Editorial comment

Functional assessment of bypass grafts by fractional flow reserve

In an interesting paper published in the present issue of the journal, Glineur et al. describe systematic measurements of fractional flow reserve in coronary bypass grafts [1]. These data are important because they tell us more about the function of normal grafts both at rest and during maximum hyperemia, corresponding with physiologic exercise in true life.

Fractional flow reserve (FFR) is the gold standard for functional assessment of coronary arteries. It is an index which is exclusively calculated during maximum coronary and myocardial hyperemia and expresses maximum achievable blood flow in a particular conduit (native or graft) as a fraction of normal maximum blood flow to the same myocardial territory in case the patient would be completely healthy [2,3].

FFR can be easily calculated during cardiac catheterization by the ratio of distal coronary pressure (or distal bypass graft pressure) compared to aortic pressure after administration of a sufficient hyperemic stimulus, mostly adenosine.

In normal coronary arteries, fractional flow reserve equals 1.0 even under conditions of maximum hyperemia [4]. This indicates that resistance in a normal coronary artery is negligible. A value of FFR < 0.75 indicates inducible ischemia with a specificity and sensitivity of more than 90% [2,3]. In the last 10 years, FFR has been validated repeatedly in many physiologic and pathologic conditions.

In fact, FFR can also be considered as an inverse measure of resistance of a particular conduit. If there is no resistance at all along the conduit, the pressure distal in the conduit and proximal in the conduit should be equal, even at maximum blood flow. With increasing resistance, decline of pressure will be more pronounced.

Until recently, only few data have been available for FFR in bypasses. It has been suggested that resistance in a mammarian bypass graft (ITA) would be higher than in saphenous venous grafts. In earlier studies, it has even been suggested that resistance in an ITA graft would be so high that myocardial ischemia could result, especially shortly after the operation before hyperplasia has occurred and especially in case of a large myocardial territory depending on the graft.

The present study by Glineur does not allow us to assess this latter point quantitatively but at least it enables us to establish the functional capacity of bypass grafts 6 months after surgery [1]. The authors show that even in a mammarian bypass graft, often long and sometimes tortuous, and even if placed on a normal viable anterior wall representing a large perfusion territory, the resistance to blood flow is small (although not negligible) under maximum hyperemic conditions. A value of fractional flow reserve of 0.90 ± 0.04 for the left ITA and 0.95 ± 0.03 for the right ITA indicates that, although mild resistance is present, the function of such a graft is far above the threshold at which myocardial ischemia might occur.

Glineur et al. [1] also show that a normal venous bypass graft has a resistance, which is completely negligible (FFR = 0.96 ± 0.03) and therefore is comparable in this respect to a normal coronary artery.

A strong issue in their paper is the fact that the study was not performed in patients with complaints but in well functioning patients with angiographically normal grafts. So, it can be presumed that these data are truly representative for normal bypass grafts.

A minor point of criticism is that it would have been better to use intravenous adenosine as hyperemic stimulus in their study, allowing a pressure pull-back recording which could show that the minimal decline of pressure along the course of the ITA graft was uniformly distributed along that graft.
Especially under pathologic conditions, intravenous adenosine will be preferable.

The observations by Glineur et al. [1] are not only important from the physiological point of view, but also enable us to better understand bypass graft function under pathologic conditions. The question is often raised in the catheterization laboratory how to assess the hemodynamic significance of bypass graft stenosis and how to apply fractional flow reserve in such situation.

In case that the native coronary artery is occluded, FFR can be applied in grafts in a completely similar way as in native coronary arteries and there is no reason to suppose that the ischemic threshold of 0.75 is different.

More complex is the situation when both the bypass graft and the native coronary artery are stenotic but not occluded. In such case, the pressure sensor can either be advanced through the native artery or through the bypass and should be placed preferably distal to the anastomosis. If fractional flow reserve measured at that location is <0.75, it can be concluded with certainty that both the bypass graft and the native vessel are significantly diseased from a functional point of view. Depending on the respective anatomy, the choice should be made than either to dilate the bypass, the native vessel, or to decide upon re-CABG.

If FFR, measured at that particular point, is above the ischemic threshold, this indicates that either the bypass graft or the native vessel or both are not narrowed significantly from a functional point of view. Further discrimination cannot be made with certainty in that situation but the clinical decision is clear: no mechanical treatment is indicated in such situation.

In case of serial abnormalities, either in the graft or in the native vessel, and also in case of uncertainty about the anastomosis by angiography, a pressure pullback recording during intravenous adenosine infusion will be helpful and indicate where abnormal resistance is present [3].

Because the shortcomings of coronary angiography for correct assessment of functional stenosis severity are well known for decades and are even more pronounced after bypass surgery, studies to the physiologic assessment of bypass graft function by fractional flow reserve contribute to a better understanding and treatment of such patients. Glineur et al. [1] made a significant contribution in this respect.

References


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Available online 18 January 2007
doi:10.1016/j.ejcts.2006.12.022