Percutaneous Coronary Interventions: what the general practitioner should know

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Percutaneous coronary interventions (PCI) have become standard treatment for many patients with coronary artery disease (CAD). It is therefore important that general practitioners know what the indications, limitations, complications and expectations of the procedure are in order to advise their patients. This is the 3rd article in a series of articles on coronary artery disease. The first article defined the acute coronary syndromes clinically and the second article discussed post-MI care by the GP. The next article will be on Coronary Artery Bypass Graft (CABG) surgery.

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Indications for percutaneous coronary interventions[1]

A broad spectrum of clinical presentations exists wherein patients may be considered candidates for PCI, ranging from asymptomatic to severely symptomatic or unstable, with variable degrees of damaged and dysfunctional myocardium.

When PCI are considered, the benefits and risks of surgical revascularisation and medical therapy always deserve thoughtful discussion with the patient and family. The initial simplicity and associated low morbidity of PCI as compared to surgical therapy is always attractive, but the GP, patient and family must understand the limitations inherent in current PCI procedures, including a realistic presentation of the likelihood of restenosis and the potential for incomplete revascularisation as compared with CABG surgery. In patients with CAD who are asymptomatic or have only mild symptoms, the potential benefit of antianginal drug therapy along with an aggressive program of risk reduction must also be understood by the patient before a revascularisation procedure is performed.

In asymptomatic patients, who do not have treated diabetes with asymptomatic ischaemia or mild angina with 1 or more significant lesions in 1 or 2 coronary arteries, the ACC/AHA gives a Class I recommendation for PCI. The procedure has a high likelihood of success and a low risk of morbidity and mortality. The vessels to be dilated must subtend a large area of viable myocardium.

If the patient has the same clinical and anatomic requirements for Class I, but the myocardial area at risk is of moderate size or the patient has treated diabetes, then ACC/AHA classifies this as a Class IIa recommendation for PCI.

A Class IIb recommendation for PCI is a patient with asymptomatic ischaemia or mild angina with >3 coronary arteries suitable for PCI with a high likelihood of success and a low risk of morbidity and mortality. The vessels to be dilated must subtend at least a moderate area of viable myocardium. In the cardiologist's judgement, there should be evidence of myocardial ischaemia by ECG exercise testing, stress nuclear imaging, stress echocardiography or ambulatory ECG monitoring, or intracoronary physiologic measurements.

The following patients are classified in ACC/AHA's Class III recommendation: Patients with asymptomatic ischaemia or mild angina who do not meet the criteria as listed under Class I or Class II and who have:

a. Only a small area of viable myocardium at risk.
b. No objective evidence of ischaemia.
c. Lesions that have a low likelihood of successful dilation.
d. Mild symptoms that are unlikely to be due to myocardial ischaemia.
e. Factors associated with increased risk of morbidity or mortality.
f. Left main disease.
g. Insignificant disease <50%.

The ACC/AHA recommendation are classified as follows:

1. Class I: Conditions for which there is evidence for and/or general agreement that the procedure or treatment is useful and effective.
2. Class II: Conditions for which there is conflicting evidence and/or a divergence of opinion about the usefulness/efficacy of a procedure or treatment.
   - Class IIa: Weight of evidence/ opinion is in favour of usefulness/ efficacy.
   - Class IIb: Usefulness/efficacy is less well established by evidence/ opinion.
3. Class III: Conditions for which there is evidence and/or general

agreement that the procedure/ treatment is not useful/effective, and in some cases may be harmful.

