mmol/L, K: 4 mmol/L, HDL: 47 mg/dl, LDL: 52 mg/dl, CPK: 40 U/L, CK-MB: 11.6 U/L, AST: 12 U/L, ALT: 14 U/L, ALP: 385 U/L, Troponin I: < 0.1 ng/ml, CRP: 118 mg/dl, mg/H and ESR (63 mm/hr).

Angiography report

The Left Main Coronary Artery (LMCA) exhibited typical characteristics. The Left Anterior Descending (LAD) showed notable stenosis in its proximal, mid, and distal segments. The Left Circumflex Artery (LCX) presented severe, multiple, diffuse stenoses. The Obtuse Marginal (OM) arteries displayed severe, multiple, diffuse stenoses, and the Right Coronary Artery (RCA) was nearly occluded at its proximal portion with inadequate blood flow, being supplied by the left system, confirming a diagnosis of three-vessel disease (3VD) (Figure 2).

Following confirmation of three-vessel coronary involvement through angiography, the patient underwent CABG surgery involving grafting of the RCA, LAD, and OM artery. Minimally invasive CABG techniques have gained popularity in recent years due to their reduced recovery times and lower risk of complications. A renowned cardiac surgeon and researcher at Iran University of Medical Sciences has introduced a groundbreaking technique for identifying intravascular coronary arteries during minimally invasive CABG procedures using fluorescein injection. The injections were all intravenous-compatible (5 to 10 cc). The injection was done before grafting and during thoracoscopic surgery that used fluoroscopy to locate the LAD site (Figure 3).

Outcome and follow-up

Following the surgical procedure and successful stabilization of the patient's hemodynamic status, he was discharged in a favorable overall state of health.

Ethical disclosure

The Ethics Committee of Iran University of Medical Sciences (Tehran, Iran) approved this study, and the study

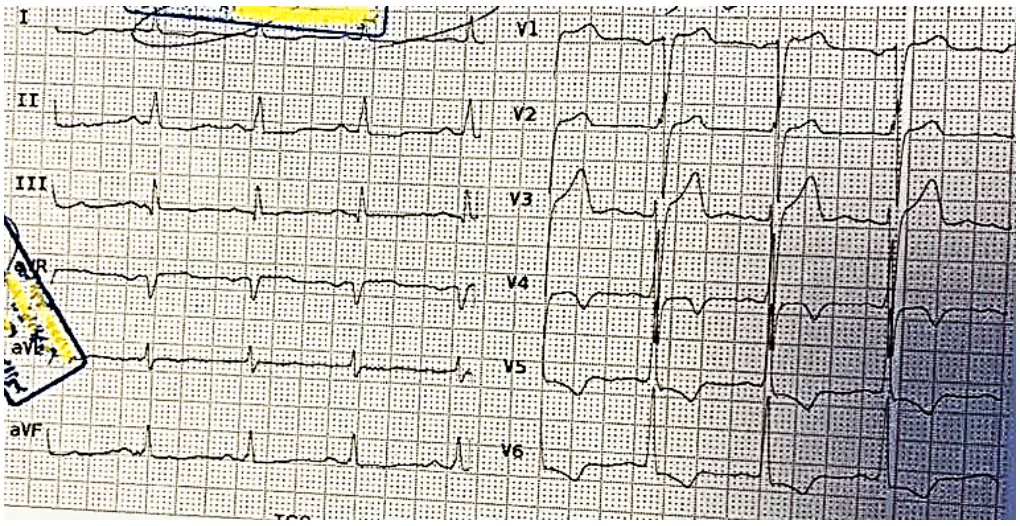

Figure 1. Alterations in the electrocardiogram (ECG) indicative of an impending myocardial infarction

