Percutaneous coronary intervention of the right ventricular artery: is it worth the effort?

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Abstract

Loss of the right ventricular artery (RVA) is generally thought to be of little consequence. Nonetheless, reperfusion can enhance right ventricular recovery and improve the clinical condition.

Five cases of percutaneous coronary intervention involving right ventricular branches are presented.

We advocate a more positive approach to a significant stenosis in the RVA in patients who have stable or unstable angina or non-ST segment elevation myocardial infarction. Re-establishment of flow should limit ischaemia and infarction of the right ventricle and limit their adverse effects.

Key words: percutaneous coronary intervention, right ventricular artery, angina, myocardial infarction.

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Introduction

The right ventricular artery (RVA) usually originates from the right coronary artery (RCA) and supplies the right ventricular myocardium. The right ventricle (RV) may also receive a blood supply from the left coronary artery and the thinner RV wall may perhaps derive oxygen from blood within the RV cavity. Hence, loss of the RVA is thought to be of little consequence. However, it is well recognised that acute occlusion of the right ventricular branch or of the RCA itself proximal to the origin of the RV branch(es) can cause right ventricular infarction, systolic dysfunction, reduced transpulmonary delivery of left ventricular preload and a fall in cardiac output. Hypotension, jugular venous distension and dyspnoea with clear lung fields may result and the outcome may be adversely affected.[1] RV branch loss is associated with cardiac enzyme elevation and potentially lethal ventricular arrhythmias.[2] Reperfusion enhances right ventricular recovery and often improves the clinical condition.[3]

In patients with stable or unstable angina, little regard is paid to disease in the RVA as a cause for symptoms; rarely is the vessel addressed by percutaneous coronary intervention (PCI) and never by coronary artery bypass grafting (CABG). When disease is present in the RV branch, it is usually accompanied by stenoses in one or more of the three major coronary arteries, which are usually the point of focus for the interventionist. The RVA disease is often ignored because the vessel is of small calibre and perceived to be unimportant or because it has been jailed by stenting in the main RCA and the effort to address the RVA disease is thought not to be worthwhile.

We present five cases of PCI involving RV branches to illustrate the technique and the value of this approach and discuss the relevant issues which require further study and research.

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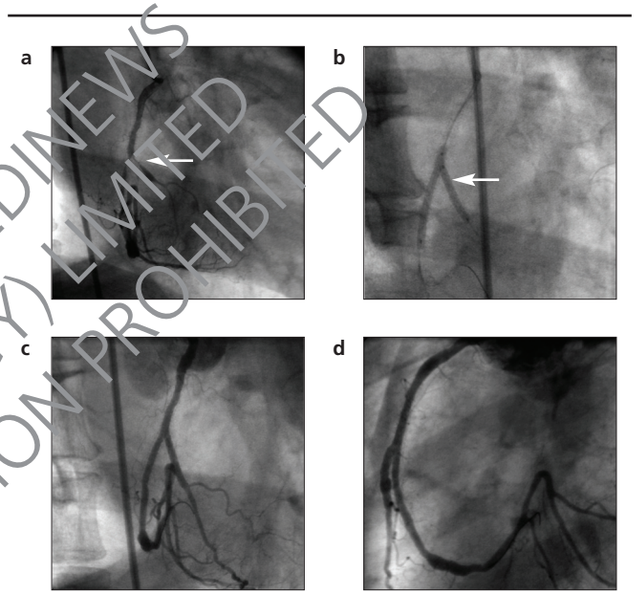
Figure 1. **a**: severe restenosis in both the right ventricular branch of the right coronary artery (RCA) (arrow) and inside the Zeta™ stent placed in the main RCA itself in a true bifurcation stenosis.
b: a 2.5 mm x 18 mm long Cypher Select™ stent is deployed in the right ventricular branch (arrow) with a 3.0 mm x 30 mm long Aqua T3 balloon in the RCA in T-stenting fashion.
c, d: the angiographic result was excellent