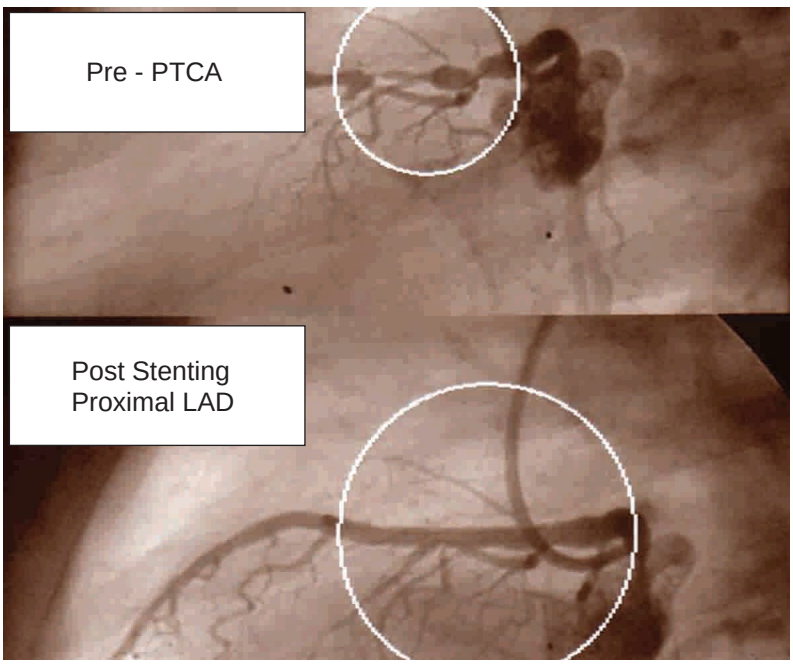
Mechanism of balloon angioplasty and coronary stenting

During percutaneous transluminal coronary angioplasty (PTCA), the gain in lumen diameter is derived from vessel dilation and "controlled" dissection of intima and media. Two limitations of this procedure are that 1) some of the initial gain is lost because of normal elastic recoil and 2) excessive dissection of the vessel may result in impairment of blood flow or even total occlusion of the vessel. Despite a high acute success rate, the biggest long-term limitation of PTCA remains restenosis due to vessel wall recoil and neointimal growth. When present early, recoil is associated with a high frequency of restenosis (74% compared to 10% in those without recoil).[2] When lesions with recoil were randomised to either medical therapy alone or to elective stenting, restenosis was significantly reduced (76% versus 21%) among those receiving intracoronary stents.

Preventing recoil and maintaining initial lumen gain are of the most important advantages of stenting over PTCA. Stenting also allowed non-surgical management of acute occlusions or dissection after PTCA (4-8% of patients), making life easier for both cardiologist and patient.

While stenting reduced acute complications leading to emergency surgery and the restenosis rate compared to PTCA, restenosis remained an obstacle occurring in 20-40% of patients. Certain patients' (diabetics) vessel characteristics (proximal left anterior descending artery, artery diameter 3 mm) and lesion characteristics (length >15 mm, eccentric lesions, presence of thrombus) had a predictable high restenosis rate limiting the advantage of stenting in these groups (**Figure 1**). The histopathology of the restenotic lesions consistently shows neointimal proliferation, and inhibition of neointimal proliferation was necessary to improve the long-term results of coronary stenting. Coating bare metal standard stents with cytostatic agents (sirolimus and tacrolimus) significantly reduced restenosis as well as target-lesion revascularisation. It is important to note that drug-eluting stents (DES) have the same procedural success and in-hospital outcomes as the standard uncoated stents and their main advantage is reducing restenosis by inhibiting neointimal proliferation. In a recent double-blind randomised trial of >1 000 patients, clinical restenosis at 9 months was 4.1% in the sirolimus group versus 16.6% in the standard uncoated stent group and at 12 months the absolute difference in target-lesion revascularisation continued to increase (4.9% vs. 20%; p<0.001).[2] Paclitaxel-eluting stents reduce angiographic restenosis from 26.6% to 7.9%, and target-lesion revascularisation from 11.3% to 3% at 9 months.[4]

Fig 1: Pre- and post-stenting of a long complicated left anterior descending artery stenosis with a drug eluting stent.