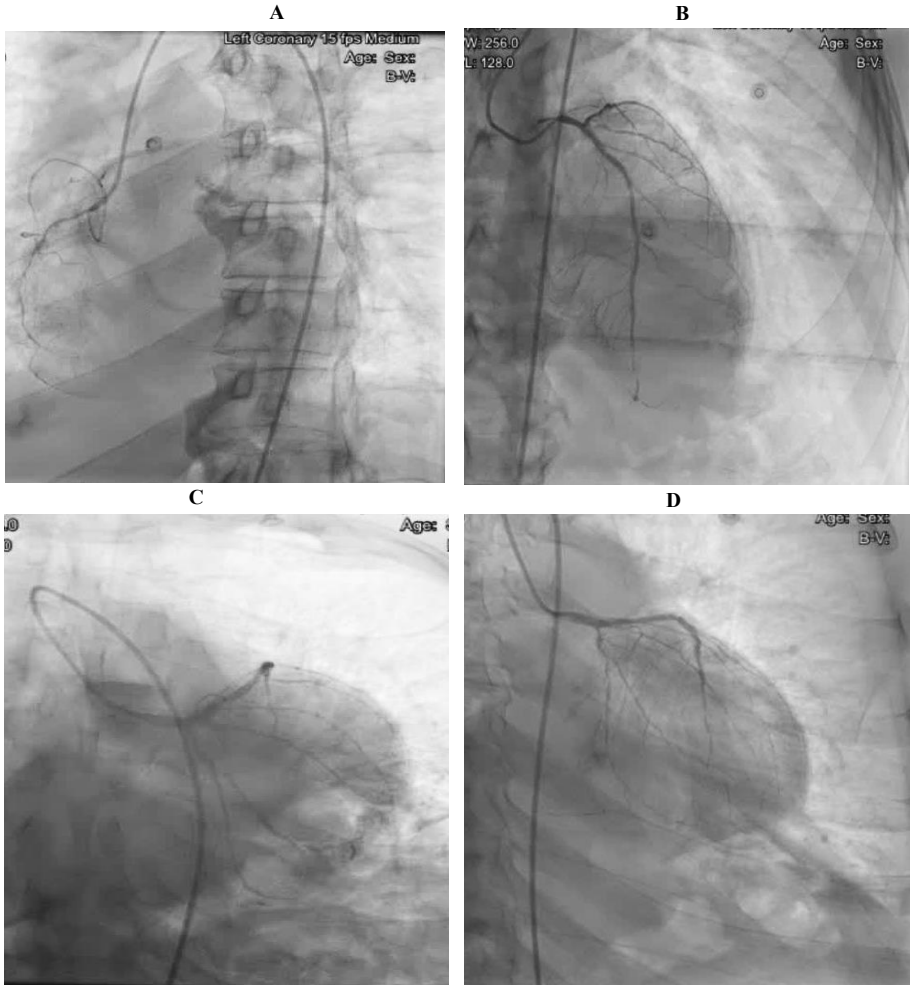

Figure 2. The different types of coronary angiography views: **A**: RCA with Diffuse Course Stenosis from The Ostia Throughout the Vessel Course **B**: LAD and OM with The Stenosis at Their Full Course Specially LAD ostial Just Like Semi CTO **C**: Spider View with The Patent Left Main Truncus but LAD and OM Stenosis **D**: Another View of LAD with the Same Amount of Stenosis

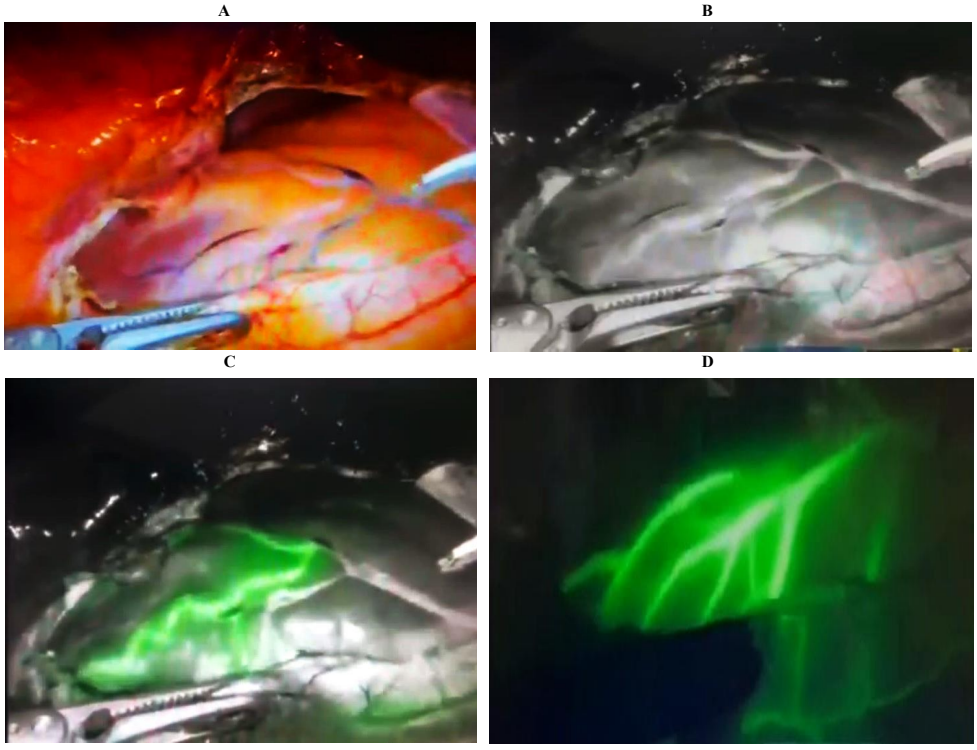

Figure 3. Various imaging techniques used to capture images of the heart both before and after the administration of fluorescein. **A:** Before imaging the heart **B:** Taking pictures of the heart without light **C & D:** After Fluorescein injection and visibility of vessels and diagnosis of LAD stenosis

was performed under the approved guidelines (Ethical code: IR.IUMS.REC.1403.1145). For the report of this case, informed consent was obtained from the patient, and he was assured that his identity would be withheld in the article, and his personal information would be kept confidential.

Discussion

In recent years, fluorescence imaging has emerged as a valuable intraoperative tool to enhance visualization and improve surgical decision-making during CABG (4). The present case report introduces a novel approach involving intravascular injection of fluorescein for real-time visualization of coronary arteries during minimally invasive CABG. This technique offers a promising alternative to conventional methods, particularly in patients with complex coronary anatomy and high surgical risk.