Case report 1

A 49-year-old dentist presented with unstable angina due to in-stent restenosis in the RCA affecting the bifurcation with the RV branch and the RVA itself (figure 1a). The initial procedure (six months earlier) was carried out for a RCA/RV branch bifurcation lesion and consisted of kissing-balloon angioplasty followed by a

Figure 2. **a**: severe stenosis in a right ventricular branch of a non-dominant right coronary artery (arrow). **b**: the stenosis was dilated with a 2.0 mm x 10 mm long Aqua T3™ balloon and stented with a 2.25 mm x 12 mm long Taxus™ stent. **c**: the angiographic result was excellent

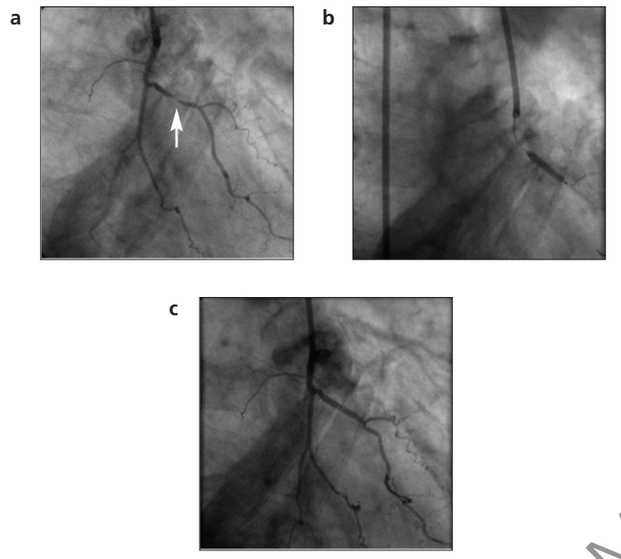
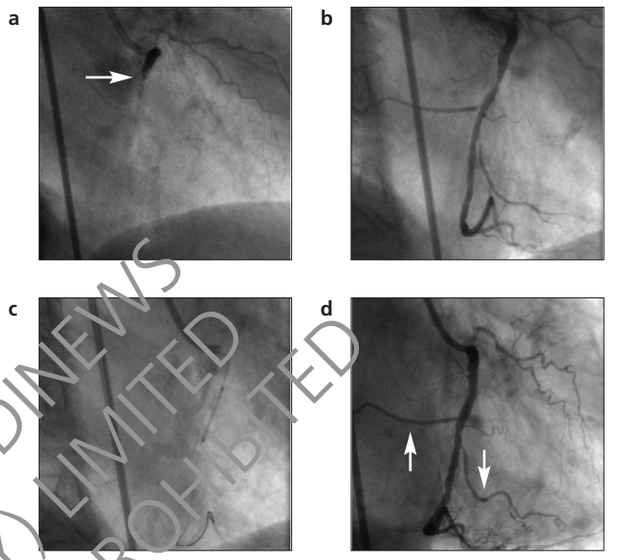


Figure 3. **a**: proximal occlusion in a right coronary artery (RCA) (arrow) obliterates flow to the right ventricle. **b**: after opening the RCA with a guidewire, a severe stenosis is evident but the right ventricular (RV) branches reappear. **c**: following stenting with a 3.0 mm x 18 mm long Vision™ stent, the angiographic result is excellent. **d**: and the two RV branches (arrows) provide secure reperfusion to the RV



3.0 mm x 38 mm Zeta™ stent placed in the main RCA across the ostium of the RV branch. Risk factors included continued smoking and hypercholesterolaemia.

Both lesions were crossed with 0.014" floppy guidewires and after predilating the RV branch through the side-wall of the Zeta™ stent with a 2.0 mm x 20 mm long Aqua T3™ balloon, a 2.5 mm x 18 mm long Cypher Select™ stent was placed in the RV branch beginning at the ostium, with a 3.0 mm x 30 mm long Aqua T3™ balloon in the main RCA across the origin of the RV branch in kissing-balloon fashion (figure 1b). The angiographic result was excellent (figure 1c, 1d) and the patient remains symptom-free 12 months later.

