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Commentary: Transit time flow measurement: Similar to the National Football League's "play under review" for arterial and venous coronary artery bypass grafts

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The editorial "Intraoperative Graft Patency Validation: Friend or Foe?" by Akhrass and Bakeen¹ makes sensible recommendations regarding intraoperative determination of coronary graft patency. The article references transit time flow measurement (TTFM), epicardial ultrasound, indocyanine green imaging, and on-table coronary angiography, with most of the discussion detailing TTFM.

In my practice, TTFM is akin to the National Football League's (NFL's) "play under review" feature.² Started in 1986, "play under review" employs multiple camera images of controversial plays to scrutinize for "indisputable visual evidence" that would overturn the on-field referee's call on that particular play. For NFL aficionados, the "play under review" version from 1986 to 1991 had a 10% to 12% reversal rate, whereas the updated 1999 to present version has a 38% reversal rate. Interestingly, Super Bowl "play under review" has a greater than 50% call reversal.

As "play under review" has evolved since its introduction, TTFM has improved since its inception. Also similar to "play under review," TTFM should not be the decider but a tool to assist in a decision on graft revision. Ultrasound probe flow measurements can be used to confirm clinical judgment on graft flow. TTFM will rarely provide



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CENTRAL MESSAGE

Like the NFL's "play under review," use TTFM as additional tool when making a decision to revise a CABG conduit.

"indisputable evidence" of impending graft failure. Thuijs and colleagues³ reported that only 15% of grafts that met criteria for revision were revised. Another caveat is that grafts that were considered abnormal on TTFM and not revised still had 75% patency on angiography at 1 year.⁴

Beginning with viewing the preoperative cardiac catheterization, the surgeon has an impression of which vessels will be good or marginal targets. Preoperative marginal targets may be better in the operating room if they fill only via collaterals, are in a recent infarct distribution, or are intramyocardial. The quality of the vein and radial artery, their number of side branches, areas of narrowing, location of vein valve to an anastomosis, regions of hematoma or dissection and graft flow by hand injection are assessed after harvesting. Flow through the mammary/mammaries must also be evaluated before bypass.

After completing the distal vein or in situ radial artery anastomosis, flow can be judged via hand injection of the distal anastomosis. Mammary flow can be roughly assessed by how rapidly the distal artery fills, or by witnessing rapid temperature increase in the cooled, arrested bypassed coronary's distribution after the internal mammary artery bulldog is removed. If there is suspicion of a technical issue after the distal anastomosis (especially the left anterior descending), the anastomosis should be revised at this juncture.

After removing the crossclamp or side-biting aortic clamp, the proximal vein and in situ radial anastomoses are assessed. Weaning from cardiopulmonary bypass and transesophageal echocardiogram review of regional wall function allows further input into graft patency. TTFM is most valuable at this point.

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The surgeon has a good idea which grafts are augmenting cardiac function and which may be suspect. He or she knows which targets were marginal, or which targets received poor quality graft conduit, and therefore the conduits which may have low TTFM. In this scenario, TTFM provides information to confirm the surgeon's clinical impression. If a bulldog clamp has been inadvertently left on a distal graft, or if the graft has a twist or kink, then TTFM will provide "indisputable visual evidence." More commonly the properly sized, lubricated, and aligned ultrasound probe will confirm the surgeon's convictions. Unless there is an obvious technical problem, most grafts will not be revised. In fact, Kim and colleagues⁵ reported that in TTFM-evaluated conduits having revision, up to 50% still had an abnormal TTFM after revision.

My experience is that patients undergoing coronary artery bypass grafting with grafts redone at this juncture of the operation have greater morbidity/mortality than patients in whom grafts were revised after the initial distal anastomosis.

The harvesting of internal mammary and radial artery grafts has greater propensity than vein for localized dissection, hematoma, or misapplied clips, which can affect flow. As the use of arterial conduits increases, TTMF will likely

have greater relevance because these anastomoses cannot be evaluated with hand injections.

Unlike the Super Bowl "play under review," which can only be requested by the head coach 2 times per half, the operating surgeon can measure arterial or venous conduit flow as frequently as necessary. Use of TTFM in concert with the clinical picture will result in infrequent "indisputable evidence" to revise coronary artery bypass grafting conduits. TTFM will be unlike "play under review" in that the graft revision rate will not approach the NFL's "play under review" 38% call reversal rate.

References

1. Akhrass R, Bakaeen F. Intraoperative graft patency validation: friend or foe? *J Thorac Cardiovasc Surg Tech.* 2021;7:131-7.
2. National Football League. Football Operations. Available at: <http://www.operations.NFL.com>. Accessed February 1, 2021.
3. Thuijs DJFM, Bekker MWA, Taggard DP, Kappetein AP, Kieser TM, Wendt D, et al. Improving coronary artery bypass grafting: a systematic review and meta-analysis on the impact of adopting transit-time flow measurement. *Eur J Cardiothorac Surg.* 2019;56:654-63.
4. Singh SK, Desai ND, Chikazawa G, Tsuneyoshi H, Vincent J, Zagorski BM, et al. The Grafting Imaging to Improve Patency (GRIIP) clinical trial results. *J Thorac Cardiovasc Surg.* 2010;139:294-301.e1.
5. Kim KB, Kim JS, Kang JJ, Koo BK, Kim HS, Oh BH, et al. Ten-year experience with off-pump coronary artery bypass grafting: lessons learned from early postoperative angiography. *J Thorac Cardiovasc Surg.* 2010;139:256-62.