The changing scene of preoperative coronary diagnostics

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Current data supporting coronary artery bypass grafting surgery (CABG) versus percutaneous coronary intervention (PCI) have been derived from studies in which the extent and severity of angiographic stenoses were largely based on visual inspection of the coronary anatomy.^{1,2} Whereas decisions of target vessel revascularization have typically been predicated on this diagnostic modality, the use of physiologically based hemodynamic effects of stenosis using fractional flow reserve (FFR) has rapidly emerged for PCI.³⁻⁶ A recent meta-analysis⁷ of 19 studies concluded that it was safe to defer PCI based on negative FFR results. Another meta-analysis⁸ that included the 2-year results from the Fractional Flow Reserve versus Angiography for Multivessel Evaluation study⁵ concluded that PCI should only be performed in the presence of hemodynamically significant lesions according to FFR. These findings support both the American (class IIA) and European (class IA) guidelines that recommend FFR for guiding percutaneous coronary revascularization.⁸⁻¹⁰ In CABG, the application of FFR in deciding whether to bypass selected targets is not yet clear.¹¹ The lack of clarity could be due to the differences between PCI and CABG. The risks of performing unnecessary PCI may outweigh the risks of additional grafts; graft failure or string sign of a graft to a target with a mild stenosis may not be as clinically important as stent failure of a similar native vessel. Furthermore, staged PCI is easier to perform than staged CABG.

In this issue of the *Journal of Thoracic and Cardiovascular Surgery*, Honda and colleagues¹² present the results of their investigation into the relationship between the preoperative severity of FFR for mild-to-moderate stenosis by visual inspection and intra- and postoperative graft characteristics. More specifically, they investigated 72 in-situ internal thoracic arteries (ITAs) (left $n = 58$ and right $n = 14$) grafted to the left anterior descending artery; each left anterior

descending artery was preoperatively stratified as severe functional stenosis (group S: $\text{FFR} < 0.70$; $n = 44$), mild functional stenosis (group M: $0.70 \leq \text{FFR} < 0.75$; $n = 14$), or

functionally nonstenotic (group N: $\text{FFR} \geq 0.75$; $n = 14$). They reported better intraoperative graft flow parameters to target vessels with more severe functional stenosis, and highlighted the presence of competitive flow in mild functional coronary stenosis. Whereas all patients left the operating room with patent grafts, postoperatively a distal thread sign was present in 50% in group N and 4.2% in group S; the latter group also had a failed ITA graft.

The strengths of this study include the simple, statistically sound design and the use of objective techniques to assess intraoperative graft flow parameters using transit time flow (TTF) measurements and indocyanine green fluorescence along with assessment of postoperative graft status with computed tomography (CT) ($n = 65$) or magnetic resonance imaging for those with renal dysfunction ($n = 2$) within 1 year. The study also had multiple limitations. Studies have shown that although TTF can predict early graft failure, cutoff values are not yet clear.^{13,14} It has been suggested that both TTF and indocyanine green fluorescence are valuable at identifying extremes (ie, occluded or patent), but neither is specific or sensitive at identifying subtle abnormalities.¹⁵ Furthermore, a distal thread sign was seen in 50% of group N patients, which could be speculated to be due to competitive flow. However, the overall incidence of thread sign was much higher than expected in 11 out of 72 (15.2%) ITAs within 1 year; this was assessed mostly by CT scan, which may not be ideal to detect such phenomena. This study was also limited by small numbers and the biases associated with a retrospective study. Furthermore, it included combined procedures that could affect intraoperative results.

Despite these limitations, Honda and colleagues¹² highlight a potentially important area in cardiac surgery—the use of FFR in CABG. Although the literature is limited, a recent observational study by Toth and colleagues¹⁶ involving 627 patients reported that FFR-guided CABG was associated with fewer graft anastomoses and a lower rate of on-pump surgery and angina compared with angiography-guided CABG. Botman and colleagues¹⁷

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studied 164 patients and reported an occlusion rate of 8.9% in bypass grafts with functionally significant lesions compared with 21.4% of the functionally nonsignificant lesions at 1 year. Furthermore, the study by Honda and colleagues¹² sheds light on the early graft flow characteristics based on the functional stenosis severity of the native vessel. These studies support the notion that the nature of stenosis (anatomic vs functional) is important in surgical revascularization.¹¹ Such findings further reinforce the importance of the heart team approach for patients with multivessel disease. Moreover, as further studies, including the third Fractional Flow Reserve versus Angiography for Multivessel Evaluation study,¹⁸ continue to evolve and noninvasive methods of FFR are developed, including CT¹⁹ and magnetic resonance imaging,²⁰ there stands a likely possibility that coronary disease will be reclassified from anatomic to functional, which may change indications altogether for surgical revascularization in the future.¹¹

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