SCIENTIFIC LETTER

Haemodynamic significance of ostial side branch nipping following percutaneous intervention at bifurcations: a pressure wire pilot study

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Stenting of a coronary artery narrowing across a bifurcation with a side branch artery may result in a significant angiographic stenosis (nipping) of the side branch. If this causes symptoms of chest pain or ischaemic ECG changes at the time of the procedure, additional angioplasty (with or without stent insertion) through the stent struts is usually undertaken to improve blood flow into the side branch, but this increases subsequent risks of restenosis and stent thrombosis in the main vessel. In the absence of symptoms or ECG abnormalities, the functional significance of side branch nipping is uncertain and opinion on whether to treat a nipped side branch remains divided.^{1–4}

The coronary pressure-derived fractional flow reserve (FFR) is a lesion-specific means of determining the functional significance of coronary artery narrowings, but its value in assessing side branch nipping is not known.

This pilot study aimed to assess the correlation between the FFR across nipped side branch arteries that have been crossed by main vessel stents, with the degree of angiographic narrowing at the side branch ostium. The potential role of the coronary pressure wire in guiding treatment of the nipped side branch is considered.

METHODS

This study was registered with Southampton University NHS Trust R&D Department and approved by the local ethics committee. All patients gave written informed consent.

All patients were scheduled for elective percutaneous intervention (PCI) for symptoms of chronic stable angina. Patients had bifurcation lesions with a larger main vessel and a smaller side branch, in which there was no significant ostial side branch disease and the primary clinical strategy did not mandate PCI treatment of the side branch. A pressure wire assessment of the side branch was made before and after the main vessel was stented. Further treatment of the side branch was performed according to the degree of angiographic nipping of its ostium at the discretion of the operator who was blinded to the results of the pressure wire assessment. All pressure wire measurements were made using the RADI pressure wire system with injections of intracoronary adenosine (average of three 50- μ g injections). Results were recorded by a trained cardiac physiologist. Angiographic assessment of side branch stenosis was performed using quantitative coronary angiography (QCA) by a senior radiographer (IC) blinded to the pressure wire results.

RESULTS

Fifteen patients were enrolled in the study. In one patient the pressure wire could not be passed back through the stent struts into the side branch and so no data following stenting of the

main vessel were obtained, leaving data on 14 patients for analysis.

Lesion characteristics

In nine patients (64%) the lesions involved the left anterior descending artery (LAD) and a diagonal branch, in three (21%) the main circumflex artery and an obtuse marginal branch, in one the right coronary artery and the posterior descending branch, and in one the LAD and the first septal branch. The mean main and side branch vessel reference diameters were 2.9 ± 0.4 mm and 2.3 ± 0.2 mm, respectively.

QCA and FFR

Figure 1 is a plot of the QCA of the side branch ostium against the FFR in the side branch in the 14 patients following deployment of the main vessel stent. Lines indicating significant side branch nipping (QCA >50%) and flow limiting nipping of the side branch ostium (FFR of <0.75%) are shown.

QCA demonstrated a significant stenosis in the side branch in 9/14 (64%) patients, but haemodynamic obstruction by pressure wire criteria was seen in only 3/14 (21%). In 6/14 patients (43%) a significant stenosis was seen on QCA, but FFR was not reduced. In no patients was a reduction in FFR measured in the absence of a significant stenosis on QCA.

There was a poor correlation between the angiographic degree of nipping by QCA and the FFR in the side branch after stenting of the main vessel (correlation coefficient -0.54 , $p = 0.053$, with a coefficient of determination of 0.3).

In all cases, TIMI 3 flow was seen in both the main vessel and side branch after deployment of the main vessel stent.

DISCUSSION

This pilot study demonstrates that the development of a functionally significant stenosis in the side branch after stenting the main vessel of a bifurcation lesion with no prior side branch involvement is infrequent. Furthermore, although angiographic ostial nipping of the side branch following main vessel stenting is frequently seen, this bears little relation to functional impairment of flow.

Specifically, in 43% of patients, the angiographic nipping by QCA, which is known to underestimate ostial disease, was over 50%, a level that would trigger treatment by many interventionists, while the pressure wire data suggested that there was no haemodynamic obstruction in the vessel (group B). By contrast, when there was no important angiographic narrowing, the FFR was non-significant (group C) and it would clearly be difficult to justify treatment. Finally, in group A, the FFR

Abbreviations: FFR, fractional flow reserve; LAD, left anterior descending artery; PCI, percutaneous intervention; QCA, quantitative coronary angiography

Figure 1 Percentage stenosis by QCA and pressure wire fractional flow reserve (FFR) (where <0.75 represents a flow limiting stenosis) for the side branch after main vessel stenting. Lines representing a significant 50% stenosis and an FFR of <0.75 are shown.

suggested important haemodynamic compromise in side branch flow which was consistent with significant ($\geq 50\%$) angiographic narrowing.

These preliminary results are clinically important. Firstly, they suggest that in the majority of such cases (79%) a simple approach to bifurcation lesions, using one stent across a side branch, achieves a functionally adequate result. Secondly, despite this, the majority of cases will demonstrate angiographic side branch nipping, and in these cases the pressure wire may be a useful tool to assess the haemodynamic significance of this side branch nipping. The FFR measurement may thereby guide treatment decisions, perhaps avoiding unnecessary treatment of the side branch. Our sample size is small, but these data are consistent with a similar, larger study, in which only 27% of jailed side branches with diameter stenosis of 75% or more had a functionally significant stenosis as determined by the FFR.⁵

The cause of this phenomenon of an angiographically apparent stenosis in the absence of a functionally significant stenosis remains unclear. It may partly be due to an artefact created by some compression of the ostium of the side branch adjacent to a radiodense stent. Another explanation could be spasm, although this seems less likely, firstly because of the

lack of response to intracoronary nitrate, and secondly because significant spasm may be expected to reduce the FFR in its own right.

The DEFER study⁶ established the use of the pressure wire in guiding treatment decisions in main vessel narrowings, where an FFR of 0.75 or above justified a conservative treatment approach. A similar trial is now needed to randomise patients who have had their main vessel stented and are left with angiographically significant side branch nipping but an FFR of ≥ 0.75 , to treatment or no treatment of the side branch to establish whether the FFR-directed treatment of side branch nipping improves clinical and angiographic outcome.

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