complex network meta-analysis that suffers from the methodological biases typical of this statistical technique.

Declaration of interests

The authors declare no conflicts of interests.

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29 July 2020

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https://doi.org/10.1016/j.amjcard.2020.08.023

Meta-Analysis Comparing Angiography-Guided Versus FFR-Guided Coronary Artery Bypass Grafting

Fractional flow reserve (FFR) is the ratio of mean distal coronary artery pressure to the simultaneous mean aortic pressure at maximal hyperemia. FFR provides an objective assessment of the flow in a coronary artery and is the gold standard for physiological stenosis severity assessment. An FFR cutoff of ≤ 0.80, indicating the mean hyperemic coronary pressure is reduced by at least 20% from the theoretical maximum value, is used in contemporary practice to define a physiologically significant stenosis. FFR-guided decision making for percutaneous coronary intervention (PCI) has showed improved outcomes compared with angiography alone.[1] It remains unknown if such an approach can improve outcomes for coronary artery bypass grafting (CABG). The goal of this meta-analysis is to determine if FFR-guided CABG has better outcomes compared with angiography guidance alone.

We searched multiple databases for studies comparing FFR-guided versus angiography-guided CABG. We used the aggregated odds ratio (OR) and corresponding 95% confidence interval (CI) for measuring outcomes. Statistical analyses were performed using Review Manager Version 5.3 (The Nordic Cochrane Center, The Cochrane Collaboration, 2014).

There were 5 studies included in this meta-analysis (2 randomized control trials, 2 prospective observational studies, and 1 retrospective propensity matched observational study).[2–6] Studies were done from 2007 to 2019. The follow-up ranged from 6 to 85 months. The total number of patients included in the analysis was 898. A total of 3,317 grafts were placed. Graft anatomy was described in 4 studies (2,882 grafts, FFR-1,126, angiography-1,756). There were 1,629 arterial and 1,253 venous grafts. The mean age in the studies ranged from 62.4 years to 67. There were 72.5% men, 33.6% with diabetes mellitus, 69.2% with hypertension, 74.1% with hyperlipidemia, 40.9% smokers, and 21.4% with history of PCI.

There was no statistical difference between the FFR-guided group and the angiography-guided group for all-cause mortality (6.3% vs 10.6%, OR 0.59 CI 0.33 to 1.04, $p = 0.07$, I^2 0%), myocardial infarction (3.6% vs 6.7%, OR 0.54 CI 0.26 to 1.11, $p = 0.09$, I^2 0%), target vessel revascularization (5% vs 4.9%, OR 1.0 CI 0.51 to 1.95, $p = 1.0$, I^2 0%), and CCS class II-IV angina (24.6% vs 38.7% OR 1.1, 95% CI 0.21 to 5.82, $p = 0.91$, I^2 86%; see Figure 1) FFR group was more likely to have a greater proportion of arterial grafts compared with the angiography group (61% vs 53%, OR 1.33, 95% CI 1.14 to 1.55, $p = 0.0003$). There were fewer loss of graft patency events in the FFR group compared to the angiography group (10.2% vs 22.1%, OR 0.34, 95% CI 0.12 to 0.98, $p = 0.05$, I^2 90%; see Figure 1)

This meta-analysis shows similar outcomes for the FFR and angiography groups except for graft patency. Graft patency was significantly better in the FFR group. We found FFR-guided CABG results in fewer grafts per patient and higher proportion of arterial grafts. This is the likely explanation for better graft patency with FFR-guided CABG. FFR guidance often results in a simplified grafting strategy. Coronary arteries that would otherwise be grafted based on angiography alone, may not be grafted after FFR is used to determine physiologic significance.[6] Although we found better graft patency with FFR-guided CABG, this did not translate into better clinical outcome. A functionally nonsignificant coronary artery with a graft has a higher likelihood of graft failure because of competitive flow.[4,6] Failure of such a graft may remain clinically silent as the native vessel may still be able to supply the myocardium. The findings from this meta-analysis differ from the Fractional Flow Reserve versus Angiography for Multivessel Evaluation (FAME) trial. The FAME trial showed that in comparison with angiography alone, FFR-guided PCI reduced the rate of the composite end point of death, nonfatal myocardial infarction, and repeat revascularization.[1] PCI and CABG are different forms of revascularization and this study shows FFR guidance data from PCI cannot be extrapolated to CABG.

There are certain limitations in this analysis. The follow-up is not uniform, and some studies did not have a long follow up. A prolonged follow-up could show different results. Subgroup analysis for arterial and venous grafts could not be done. The overall sample size is modest despite meta-analysis. The p values for individual adverse outcomes are of borderline significance and it is possible that the study is underpowered. Given the very small number of subjects in randomized controlled trials, heterogeneous study designs were included in this meta-analysis. In addition, certain endpoints, namely loss of graft patency and angina have high heterogeneity. Future randomized trials assessing angiography-guided versus FFR-guided revascularization in CABG are needed. Furthermore, data on non-hyperemic indexes such as instantaneous wave-free ratio in the CABG decision making are limited and could not be assessed in this meta-analysis.

