New Technology: Real-time Intraoperative Visual Assessment of Coronary Artery Bypass Graft (CABG) Patency

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Abstract

Introduction:
PREVENT IV trial data indicate that 1-year CABG vein graft patency may be sub-optimal due to technical and pathophysiologic factors. Identification and correction of these factors in the operating room may impact long-term graft patency. The Novadaq Spy® technology uses Intraoperative Fluorescence Imaging (IFI) to assess graft patency and the technical quality of coronary anastomoses.

Methods:
Induced fluorescence from injected ICG dye is digitally captured on a video imaging system. The entire imaging process takes 2-3 minutes/graft. ICG can be injected centrally (on-pump and off-pump CABG), or at lower concentration directly into the graft. First-pass, real-time images of graft, anastomosis and distal myocardium are acquired. Pre-revascularization images can be obtained, and compared to any post-procedure abnormalities that may be found.

Results:
Data from early US adopters (N = 5 centers) from 7/05 - 1/06 were analyzed. All pts (N = 157) underwent elective or urgent CABG. A total of 478 grafts (mean 3.04 grafts/pt) and 519 image sequences were obtained (mean 3.31 images/ procedure; range 1-9). There were no system- or dye-related complications. The "learning curve" for interpretation was short, and led to appropriate and effective revisions.

Conclusion:
IFI graft patency assessment in CABG is safe, straightforward and easy to use. Immediate technical assessment of graft patency is now possible, as is intraoperative correction. Distal myocardial perfusion characteristics resulting from revascularization may also be evaluated. IFI graft patency and perfusion assessment has the potential to become a quality metric for CABG surgery in the future.

This Study

- Data from 5 US early adopters
- July 2005 - Mar 2006
- Used for 249 elective or urgent CABG procedures
- 764 grafts (3.07 grafts/patient)
- 809 images (3.25 images / patient; range 1-9)
- No system related complications
- No dye related complications
- Short "learning curve"
- Images led to appropriate and effective revisions (see Fig)

The SPY® Intra-operative Imaging System

- Enables cardiac surgeons to
  - confirm the location of the coronary arteries
  - assess bypass graft functionality during coronary artery bypass procedures
  - assess coronary artery flow during other cardiac procedures.
- Surgeon can view, record, replay, print, and archive high quality, real-time images of the coronary arteries and bypass grafts.

Features of the SPY® Imaging Device

Imaging Head: Imaging head contains a Charge Coupled Device (CCD) camera, a laser light source, motion sensor and distance sensor attached to an articulating arm.

Automatic Focus Camera: Charge Coupled Device (CCD) camera enables the surgeon to view close-up images of the surface of the heart, Images of the fluorescence are captured at 30 frames per second.

Laser Light Source: Laser has an output of 2.0 W, illuminating an area of 56 cm^2 of the heart. The laser induces fluorescence from the injected IC-Green dye, which is digitally captured on the video imaging system.

Automatic Distance/Focus Sensor: Ensures the camera remains in constant focus

Articulating Arm Mount: Allows the camera head to be positioned easily over the patient without contaminating the sterile field

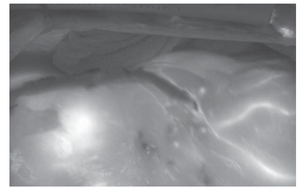
Computer Hard Drive with DVD Burner: Allows real-time digital images to be captured and stored

Keyboard: Easily accessible and allows patient information to be immediately input into the computer

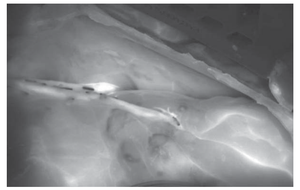
Image Printer: Allows the printing of a selected still image with the push of a button

Mobile Cabinet: Moves easily within the surgical suite and from room to room. The cabinet conveniently stores all the components of the SPY® System and the SPY® Paq

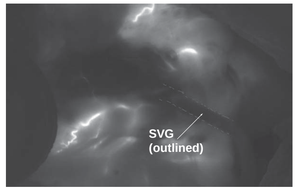
LIMA to LAD graft shows poor flow initially



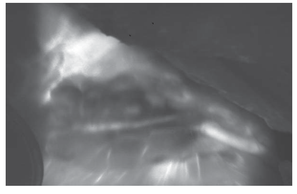
Good flow after revision of anastomosis



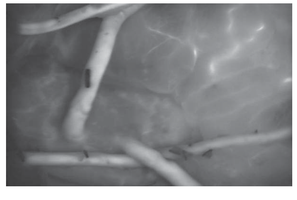
SVG to PDA shows no flow through vein graft initially



After revision SVG shows flow



Four Proximal Grafts (2SVG, RIMA, LIMA)



Conclusions

- Assessment of graft patency using Intraoperative Fluorescence Imaging is safe, straightforward and easy to use
- Allows immediate assessment of graft patency during surgical procedure
- Can be used to evaluate distal perfusion quality after revascularization

Author Disclosures

M.J. Magee, Novadaq; **L. Poa**, Novadaq; **C.M. McCarty**, None; **W. Boyd**, Novadaq; **M. Ramchandani**, Novadaq; **S.L. Prince**, None; **M.J. Mack**, Novadaq; **T. Ferguson**, Novadaq; **M.K. Dullum**, Novadaq.