Adjunctive drug therapy

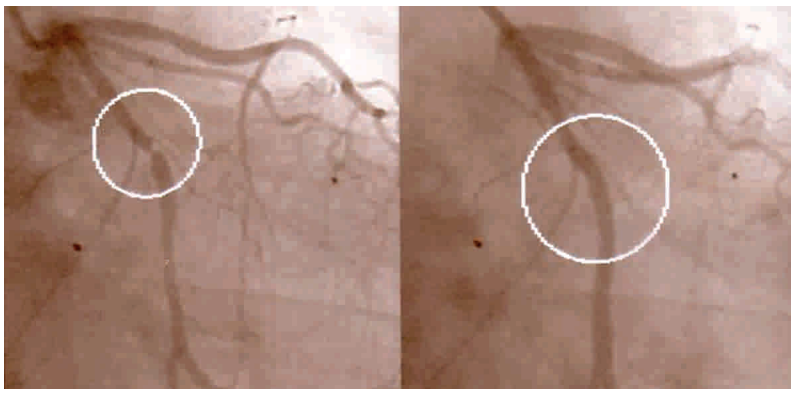
Antiplatelet therapy

- ***Aspirin*** (a permanent cyclo-oxygenase inhibitor} is standard treatment for all patients unless a specific contra-indication is present and is continued indefinitely at a dose of 75-150 mg daily. Aspirin versus placebo significantly reduces mortality, nonfatal reinfarction, and nonfatal stroke at one month. Pre-treatment is necessary to avoid the incidence of early complications. Note that dipyridamole is not recommended for aspirin sensitive patients. Clopidogrel is preferred in these cases.
- ***Clopidogrel*** in combination with aspirin is routinely administered to patients who proceed to stenting. A loading dose of 300 mg is usually given followed by 75 mg daily. Duration of chronic treatment varies from 2 to 12 months (most cardiologists favouring the longer duration). Clopidogrel inhibits adenosine diphosphate (ADP) receptor mediated platelet

activation and is a more potent platelet inhibitor than aspirin. Maximal inhibition of platelet aggregation takes 3 to 5 days after initiation of a standard dose (75mg daily) but occurs within 4-6 hours after the administration of a larger loading dose (300 to 600mg). The use of a high loading dose has been shown to obviate the need for Gp IIb/IIIa inhibitors in low-to-moderate risk patients undergoing PCI. Unfortunately, the administration of clopidogrel also increases the risk of serious bleeding and some physicians delay such treatment until the results of coronary arteriography are known and confirm that bypass grafting is not necessary. Should the drug be given before surgery, it should be discontinued for 5 to 7 days prior to surgery to avoid serious bleeding. In patients undergoing percutaneous coronary interventions, the combination of aspirin and clopidogrel reduces the risk of vessel thrombosis compared with the aspirin alone. Until recently it was given for a period of 8-12 weeks mainly to prevent sub-acute thrombosis of the stented segment. Recent studies have however shown that the administration of aspirin and Clopidogrel for 9 to 12 months after such a procedure reduces the incidence of major cardiovascular events without increasing the risk of bleeding as compared with aspirin alone. The excepted recommendation is now that all patients should be continued for at least 9 to 12 months on the combination.

- ***Glycoprotein IIb/IIIa platelet inhibitors*** (abciximab, eptifibatide, tirofiban). The value of these drugs has been proven in the setting of infarct artery stent implantation.[5] At 1 year, the survival rate was 95% in the abciximab group and 88% in the stent-alone group (p=0.017) and the reinfarction rate 1% in the abciximab group and 6% in the stent-alone group. Diabetics benefit more than non-diabetics when undergoing stenting[6] and have less ischaemic complications after PCI when treated with Gp IIa/IIIb inhibitors. There is abundant evidence that Gp IIb/IIIa inhibitors reduce thrombotic cardiac complications in patients with acute coronary syndromes undergoing PCI, especially in the group with raised troponin concentrations.[7]

Fig 2: Balloon angioplasty of a tight short uncomplicated stenosis in a 3.5 mm circumflex artery with a "stent-alike" result.



