



Case report

ACTA FAC. MED. NAISS. 2005; 22 (2): 81-84

Miloje Tomašević¹, Branko Beleslin², Svetlana Apostolović¹, Milan Pavlović¹, Zoran Perišić¹

¹Cardiovascular Clinic, CC Niš
²Cardiovascular Clinic, CC Serbia

USEFULNESS OF FUNCTIONAL LESION ASSESSMENT BY CORONARY PRESSURE MEASUREMENT IN CLINICAL CONDITIONS

SUMMARY

The shortcomings of coronary arteriography to assess the physiological significance of coronary stenosis have been recognised for decades. Non-invasive test can be inconclusive in some patients. In patients with moderate coronary stenosis, fractional flow reserve (FFR) provide important information and appears to be a useful index of the functional severity of the stenosis and need for coronary revascularization. FFR is invasive index of stenosis severity that is a substitute for noninvasive stress testing. A patient with long stenosis of the mid and distal right coronary artery and inconclusive noninvasive test was presented. FFR was significantly improved, from 0,45 to 0,92, after the coronary intervention. It predicts low restenosis rate.

Key words: fractional flow reserve, coronary pressure, stent implantation

INTRODUCTION

Angiographic data are sometimes insufficient to assess the severity of the present coronary stenosis. This is usually the case in intermediate stenosis for which interventional cardiologists have 2 questions: can this lesion induce myocardial ischemia? and consequently, does it require angioplasty?

If we have objective evidence of myocardial ischemia with significant coronary stenosis at angiography, revascularization is warranted. Acute ischemic events occur predominantly at the site of previously insignificant or mild stenoses. But, atherosclerosis sometimes increases external arterial dimensions preserving the lumen dimensions and making compensatory dilatation. There is no correlation between vulnerability of plaque and degree of coronary artery stenosis. A high proportion of vulnerable plaques is angiographically invisible.

Angiogram cannot give information on the risk or site of future coronary thrombotic events. Within one coronary artery, one plaque may be associated with remodeling to a degree that the lumen size is unaltered, while within a few centimeters another plaque has not invoked remodeling and angiographic stenosis is present. There is a belief that mild stenoses would have a worse prognosis than severe stenoses and that the use of PTCA in such mild lesions would be beneficial. Some data show that PTCA of such lesions without functional significance did not improve outcome or anginal status and did not reduce the use of antianginal medication. Even free survival is similar in deferral and performance PTCA groups if functional severity of stenosis is not significant. Yet, PTCA is often recommended on the basis of the angiogram, although noninvasive testing for reversible ischemia is negative, equivocal, or not performed. Noninvasive tests

have 2 limitations: they can be inconclusive and some patients undergo a coronary angiogram before a noninvasive evaluation.

Fractional flow reserve (FFR) is an index derived from coronary artery pressure measurements, providing functional data through a simple and safe procedure. It is a new index of functional severity of coronary stenosis calculated from coronary pressure measurements made during coronary angiography. It is defined as the ratio between the maximal blood flow to the myocardium in the presence of a stenosis in the supplying artery and the theoretical normal maximal blood flow in the same area in the absence of the stenosis. To induce maximal hyperemia, some drugs are available: Adenosine (intracoronary bolus or intravenous infusion), ATP (intracoronary bolus or intravenous infusion) or Papaverine (intracoronary bolus)(1). Each drug is used with a specific dosage, which is validated in humans to induce maximal hyperemia. Adenosine induces hyperemia by stimulating specific receptors, mainly A₂ arteriolar receptors. Therefore, there is no need to stop medicines such as nitrates, beta-blockers or calcium blockers. Another interesting feature of FFR, is that it is independent of hemodynamic conditions (heart rate, blood pressure, and contractility). In practice, a pressure guide wire is placed distally to the stenosis giving a distal pressure (Pd). Aortic pressure (Pa) is measured as usually through the guiding catheter. FFR is calculated at maximal hyperemia by dividing mean distal pressure by mean aortic pressure.

$$FFR = Pd / Pa$$

FFR expresses maximum achievable blood flow to the myocardium supplied by a stenotic artery as a fraction of normal maximal flow. Its normal value is 1.0 and a value of 0.75 reliably identifies stenoses associated with inducible ischemia. The diagnostic accuracy of FFR for that purpose is 90%, which is higher than for any other invasive or noninvasive test. The sensitivity of FFR in the identification of reversible ischemia was 88%, the specificity 100%, and accuracy 93% (2).

