CORONARY ARTERY SPASM

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A. BALLOON ANGIOPLASTY

1. Intralesional Spasm. Coronary artery spasm has been reported in 1-5% of balloon angioplasty procedures. Intralesional spasm may be useful in cases where it is difficult to distinguish refractory spasm from dissection. Fortunately, most cases can be successfully treated by intracoronary nitrates and/or calcium antagonists; repeat PTCA at low inflation pressures is effective, but is rarely necessary.

2. Distal Epicardial Spasm. Spasm of the distal vessel is common after percutaneous intervention. Distal epicardial spasm can be reversed by intracoronary nitroglycerin or prevented by continuous intravenous nitroglycerin. Serotonin released from circulating platelets plays an important pathogenic role; ketanserin, a selective serotonin2-receptor antagonist, can blunt distal epicardial spasm after PTCA. Pretreatment with aspirin does not reliably prevent distal spasm.

3. Microvascular Spasm. In contrast to epicardial spasm, spasm of the microvascular bed rarely responds to nitrates. The incidence, risk factors, and management of this condition are reviewed in the chapter on “no-reflow” (Chapter 21).

4. Post-Procedural Spasm. The PTCA site remains susceptible to spasm for several months after the procedure; ergonovine and acetylcholine can induce vasospasm after PTCA in 15% and 46% of patients, respectively. Spontaneous episodes of spasm may cause angina in the weeks or months following PTCA.

B. PATHOPHYSIOLOGY. Percutaneous devices result in coronary endothelial denudation and loss of nitric oxide, which increases sensitivity to local vasoconstrictors (e.g., serotonin from aggregating platelets) and decreases sensitivity to local vasodilators (e.g., prostacyclin, prostaglandin E2). Other putative mechanisms include increased production or impaired degradation of norepinephrine or platelet-derived vasoconstrictors (thromboxane, serotonin, platelet-activating factor), altered arachidonic acid metabolism (resulting in the overproduction of vasoconstricting prostanoids and leukotrienes), release of endothelium-derived contractile factor (EDCF), local adrenergic nerve dysfunction, and stimulation of stretch-dependent myogenic tone. A decrease in forearm bloodflow and an increase in vascular resistance have been observed after coronary angioplasty; these changes were abolished by pretreatment with phentolamine (α-blocker) or verapamil, suggesting the presence of a generalized neural or hormonal mechanism.
C. NON-BALLOON DEVICES. Compared to PTCA, coronary artery spasm after other devices appears to occur with equal or greater frequency.\textsuperscript{19-27} Spasm has been reported in 4-36\% of Rotablator cases,\textsuperscript{16,24,28,29,37} but severe spasm resulting in abrupt occlusion requiring repeat PTCA or CABG is less common (< 2\%).\textsuperscript{19} Spasm was reported in 1.2-16\% of laser procedures but is very uncommon with current saline infusion techniques (Chapter 30).\textsuperscript{21,22,25-27,30} Coronary spasm following these devices responds to intracoronary nitrates.

D. MANAGEMENT (Figure 19.1)

1. Nitrates. Coronary artery spasm usually resolves promptly to intracoronary nitroglycerin (200-300 mcg), but higher doses may be needed in some patients. Patients receiving IV, oral, or transdermal nitroglycerin without a nitrate-free interval may not respond to intracoronary nitroglycerin (or may require a higher dose), due to nitrate tolerance.

2. Removal of Interventional Hardware. If intralesional spasm is evident, the guidewire should remain across the lesion to maintain vascular access while nitroglycerin is administered. If spasm occurs distal to the target lesion, partial or complete removal of the guidewire may be required for the spasm to resolve.

3. Calcium Antagonists. Intracoronary verapamil (100 mcg/min up to 1.0-1.5 mg)\textsuperscript{31} or intracoronary diltiazem (0.5-2.5 mg over 1 minute, up to 5-10 mg)\textsuperscript{32} may reverse coronary spasm refractory to intracoronary nitroglycerin. A temporary transvenous pacemaker should be readily available, although the risk of AV block, bradycardia, and hypotension is low.

4. Repeat Balloon Dilatation. If intralesional spasm persists despite nitrates and intracoronary calcium antagonists, a prolonged (2-5 minute) low-pressure (1-4 atm.) inflation using a balloon matched to the reference segment is frequently successful at “breaking” the spasm. In fact, the vast majority of episodes of spasm respond to nitrates and repeat PTCA. “Refractory spasm” is probably due to dissection and should respond to stenting.