Anticoagulants

- Heparin. Low molecular weight heparin is currently favoured by most cardiologists and is routinely administered at the onset of a PCI.
- Warfarin is no longer used after PCI unless a specific indication for anticoagulation exists.

Thrombolytics

These drugs are now infrequently used and in the presence of thrombus Gp IIb/IIIa inhibitors are the drugs of choice.

One overview of RCTs in people with acute myocardial infarction and ST elevation or bundle branch block on their initial electrocardiogram has found that prompt thrombolytic treatment (within six hours and perhaps up to 12 hours and longer after the onset of symptoms) versus placebo significantly reduces short-term mortality. The overview found that thrombolytic treatment versus control significantly increased the risk of stroke or major bleeding. Meta-analysis of RCTs comparing different types of thrombolytic agents versus each other have found no significant difference in mortality

Other small randomised trials have found that percutaneous transluminal coronary angioplasty (PTCA) is superior to thrombolytic therapy in the treatment of patients with acute MI. Based on these results, the ability to care for patients with acute MI would be limited to facilities that have these capabilities. Other studies have found no substantial survival benefit with PTCA when compared with thrombolytic therapy. A review by Mehta and colleagues[8] evaluated the clinical outcomes in patients with acute MI who were treated with fibrinolytic therapy in hospitals with and without coronary artery revascularization capabilities.

They analysed the outcomes of patients enrolled in the Global Use of Streptokinase and TPA (alteplase) for Occluded Coronary arteries (GUSTO-1) trial. Of the patients who met the inclusion criteria, 25,515 were enrolled in the study. The baseline characteristics of the two patient groups were similar, with no difference in complication rates. Patients admitted to hospitals with coronary artery revascularisation capabilities

underwent substantially more procedures, but the 30-day and one-year survival rates were similar between the two groups. Also, the rates of recurrent ischemia, reinfarction, congestive heart failure, shock, and stroke did not differ between the two hospital types. The authors concluded that similar outcomes occur in patients with acute MI treated with fibrinolytic therapy regardless of whether the hospital has coronary artery revascularization capabilities, provided that appropriate candidates receive aspirin and beta-blocker therapy. Hospitals without revascularization capabilities must therefore have the capacity to immediately transfer patients who need angiography or revascu-larisation.[7]

The thrombolysis in myocardial infarction (TIMI) risk score (discussed in the first article) integrates historical factors, frequency of symptoms, electrocardiographic findings, and cardiac biomarker levels. Higher scores are associated with an increased risk of adverse outcomes such as death, (re)infarction, or recurrent ischemia requiring revascularisation. The risk of these outcomes ranges from approximately 5 percent with a TIMI risk score of zero or one point to approximately 41 percent with a risk score of six or seven points. The risk score may be used to help guide therapeutic decisions. Patients with higher risk scores have been shown to derive greater benefit from specific pharmacologic therapies (enoxaparin), platelet glycoprotein IIb/IIIa inhibitor and an early cardiac catheterisation (invasive) strategy.

Complications of PCI

- ***Bleeding and vascular injury***. Due to the intensive anticoagulation and antiplatelet therapy, bleeding at the site of vascular access remain a problem and is more common in the elderly and in women. The role of vascular closure devices is still undefined but appears promising. False aneurysms occur occasionally in the femoral artery and usually require surgical correction. The radial artery is frequently used in patients with occlusive aorto-iliac disease or who are at risk for bleeding complications (on warfarin) because it is easily compressible.
- ***Coronary rupture and/or perforation*** are serious but fortunately rare complications, which are usually related to too large balloons in small vessels. Patients may be managed by prolonged balloon inflation and administration of protamine, but emergency surgery is sometimes unavoidable.
- ***Side branch occlusion*** may occur if a lesion is located at a bifurcation and a calculated risk is then taken by the operator on whether the side branch may be sacrificed. Different techniques are available to protect larger side branches that supply a significant amount of pericardium.
- ***Thrombosis***. **Acute** stent thrombosis occurring within hours of the procedure is usually due to incomplete stent expansion or arterial dissection. Since the patients are still hospitalised, early diagnosis and appropriate percutaneous treatment is possible. **Subacute** stent thrombosis is more frequent (<2% in elective cases and 5% in the treatment of abrupt vessel closure after PTCA) and is more disastrous since patients are already discharged, resulting in a high rate of ischaemic sequelae (61% myocardial infarction, 12% death). Enhanced platelet therapy (aspirin and clopidogrel) and proper stent expansion during the implantation reduced the frequency of this dreadful complication. Early recognition by the GP is essential.
- ***Myocardial infarction***. Depending on the definition (CK rise or new Q waves), the incidence varies from 1-20% and is caused by dissection, coronary artery spasm or thrombosis. Adequate antiplatelet therapy, heparin administration, and the use of stents in complicated lesions have reduced the occurrence of AMI, but will unfortunately not eradicate it.