In patients with a coronary stenosis without any evidence of ischemia, coronary pressure derived FFR identifies those who will benefit from PTCA (4).

After regular coronary balloon angioplasty, FFR would be helpful to identify those patients who have a low cardiac event rate. In patients with residual diameter stenosis <35% and FFR>0,90, clinical outcome up to 2 years is excellent. Therefore, there is a complementary value of coronary angiography and coronary pressure measurement in the evaluation of PTCA result (5).

The evaluation of in-stent restenosis is usually based on angiographic quantification. A poor correlation between angiographic quantification and FFR of moderate in-stent restenosis was found. Conservative management of moderate 40–70% in-stent restenotic lesion with FFR value>0.75 is safe avoiding unnecessary revascularization based solely on the angiography (3).

CASE REPORT

A 51-year-old man was admitted to hospital because of PTCA RCA. His diagnosis was inferior non-ST-segment elevation myocardial infarction (NSTEMI), in May, 2003. Exercise test was inconclusive. Because his chest oppressive sensation on exertion was continued, coronary angiography was done in March, 2005. Coronary angiogram revealed significant stenosis of the mid and distal right coronary artery. It was long and complicated lesion.

A 0,014" pressure guidewire (Pressure wire 4, Radi Medical Systems) was used instead of a regular wire to perform PTCA and pressure sensor was placed in distal segment of RCA (figure 1 and 2). The new one, PressureWire XT (extra torque) with excellent torquability was used with sensor area 3 cm proximal of a radiopaque type. Measurements were done at baseline and after maximum hyperemia induced by intracoronary injection of 60 µg adenosine triphosphate. FFR (fractional flow reserve) was calculated to be 0.45 (figure 3). PTCA was performed and stent Driver 3.5x24 mm was implanted (figure 4). TIMI grade 3 flow was achieved without residual stenosis (figure 5). Measurement of FFR was repeated at maximum hyperemia and FFR was improved significantly to 0.92 (figure 6). If FFR is ≥0.90 and the angiogram is good, restenosis rate will be low, in the range of 10%–15% (5). After 3 months of follow-up, our patient is stable without angina.



Figure 1. Coronary angiogram before PTCA, 80% stenosis at the long mid and distal portion of RCA

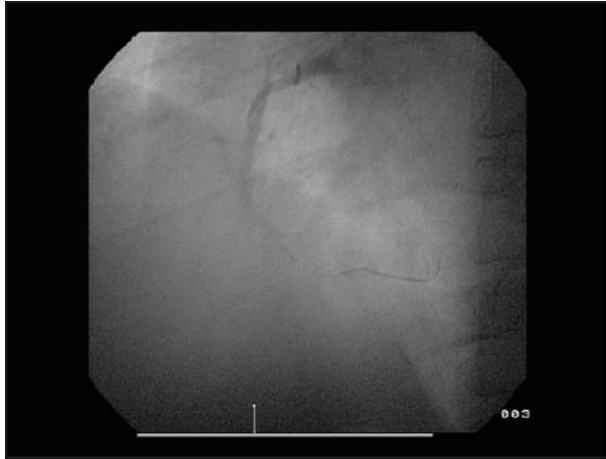


Figure 2. Coronary angiogram after wire is advanced and crosses stenosis



Figure 3. FFR after induction of maximum hyperemia by intracoronary administration of 60 µg of adenosine in RCA