Case report 2

A 69-year-old man with stable angina was found to have a severe stenosis at the ostium of a large first diagonal artery and in the mid-third of a right ventricular branch of a non-dominant RCA (figure 2a). The stenosis in the RV branch was dilated with a 2.0 mm x 10 mm long Aqua T3™ balloon (figure 2b) and stented with a 2.25 mm x 12 mm long Taxus™ stent with an excellent angiographic result (figure 2c). The diagonal artery was stented directly with a 2.25 mm x 12 mm long Taxus™ stent and the patient remains symptom-free 15 months post-procedure.

Case report 3

A 73-year-old woman presented with an acute inferior myocardial infarction (MI) for primary PCI. The RCA was totally occluded proximally (figure 3a). Recanalisation using a 0.014" intermediate guidewire revealed a severe stenosis in the proximal RCA above two RV branches (figure 3b). Idioventricular rhythm and non-sustained ventricular tachycardia occurred after reperfusion and the ST-segment elevation normalised immediately. The lesion was stented directly with a 3.0 mm x 18 mm Vision™ stent (figure 3c) and post-dilated with a 3.5 mm x 8 mm long Quantum™ balloon, with an excellent result (figure 3d).

Case report 4

A 51-year-old man was found to have significant two-vessel coronary artery disease 10 years after cardiac transplantation. PCI with drug-eluting Cypher Select™ stents was performed to the LAD and RCA. The right ventricular artery was severely stenosed in its proximal third (figure 4a) and was successfully treated by percutaneous transluminal coronary angioplasty (PTCA) with a 2.5 mm x 20 mm long Maverick™ balloon (figure 4b). The final result was excellent (figure 4c).

Case report 5

A 61-year-old woman had recurrent angina eight years after CABG surgery, despite patent bypass grafts. A non-dominant RCA had developed a severe stenosis proximally above the origin of two RV branches (figure 5a). The lesion was directly stented with a 2.25 mm x 33 mm long Cypher Select™ stent (figure 5b), with an excellent angiographic result (figure 5c) and with relief of the patient's angina symptoms.

Figure 4. **a**: severe stenosis (arrow) in right ventricular artery. **b**: percutaneous transluminal coronary angioplasty (PTCA) with a 2.5 mm Maverick™ balloon. **c**: satisfactory angiographic result (arrow)

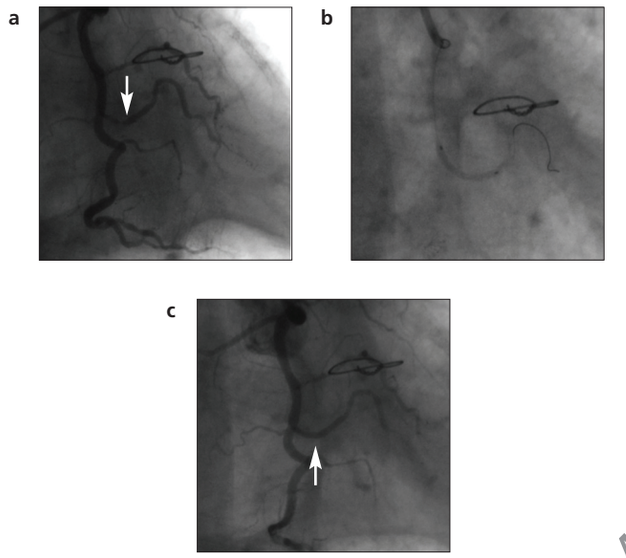
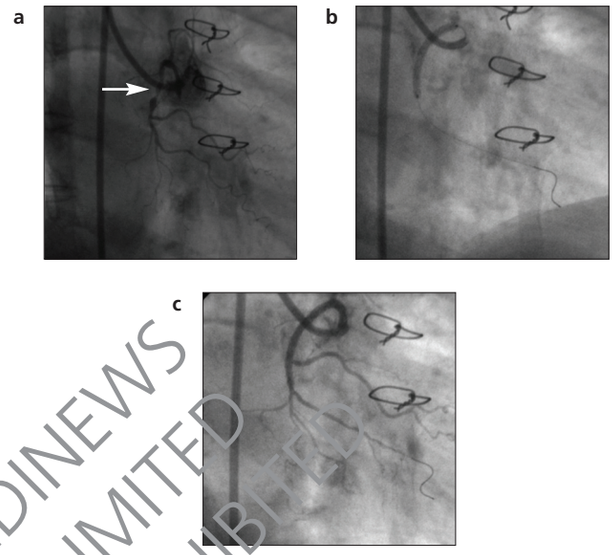


