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The Prognostic Value of Residual Coronary Stenoses After Functionally Complete Revascularization

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ABSTRACT

BACKGROUND The residual SYNTAX score (RSS) and SYNTAX revascularization index (SRI) quantitatively assess angiographic completeness of revascularization for patients with multivessel coronary artery disease. Whether residual angiographic disease remains of prognostic importance after "functionally" complete revascularization with fractional flow reserve (FFR) guidance is unknown.

OBJECTIVES This study sought to investigate the prognostic value of the RSS and SRI after FFR-guided functionally complete revascularization.

METHODS From the FFR-guided percutaneous coronary intervention (PCI) cohort of the FAME (Fractional Flow Reserve Versus Angiography for Multivessel Evaluation) trial, the RSS and SRI were calculated in 427 patients after functionally complete revascularization. The RSS was defined as the SYNTAX score (SS) recalculated after PCI. The SRI was calculated as: 100 × (1 − RSS/baseline SS) (%). We compared differences in 1- and 2-year outcomes among patients with RSS of 0, >0 to 4, >4 to 8, and >8, and with SRI of 100%, 50% to <100%, and 0 to <50%.

RESULTS The mean baseline SS, RSS, and SRI were 14.4 ± 7.2, 6.5 ± 5.8, and 55.1 ± 32.5%, respectively. Major adverse cardiac events (MACE) at 1 year occurred in 53 patients (12.4%). Patients with MACE had higher SS than those without (18.0 [interquartile range (IQR): 11.0 to 21.0] vs. 12.0 [IQR: 9.0 to 18.0], p = 0.001), but had similar RSS and SRI after PCI (RSS: 6.0 [IQR: 3.0 to 10.0] vs. 5.0 [IQR: 2.0 to 9.5], p = 0.51 and SRI: 60.0% [IQR: 40.9% to 78.9%] vs. 58.8% [IQR: 26.7% to 81.8%], p = 0.24, respectively). Kaplan-Meier analysis showed similar 1-year incidence of MACE with RSS/SRI stratifications (log-rank p = 0.55 and p = 0.54, respectively). Results were similar with 2-year outcome data analysis.

CONCLUSIONS After functionally complete revascularization with FFR guidance, residual angiographic lesions that are not functionally significant do not reflect residual ischemia or predict a worse outcome, supporting functionally complete, rather than angiographically complete, revascularization. (Fractional Flow Reserve Versus Angiography for Multivessel Evaluation [FAME]; NCT00267774) (J Am Coll Cardiol 2016;67:1701–11)

Angiographically complete revascularization is associated with improved long-term outcome after multivessel revascularization for stable coronary artery disease (CAD) compared with incomplete revascularization (1-5). However, complete revascularization is not always pursued or achievable in patients with multivessel CAD undergoing percutaneous coronary intervention (PCI).

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ABBREVIATIONS AND ACRONYMS

CAD = coronary artery disease

CI = confidence interval

FFR = fractional flow reserve

FSS = functional SYNTAX score

IQR = interquartile range

MACE = major adverse cardiac event(s)

PCI = percutaneous coronary intervention

RSS = residual SYNTAX score

SRI = SYNTAX revascularization index

SS = SYNTAX score

As such, the residual SYNTAX score (RSS) (6,7) was recently developed to quantitatively assess the degree and complexity of residual stenoses by recalculating the SYNTAX score (SS) after PCI (8,9). Similarly, the SYNTAX revascularization index (SRI) was introduced as another quantification tool to assess the proportion of CAD that has been treated by PCI (10,11).

SEE PAGE 1712

Recent studies have found that functional significance of a lesion on the basis of fractional flow reserve (FFR) is a more important determinant of future adverse cardiac events than the angiographic appearance of the lesions (12,13). PCI on angiographically significant lesions that are not functionally significant on the basis of FFR can be deferred safely with good long-term outcomes (14). Therefore, we hypothesized that after "functionally" complete revascularization with FFR guidance in patients with multivessel CAD (15), the residual angiographic disease, which is not functionally significant, would not be predictive of outcomes, as assessed by the RSS or SRI. Accordingly, the primary goal of the present study is to investigate the prognostic value of these 2 quantification systems in patients enrolled in the FFR-guided PCI cohort of the FAME (Fractional Flow Reserve Versus Angiography for Multivessel Evaluation) trial (16–18), who underwent functionally complete revascularization with FFR guidance.

METHODS

STUDY DESIGN AND PATIENT POPULATION. The detailed study protocol has been published previously (16,18,19). In brief, the FAME trial is a prospective, randomized, controlled, multicenter trial investigating the superiority of FFR-guided PCI over angiography-guided PCI in patients with multivessel CAD (NCT00267774). In patients with multivessel CAD amenable to PCI, the investigators indicated which lesions had at least 50% diameter stenosis and were thought to require PCI. Thereafter, patients were randomly assigned to either FFR-guided or angiography-guided PCI. In patients assigned to FFR-guided PCI, only functionally significant lesions with FFR ≤0.80 were treated with PCI, and functionally insignificant lesions with FFR >0.80 were intentionally left untreated; whereas in patients assigned to angiography-guided PCI, all indicated lesions were treated without measurement of FFR. Because patients assigned to angiography-guided PCI did not undergo FFR assessment and calculation of the functional SYNTAX score (FSS), and because all patients assigned to angiography-guided PCI received "angiographically" complete revascularization, very little residual stenosis existed after PCI in these patients. Therefore, patients assigned to angiography-guided PCI were not included in this study.

Patients with ST-segment elevation myocardial infarction could be enrolled if the infarction had occurred at least 5 days before PCI. By contrast, patients with unstable angina or non-ST-segment elevation myocardial infarction were allowed to enroll earlier than 5 days after myocardial infarction if the peak creatinine kinase was <1,000 IU. Patients with prior PCI could be included. Patients were excluded if they had significant left main CAD, previous coronary artery bypass surgery, cardiogenic shock, or extremely tortuous or calcified coronary arteries. Patients were further excluded from the present substudy if the pre- and post-procedural angiogram data were not available. This study was approved by an institutional review committee from each participating site, and informed consent was obtained from all patients.

FFR MEASUREMENT AND TREATMENT. PCI was performed according to standard coronary interventional techniques, primarily with drug-eluting stents. In patients assigned to FFR-guided PCI, FFR was measured with a 0.014-inch pressure sensor guidewire (St. Jude Medical, Uppsala, Sweden). After equalization to the guide catheter pressure with the sensor positioned at the ostium of the coronary artery, the pressure guidewire was advanced down the target coronary artery. To induce maximal hyperemia, intravenous adenosine was administered at 140 μg/kg/min through a central vein. Simultaneous measurement of the mean proximal coronary pressure with the guide catheter and the mean distal coronary pressure with the pressure guidewire was performed. FFR was calculated as the ratio of the mean distal to proximal coronary pressure at hyperemia. All patients received dual antiplatelet therapy with aspirin and clopidogrel for at least 1 year after PCI (16,18,19).

CALCULATION OF THE SS, FSS, RSS, AND SRI. The detailed methodology for calculating the SS and FSS can be found elsewhere (8,9,20). In brief, the SS was calculated from the pre-procedural angiogram, in which each coronary lesion producing ≥50% diameter stenosis in vessels ≥1.5 mm by visual estimation was scored separately using the SS algorithm from the SYNTAX Score website and added to obtain the