Figure 4. Balloon inflation and direct stent implantation at 14 atm



Figure 5. Coronary angiogram after stent implantation

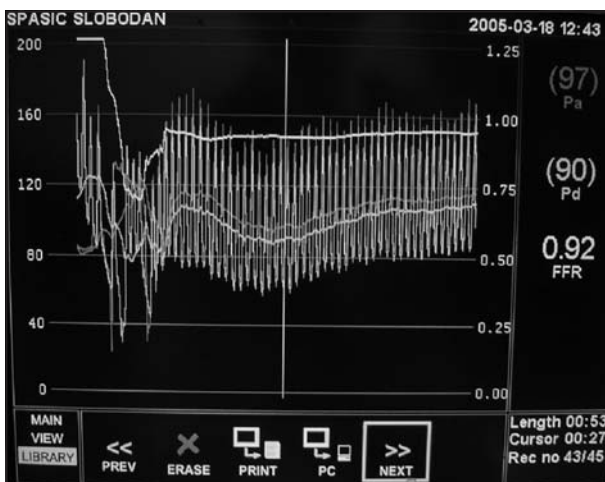


Figure 6. Post-stent FFR after induction of maximum hyperemia by intracoronary administration of 60 µg of adenosine in RCA

DISCUSSION

Fractional flow reserve, calculated from coronary pressure measurement, is an accurate and specific index of epicardial stenosis severity. In patients with mild stenosis but without functional significance PTCA did not improve outcome or anginal status (4). $FFR \geq 0.75$ identifies patients who do not benefit from PTCA and patients with $FFR \leq 0.75$ in whom PTCA is appropriate treatment. FFR is invasive index of stenosis severity that is substitute for noninvasive stress testing. FFR is very valuable in long lesions and anything short of 90% stenosis. An FFR value of 0.75 can distinguish patients with normal and abnormal noninvasive stress testing.

It is useful and valid after myocardial infarction and for a similar degree of stenosis that the value of FFR depends on the mass of viable myocardium (7). If discrepancy exists between FFR

and angiographic stenosis severity it indicates the presence of small-vessel disease (1). The simultaneous measurement of FFR (by coronary pressure) and coronary flow reserve (CFR) (by coronary thermodilution) by one single guide wire will facilitate assessment of microvascular disease (8).

The usefulness of FFR in decision making in inconclusive noninvasive testing is confirmed in our patient. On the bases of FFR and angiographic stenosis severity estimation we decided for direct stenting lesion.

In addition, FFR has considerable complementary value in the evaluation of PTCA results and the assessment of optimum stent deployment (1). The prognostic value of FFR measurement post-stenting has been demonstrated (5). Normalization of FFR after stent placement was accompanied by a restenosis rate of <5% during six-month follow-up, with a strong inverse correlation between post-stent FFR and event rate (6). FFR post-stenting in our case predicts a good outcome and low restenosis rate.

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KORISNOST FUNKCIONALNOG PROCENJIVANJA LEZIJE PUTEM MERENJA KORONARNOG PRITISKA U KLINIČKIM USLOVIMA

Miloje Tomašević¹, Branko Beleslin², Svetlana Apostolović¹, Milan Pavlović¹, Zoran Perišić¹

¹Kardiovaskularna klinika Kliničkog centra, Niš,
²Kardiovaskularna klinika Kliničkog centra, Srbija

SAŽETAK

Nedostaci koronarne angiografije u proceni fiziološkog značaja koronarne stenozе su poznate desetina godina. Neinvazivni testovi mogu ostati kod nekih pacijenta bez jasne interpretacije. Kod pacijenta sa umerenom koronarnom stenozom, frakcija rezervnog protoka (FFR) pruža važne informacije i koristan je indeks za procenu funkcionalne težine stenozе i potrebe za koronarnom revaskularizacijom. FFR je invazivni indeks težine stenozе koji je zamena za neinvazivne stres testove. Prikazan je pacijent sa dugom stenozom srednje i distalne desne koronarne arterije i neinvazivnim testovima bez moguće interpretacije. FFR je značajno popraavljen, od 0,45 na 0,92, posle koronarne intervencije. Ovakav rezultat predviđa mali rizik za nastanak restenozе.

Ključne reči: frakcija rezervnog protoka, koronarni pritisak, implantacija stenta