In minimally invasive coronary artery bypass grafting (MICS-CABG), the identification of target coronary vessels presents significant challenges due to restricted surgical exposure and the frequent occurrence of arteries embedded within myocardial tissue or adipose layers. Within this context, the intracoronary administration of fluorescent dyes, such as indocyanine green (ICG), offers a notable advantage compared to intravenous or epicardial surface application methods. Unlike intravenous delivery, which requires the fluorescent agent to traverse the systemic circulation and may result in diffuse myocardial background fluorescence, intracoronary injection introduces a concentrated bolus directly into the coronary lumen. This approach produces a high-contrast, sharply delineated arterial visualization, facilitating rapid and accurate localization of the vessel trajectory. Such precision is particularly critical in minimally invasive or robotic surgical techniques, where visualization depth and operative field access are inherently limited. Empirical evidence indicates that intracoronary fluorescence imaging enhances surgeon confidence in target vessel identification, reduces the duration of dissection, and shortens overall procedural time, all without compromising graft patency or myocardial protection (5, 6).

One of the primary reasons for adopting this technique was the need for real-time, high-resolution visualization of coronary arteries to ensure accurate graft placement. In traditional CABG, the selection of target vessels and anastomosis sites is largely based on preoperative angiography and intraoperative tactile feedback. However, preoperative imaging may not always reflect the dynamic changes in coronary flow that occur during surgery, especially in patients with compromised hemodynamics or multi-vessel disease (7). Fluorescein, a fluorescent dye widely used in ophthalmology for retinal angiography (2), was repurposed in this case to provide intraoperative vascular mapping of the LAD artery and other target vessels.

The intraoperative administration of fluorescent contrast, particularly ICG, has been shown to facilitate more efficient localization of coronary targets during CABG. In patients with intramyocardial or heavily epicardial fat-covered coronary vessels, identifying the optimal anastomotic site can be one of the most time-consuming components of the procedure. ICG fluorescence imaging enables real-time, high-contrast visualization of coronary arteries, including those embedded within myocardial muscle layers, thereby enhancing the surgeon's ability to rapidly and accurately identify the target vessel. This improved visualization reduces the need for deep and extended dissection, minimizes myocardial manipulation, and significantly shortens the time required to expose and prepare the coronary artery for grafting (8).

The advantages of this method include enhanced visualization of coronary anatomy, which can be particularly beneficial in patients with small or tortuous vessels, severe calcification, or limited surgical access due to minimally invasive approaches. In this case, fluorescein injection allowed the surgical team to clearly identify the LAD and its branches, facilitating precise anastomosis and reducing the risk of technical errors. This aligns with the findings of previous studies that have demonstrated the utility of fluorescence imaging in improving surgical precision and reducing postoperative complications (9, 10).

A notable challenge encountered during the procedure was the need for optimal timing of dye administration and coordination with the imaging system. Because fluorescein has a short half-life in the circulation, the timing of injection relative to image capture must be precise to ensure adequate visualization of the coronary tree. Additionally, the use of intravascular injection, as opposed to intravenous, requires careful planning to ensure effective delivery of the dye to the target area without systemic dispersion. While this method may reduce systemic side effects, it also demands technical expertise and familiarity with the pharmacokinetics of fluorescein. Compared to conventional CABG techniques, this novel approach offers several potential benefits. First, it allows for real-time confirmation of vessel patency and anastomotic integrity, which may reduce the need for postoperative angiography or re-exploration due to graft failure. Second, it supports minimally invasive CABG by improving visualization in limited surgical fields, such as those encountered in thoracoscopic or robotic-assisted procedures (11). Third, fluorescein is a cost-effective and widely available contrast agent, which may make this technique more accessible than alternatives such as indocyanine green (ICG), which requires specialized near-infrared imaging equipment (12).

However, there are limitations to consider. The current evidence is based on a single case report, and larger clinical trials are needed to establish the safety, reproducibility, and long-term outcomes associated with this method. Additionally, while fluorescein is generally considered safe, allergic reactions and potential toxicity have been reported, particularly in patients with renal impairment, which was present in our patient (13). Therefore, patient selection and preoperative assessment are critical to minimize risks.

Conclusion

In conclusion, the use of intravascular fluorescein injection

for intraoperative visualization of coronary arteries during CABG represents a promising innovation in cardiac surgery. It offers improved anatomical delineation, supports minimally invasive techniques, and may contribute to better surgical outcomes. Future studies should focus on optimizing injection protocols, evaluating long-term safety, and comparing this method with established fluorescence imaging techniques such as ICG-guided surgery.

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Competing Interests
The authors have no financial or nonfinancial conflicts of interest.

Data Availability Statement
The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Ethical Approval
The Ethics Committee of Iran University of Medical Sciences (Tehran, Iran) approved this study, and the study was performed under the approved guidelines (Ethical code: IR.IUMS.REC.1403.1145). For the report of this case, informed consent has been obtained, and the identity of the patient will be withheld in the article, and their personal information will be kept confidential.

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