A Randomized Comparison of Intraoperative Indocyanine Green Angiography and Transit-Time Flow Measurement to Detect Technical Errors in Coronary Bypass Grafts

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ABSTRACT:

Early coronary bypass graft failures may be preventable if identified intraoperatively. The purpose of this investigation was to compare the diagnostic accuracy of two intraoperative graft assessment techniques, transit-time ultrasound flow measurement and indocyanine green fluorescent-dye graft angiography.

METHODS:

Patents undergoing isolated coronary artery bypass grafting with no contraindications for postoperative angiography were enrolled in the study. Patients were randomly assigned to be evaluated with either indocyanine green angiography ("NOVADAQ" SPY angiography system; NOVADAQ Technologies Inc, Mississauga, Ontario, Canada) and then transit-time ultrasonic flow measurement (Medtronic Medi-Stim Butterfly Flowmeter TTF measurement system; Medtronic Inc, Minneapolis, Minn) or transit-time flow then indocyanine green angiography. Patients underwent x-ray angiography on postoperative day 4. The primary end point of the trial was to determine the sensitivity and specificity of the two techniques versus reference standard x-ray angiography to detect graft occlusion or greater than 50% stenosis in the graft or perianastomotic area.

RESULTS:

Between February 2004 and March 2005, 106 patients were enrolled and x-ray angiography was performed in 46 patients. In total, 139 grafts were reviewed with all three techniques and 12 grafts (8.2%) were demonstrated to have greater than 50% stenosis or occlusion by the reference standard. The sensitivity and specificity of indocyanine green angiography to detect greater than 50% stenosis or occlusion was 83.3% and 100%, respectively. The sensitivity and specificity of transit-time ultrasonic flow measurement to detect greater than 50% stenosis or occlusion was 25% and 98.4%, respectively. The *P* value for the overall comparison of sensitivity and specificity between indocyanine green angiography and transit-time flow ultrasonography was .011. The difference between sensitivity for indocyanine green angiography and transit-time flow measurement was 58% with a 95% confidence interval of 30% to 86%, *P*=.023.

CONCLUSION:

Indocyanine green angiography provides better diagnostic accuracy for detecting clinically significant graft errors than does transit-time ultrasound flow measurement.

KEY POINTS:

1. The primary objective of this study was to compare the sensitivity and specificity of ICG angiography versus TTF to detect technical problems in coronary artery bypass grafts using x-ray coronary angiography as the reference standard.
    a. 139 grafts were reviewed with all three techniques.
2. The sensitivity and specificity of ICG angiography to detect abnormal/occluded grafts were 83% and 100%, respectively.
    a. The sensitivity and specificity of TTF to detect abnormal/occluded grafts were 25% and 98.4%, respectively.

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Comparison of sensitivity and specificity of ICG angiography and TTF			
	ICG angiography	**TTF**	**P value**
Sensitivity (TP/TN+FN)	10/12 (83.3%)	3/12 (25%)	.023*
Specificity (TP/TN+FP)	127/127 (100%)	125/127 (98.4%)	.47*
Positive predictive value (TN/TN+FN)	10/10 (100%)	3/5 (60.0%)	.68
Negative predictive value	127/129 (98.4%)	125/134 (93.2%)	.72

ICG, Indocyanine green angiography; TTF, transit-time flowmetry; TP, true positive; TN, true negative; FP, false positive; FN, false negative. *Overall *P*=.011 from extended McNemar test for simultaneous comparison of sensitivity and specificity.

3. ICG angiography had superior diagnostic accuracy to TTF flow measurement.
    a. This difference was observed primarily in nonocclusive but clinically significant stenoses as opposed to total occlusions.
4. In the context of historical and contemporary graft patency studies, which have shown that 4% to 12% of bypass grafts fail in the early postoperative period, intraoperative ICG angiography will likely be able to identify most of these lesions before chest closure.
5. Intraoperative patency assessment with ICG angiography represents a significant advance in coronary bypass quality assurance.

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