Figure 5. **a**: severe stenosis (arrow) in non-dominant right coronary artery which mainly supplies the right ventricle. **b**: direct stenting with a 2.5 mm x 28 mm long Cypher Select™ stent. **c**: excellent angiographic result, with relief of angina pectoris



Discussion

The decision whether to perform PCI to a stenosis in the RVA seems arbitrary and most interventionists ignore such disease. Although there are no controlled trial data to support the value of a more positive approach, we would advocate PCI to a significant stenosis in the RVA in patients who have stable or unstable angina or non-ST myocardial infarction (MI) as part of a total revascularisation strategy. A successful procedure should lead to a reduction in angina as well as RV ischaemia and dysfunction. If intervention is to be performed, the RVA should be accessible and at least 2.0 mm in diameter. Using drug-eluting stents, it should be possible to limit in-stent restenosis in these relatively small vessels. Difficult ostial RVA lesions may be best dealt with by balloon angioplasty alone and certainly the main RCA should not be compromised by any PCI to the RVA.

Right ventricular infarction is usually associated with inferior or posterior infarction but may occur in total isolation in 1.7–4.6% of cases. On its own, it is rarely recognised clinically as a specific entity. In patients with acute MI due to RCA occlusion, reestablishing flow down both the main RCA and the main RV branch seems worthwhile if technically feasible. This should limit ischaemia and infarction of the RV and the adverse effects these may have on outcomes.[4-7] However, the incidence of persistent RV dysfunction following MI is lower than might be anticipated and RV recovery may well occur regardless, although it is likely to be enhanced by RVA reperfusion.[1] Even if the RCA is non-dominant, this strategy is ideal for limiting RV ischaemic dysfunction and for preventing ventricular tachyarrhythmias.[2,4,8,9] PCI is likely to be more effective than thrombolytic therapy but more studies are needed to quantify the benefits that may be accrued from successful PCI. Moreover, although the prognosis from isolated RV infarction is generally good, serious complications may occur.[10-13]

Acute RV ischaemia may be indicated by ST segment elevation in the right precordial leads V3R–V6R and RVA loss by maximal ST elevation in V1 diminishing through to V3, but seen also in V3R–V6R.[14] Body surface mapping, including colour map reconstruction, has also been shown to be useful for identifying RV infarction.[15] However, how to assess the importance of RV branches remains unclear. An estimate of the amount of myocardium in jeopardy would be useful in order to help decide whether the RVA should be addressed in patients undergoing PCI for single or multivessel disease but the very presence of multivessel disease may make interpretation of the test results difficult.

Gated-radionucleide scanning may provide an estimate of RV ejection fraction and regional RV wall abnormalities. Dobutamine stress transoesophageal echocardiography can show regional wall abnormalities that occur in response to stress; thallium scanning has been used successfully to study RV perfusion. These techniques may be useful for assessing what has been achieved by PCI but are probably of little practical value in deciding whether to address a RVA lesion. Although intracoronary contrast echocardiography might help in estimating the myocardium supplied by individual branches, this would require contrast delivery beyond the stenosis prior to PCI. More research is again required.

Conflict of interest

None declared.

Key messages

- The decision whether to perform PCI to a stenosis in the right ventricular artery (RVA) seems arbitrary
- We advocate a positive approach to a significant stenosis in the RVA in patients with angina or NSTEMI
- It is difficult to estimate the amount of myocardium

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