See CPD Questionnaire, page 38

References

1. Smith et al. ACC/AHA Percutaneous Coronary Intervention Guidelines. JACC Vol. 37, No. 8, 2001 June 15, 2001:2239(Ii–xvi)
2. Rodriguez A, Santaera O, Larribeau M, *et al.* Early decrease in minimal luminal diameter after successful percutaneous transluminal coronary angioplasty predicts late restenosis. Am J Cardiol 1993; 71:1391-1395.
3. Analysis of 1-year clinical outcome in the SIRIUS trial: a randomized trial of a sirolimus-eluting stent vs. a standard stent in patients at high risk for coronary restenosis. Holmes DR, Leon MB, Moses JW, *et al* Circulation 2004;109:634-640.
4. A polymer-based, paclitaxel-eluting stent in patients with coronary artery disease. Stone GW, Ellis SG, Cox DA, *et al.* N Engl J Med 2004;350:221-231.
5. Abciximab-supported infarct artery stent implantation for acute myocardial infarction and long-term survival: a prospective. Multicenter, randomized trial comparing infarct artery stenting plus abciximab with stent alone. Antoniucci D, Migliorini A, Parodi G, *et al.* Circulation 2004;109:1704-6.
6. Marso SP, Lincoff AM, Kereiakis DJ, *et al*. Optimising the percutaneous interventional outcomes for patients with diabetes mellitus: results of the EPISTENT diabetic substudy. Circulation; 1999:100:2477-84.
7. Boersma E, Harrington RA, Moliterno DJ, *et al.* Platelet glycoprotein IIb/IIIa inhibitors in acute coronary syndromes: a meta-analysis of all major randomised trials. Lancet 2002; 359:189-98.
8. *Mehta RH, et al.* Patient outcomes after fibrinolytic therapy for acute myocardial infarction at hospitals with and without coronary revascularization capability. J Am Coll Cardiol September 18, 2002;40:1034-40.
9. Arampatzis CA, Lemos PA, Hoye A, *et al*. Elective Sirolimus-eluting stent implantation for left main coronary artery disease: Six-month angiographic follow-up and 1-year clinical outcome. Catheter Cardiovasc Interv 2004; 62:292-96.
10. The BARI investigators. Influence of diabetes on 5-year mortality and morbidity in a randomized trial comparing CABG and PTCA in patients with multivessel disease. The Bypass Angioplasty Revascularization trial. Circulation 1997; 96: 1761-69.
11. Van den Brand MJB, Rensing BJWM, Morel MM, *et al*. The effect of completeness of revascularization on event-free survival at one year in the ARTS trial. J AM Coll Cardiol 2002; 39:559-64.
12. Mehran R, Dangas GD, Kobayashi Y, et al. Short- and long-term results after multivessel stenting in diabetic patients. J Am Coll Cardiol 2004; 43:1348:54.
13. Bhatt DL, Topol E. Percutaneous coronary intervention for patients with prior by bypass surgery: therapy in evolution. Am J Med 2000;108:176.