5. Anticholinergics. Acetylcholine may induce paradoxical vasoconstriction in de-endothelialized arteries,\textsuperscript{33} presumably due to a local loss of nitric oxide and a direct vasoconstrictor effect on vascular smooth muscle. Therefore, if spasm is accompanied by hypotension and bradycardia, atropine may be administered (0.5 mg IV every 5 minutes to a total of 2.0 mg).

6. Systemic Circulatory Support. A rare management dilemma may arise when severe spasm is associated with ischemia and hypotension, since administration of nitrates or calcium antagonists may exacerbate hypotension and lead to further clinical deterioration. In this setting, it is best to proceed with intracoronary nitrates or calcium antagonists while preparing to support the systemic circulation with IABP. Alpha-adrenergic drugs (phentolamine) may exacerbate vasospasm and should be avoided, but inotropes such as dobutamine can be used if needed.
Figure 19.1. Management of Intraprocedural Spasm

1. Nitroglycerin 100-300 mcg IC bolus + intravenous infusion (20 mcg/min)
2. Verapamil 100 mcg/min IC up to 1.5 mg; temporary pacemaker on standby
3. Diltiazem 0.5-1 mg IC over 1 min up to 2.5-5.0 mg as needed; temporary pacemaker on standby
4. Nifedipine 10 mg sublingual
5. Atropine 0.5 mg IV; may repeat every 5 min up to 2.0 mg
7. **Stents.** Intracoronary stenting has been used successfully for refractory spasm, but should be reserved for situations in which all other nonoperative alternatives have failed. Most such cases of “refractory” spasm are probably dissections, which should respond to stenting.

8. **Superimposed Coronary Dissection and Thrombus.** Multiple angiographic views of the target lesion should be obtained to exclude superimposed dissection and/or thrombus. Intravascular ultrasound may help clarify the nature of the lesion and guide further therapy.

**E. PREVENTION.** A continuous intravenous infusion of nitroglycerin (10-50 mcg/min) may prevent distal spasm and is used routinely at our institution for most patients undergoing coronary intervention.

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**PTCA FOR VARIANT ANGINA**

Patients with variant (Prinzmetal’s) angina present with unpredictable bouts of effort angina or rest pain and ST-segment changes due to spontaneous coronary vasospasm. Dynamic obstruction of coronary blood flow may occur in angiographically normal coronary arteries, but is more common in vessels with moderate or severe fixed stenoses.\(^{34}\) Although medical management alone is effective in the majority of cases, some patients continue to have disabling symptoms rarely leading to MI or sudden death. The prognosis is worse when tachy- or bradyarrhythmias occur during episodes of pain, and when spasm is superimposed on fixed lesions.\(^{34}\) Compared to patients undergoing surgery for classic angina pectoris, coronary artery bypass grafting with or without sympathetic denervation is associated with a higher incidence of post-operative MI, early graft closure, and recurrent angina.\(^{35}\) PTCA and stenting have occasionally been applied to patients with spasm superimposed on fixed lesions.\(^{39}\) Small observational reports suggest a number of general conclusions (Table 19.1).\(^{5,6,36,38}\)

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<thead>
<tr>
<th>Table 19.1. Results of PTCA for Organic Stenoses in Variant Angina</th>
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<tr>
<td><strong>A high technical success rate can be achieved</strong></td>
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<td><strong>Procedural complications, including PTCA-induced coronary</strong></td>
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<td><strong>artery spasm, are no more frequent than during PTCA for</strong></td>
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<td><strong>other types of coronary disease</strong></td>
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<td><strong>Recurrent spasm and rest angina are not uncommon following</strong></td>
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<td><strong>PTCA; pharmacologic therapy with nitrates and calcium</strong></td>
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<td><strong>antagonists may reduce their frequency and severity</strong></td>
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<td><strong>Restenosis rates are approximately 50%</strong></td>
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<td><strong>Many patients derive symptomatic benefit, although the</strong></td>
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<td><strong>impact on event-free survival (compared to medical</strong></td>
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<td><strong>therapy or CABG) has not been evaluated</strong></td>
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<td><strong>The role of other interventional devices is unknown</strong></td>
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REFERENCES