To conclude, use of FFR guidance for CABG revascularization decision making compared with angiography

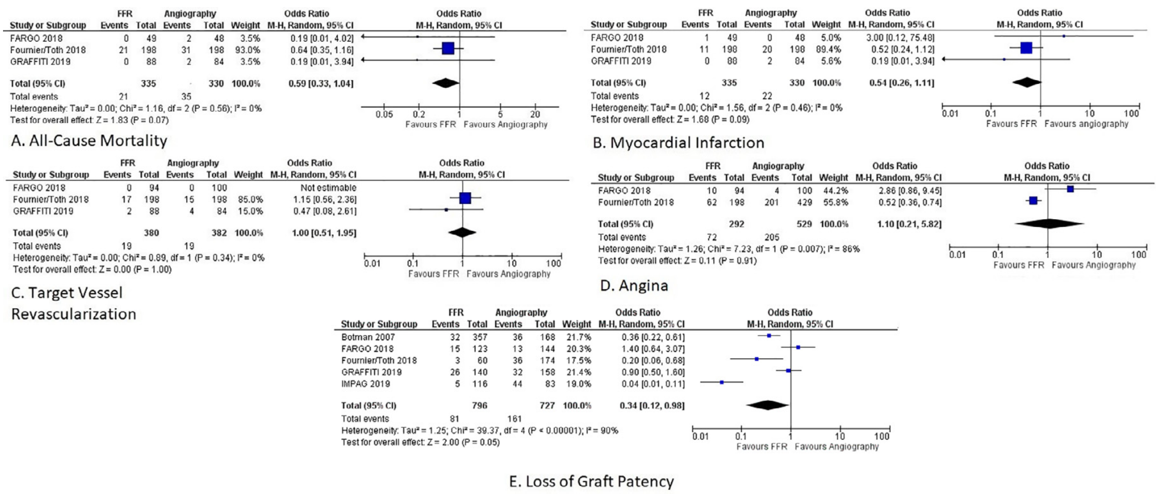

Figure 1. Forrest plots for comparison of different clinical outcomes between FFR-guided CABG compared with angiography alone. Horizontal lines represent 95% confidence intervals (CI). The rectangles represent the point estimate, and the size of the rectangle is proportional to the weight given to each study in the meta-analysis. The diamond represents the summary estimate (size of the diamond = 95% CI). The vertical line represents the reference of no increased risk. [Wherever possible propensity matched data were used for Fournier/Toth. For IMPAG, vessels that were grafted and had FFR≥0.78 were considered angiogram-guided and those that had FFR<0.78 were considered FFR guided].

alone may result in better graft patency but clinical outcomes are similar.

Disclosures

The authors have no conflicts of interest to disclose.

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27 August 2020

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https://doi.org/10.1016/j.amjcard.2020.09.002

Effect of Acute Pulmonary Embolism on the Hospitalization Rates in Patients With Heart Failure (From a Nationwide Cohort Sample)

Patients with heart failure (HF) experience high rates of hospitalization, account for over 1 million admissions annually, and place a large economic burden on the US health system.[1] HF complicated by acute pulmonary embolism (PE) is associated with even worse outcomes.[2] Previous studies demonstrated a bidirectional relation whereby both conditions increase the risk of hospitalization and mortality for the other.[3,4] Further understanding the inter-relationship between PE and HF, particularly across types of HF (HF with reduced (HFrEF) and preserved (HFpEF) ejection fraction), may help guide more tailored treatment strategies. Accordingly, we sought to explore the change in 30-day hospitalization rates before and after a diagnosis of PE in HF patients.

We used the Nationwide Readmission Database (NRD),[5] which is a deidentified publicly available all-payer database from 28 states accounting for 58.2% of U.S. hospitalizations, to identify patients hospitalized with a primary diagnosis of PE between 2010 and 2017. Patients were then stratified by presence of HF, and further subdivided into HFpEF and HFrEF by using relevant ICD-9/10-CM codes. We excluded patients < 18 years old, who died during index admission and who were hospitalized during January or December to ensure 30-day follow-up for all patients before and after index admission, as the NRD resets annually. The primary outcome was change in the 30-day all-cause hospitalization rates before and after PE diagnosis in patients with and without HF. The secondary outcomes included the change in 30-day hospitalization rates in

Disclosure: The authors have nothing to disclose, and no relationship with industry.

Funding: Self-funded