SHORT REPORT

Indocyanine Green Fluorescence Angiography for Intraoperative Assessment of Blood Flow: A Feasibility Study

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Objective. To introduce our preliminary experience with indocyanine green (ICG) fluorescence angiography for the assessment of lower leg bypasses.

Methods. 1 ml of 0.5% indocyanine green was intravenously injected in 9 patients with PAD who underwent paramalleolar artery bypass using saphenous vein grafts. A newly developed near-infrared camera system (PDE; Hamamatsu Photonics K.K. Hamamatsu, Japan) was used for this study.

Results. ICG fluorescence angiography was performed without any adverse events. Fluorescence images of ICG angiography could be viewed as real-time images of the angiography in eight patients, while one patient underwent graft revision with the absence of fluorescence in ICG angiography.

Conclusion. ICG fluorescence angiography is clinically feasible and may help surgeons assess the quality of lower leg bypasses.

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Keywords: Indocyanine green; Fluorescence; Angiography; Near-infrared camera.

Introduction

The intraoperative assessment of graft patency is particularly important in vascular surgery. Recently, some studies have reported the usefulness of indocyanine green (ICG) – based intraoperative fluorescent angiography in coronary artery bypass1 and neurovascular surgery.2 In this study, we reported our initial experience of ICG angiography following peripheral bypass.

Patients and Methods

This study included 9 patients with critical limb ischemia (6 patients with foot ulcers, 3 patients with rest pain) who underwent paramalleolar artery bypass using saphenous vein grafts (femoro-anterior tibial artery bypass 3, femoro-posterior tibial artery bypass 6 (Fig. 1A), five men, four women, mean age: 69.5 ± 10.0 years). All bypass operations were performed by one attending vascular surgeon. Patients were interviewed regarding a history of iodine allergy, pregnancy, or previous anaphylactic reactions to contrast media. With approval of the ethical committee and written informed consent, ICG fluorescence angiography was performed. After completion of the bypass anastomoses, 1 ml of ICG (Diagnogreen 0.5%; Daiichi Pharmatical, Tokyo, Japan) was intravenously injected via a central venous line by an anesthesiologist. ICG dye reached the leg artery about 30 seconds after the injection. Intravenously injected ICG binds to circulating globulins and remains intravascular. After binding to the globulins, ICG absorbs light in the near-infrared range, with a maximum at 805 nm. ICG fluoresces with a maximum at 840 nm in plasma.3 We utilized a newly developed near infrared camera system (PDE; Hamamatsu Photonics K.K. Hamamatsu, Japan) that activates ICG with emitted light (wavelength: 760 nm).4 A vascular surgeon directly handled the

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camera unit of the device, and observed real-time images on the monitor of a laptop computer.

Results

No adverse events relating to ICG angiography were experienced. All processes including preparation of the device, injection of ICG, and observation of fluorescent images took less than ten minutes. In eight cases, ICG angiography showed good fluorescent signals as the ICG passed through the graft from the proximal to distal anastomoses (Fig. 1B), in which postoperative DSA confirmed the graft patency (Fig. 1C). However, in one case, there was no fluorescence detected in the graft (posterior tibial artery bypass) at the distal anastomosis (Fig. 2). Continuous-wave Doppler ultrasound suggested graft failure. During graft revision thrombotic occlusion of the distal anastomosis was identified.

Discussion

Although Intraoperative completion angiogram can provide clear and informative images, it requires radiation shielding and a radiographer. Moreover, the contrast is nephrotoxic. On the other hand, ICG has been widely used in a variety of clinical situations such as examination of hepatic function, and retinal angiography. ICG is a safe compound with minor side effect. For patients allergic to iodine, symptoms such as urticaria or fever may occur. ICG is removed exclusively by the liver so that it can be used for patients with renal insufficiency.

The cost of ICG was around 5 EURO per angiogram. The newly developed near infrared camera system is currently commercially available at around
20,000 ~ 25,000 EURO in Japan. The technique can be performed without any training. Therefore, ICG angiography is easy to introduce into clinical practice.

We experienced one case requiring graft revision, in which the initial bypass did not show any fluorescence signals at the distal anastomosis. The graft revision identified that the failure was attributed to thrombotic occlusion of the distal anastomosis. The other eight cases showed good fluorescent signals after revascularization, in which patency was later confirmed with postoperative DSA. No technical problems such as retained valve cusp or intimal flap were revealed. However, abnormal fluorescent signal patterns due to such technical defects are yet to be identified. Further study is needed to identify such abnormal patterns.

References


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