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Coronary Angioplasty Requiring Extraordinarily High Balloon Inflation Pressure

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Two cases are presented in which extraordinarily high balloon inflation pressures (20 and 17 atm) were required to successfully dilate a saphenous vein graft stenosis and a right coronary artery stenosis. The clinical application of high balloon inflation pressures and balloon selection is discussed.

Key words: percutaneous transluminal coronary angioplasty (PTCA), myocardial ischemia, restenosis, saphenous vein grafts

INTRODUCTION

Early success in applying percutaneous transluminal coronary angioplasty (PTCA) to clinical use was hampered by technical obstacles that have largely been overcome. The development of smaller, more trackable dilating catheters and highly steerable fixed and over-the-wire systems have rendered the entire epicardial coronary bed accessible to PTCA. In addition, improvement in balloon tensile strength has been phenomenal. The original Gruentzig catheter had a low balloon burst pressure (6 atm, or 90 psi) which made it very difficult to dilate rigid lesions adequately [1]. Improvements in dilating catheter design and materials now permit inflation pressures of over 20 atm (300 psi) for selected catheters. However, in clinical practice the balloon is inflated gradually and incrementally to eliminate the "waist," a practice which seldom requires pressures in excess of 10 atm. Higher inflation pressures are usually avoided because of the potential for more extensive intimal damage and/or dissection. Thus, the clinical value of extraordinarily high inflation pressures is uncertain. The following report describes two cases in which extremely high balloon inflation pressures were required to successfully dilate lesions in a rigid saphenous vein graft (SVG) and a native right coronary artery, respectively.

CASE 1

A 67 year-old man who had undergone prior coronary artery bypass surgery in 1971 and 1981 presented to the hospital in January 1990 with unstable angina and was referred for cardiac catheterization. Selective coronary arteriography revealed 3 vessel coronary artery disease and occluded SVGs to the RCA and third OM, with patent SVGs to the LAD and second OM. However, the SVG to the second OM was stenosed with serial 50% and 80% lesions (Fig. 1). Medical therapy was first recommended based on the site of stenosis (body of the SVG) and age of the SVG (>3 years since implantation), features which have been associated with a high incidence of distal embolization and restenosis [2]. Moreover, the lesion appeared to be calcified, a somewhat unusual feature for SVG lesions which we felt would further complicate PTCA. He was stabilized on maximal doses of antianginal medications. However, three wk after discharge from the hospital he was readmitted for unstable angina. He was started on intravenous heparin with resolution of his rest angina; following one wk of intravenous heparin infusion he underwent elective angioplasty of the SVG to the second OM. Catheterization was performed via the right femoral artery approach and an initial 10,000 units bolus of intravenous heparin was given before engaging the SVG ostium with a 8 French Cordis JR 4 guiding catheter. A 3.0 mm compliant polyethylene balloon catheter (Medtronic Thruflex II, Minneapolis, MN) failed to resolve the stenosis (Fig. 2) on incremental inflation up to 11 atm. The balloon burst at 12 atm with a prominent "waist" still visible on fluoroscopy. Therefore, a 3.0 mm non-compliant polyethylene terephthalate balloon catheter (USCI Mini-Profile, Billerica, MA) with rated burst pressures in excess of 20 atm was cho-

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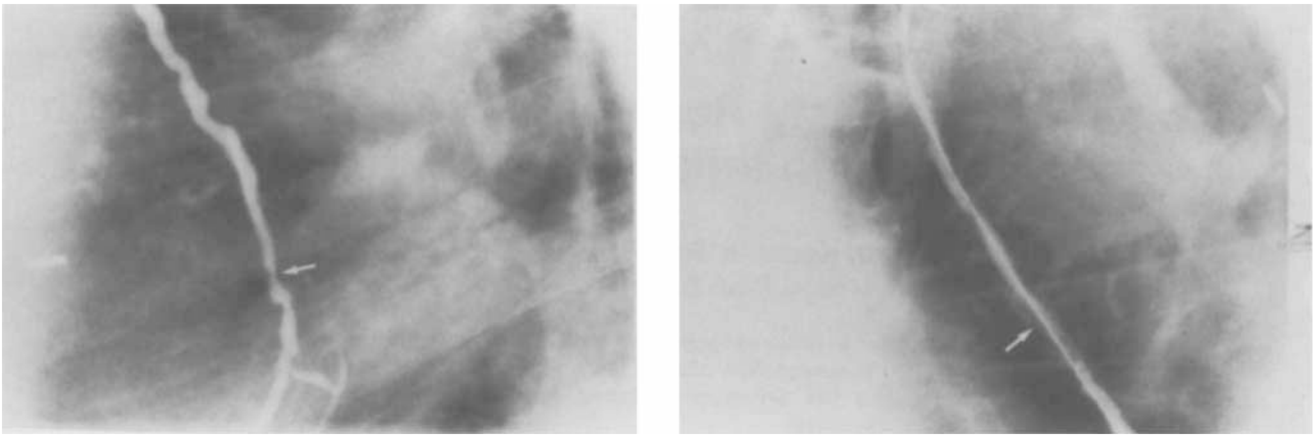

Fig. 1. Left panel: Left anterior oblique projection of the saphenous vein graft to a second obtuse marginal branch showing an 80$ stenosis (arrow). Right panel: Right anterior oblique projection of the same graft showing improvement in luminal diameter post-angioplasty with a "hazy" appearance and small dissection (arrow).

sen. Incremental increases in the inflation pressure resulted in elimination of the balloon ''waist'' at 20 atm (300 psi) (Fig. 2). The final angiogram revealed a marked improvement in luminal diameter with a ''hazy'' appearance and a small dissection (Fig. 1). The patient was transferred to the coronary care unit on intravenous heparin with arterial and venous sheaths in place. The sheaths were pulled the following morning, and the remainder of this hospital course was uneventful. He returned for his follow-up clinic appointment four wk post-PTCA doing well without recurrent angina.

CASE 2

A 64 year-old man presented with new onset angina and an early positive exercise test. Cardiac catheterization revealed normal left ventricular function, minimal coronary atherosclerosis of the left coronary system, and a calcified 95% stenosis in the mid-RCA. PTCA and the RCA lesion was performed via the right femoral artery using an 8F Williams guiding catheter (USCI). After a bolus of 10,000 units of heparin, dilatation of the lesion was attempted using a 3.5 mm polyvinyl chloride balloon (Hartzler ACX, Advanced Cardiovascular Systems, Santa Clara, CA). However, a prominent balloon ''waist'' was still present after incremental inflation to 10 atm. The balloon was then exchanged for a 3.5 mm polyethylene terephthalate balloon (USCI Sprint), and the ''waist'' disappeared at an inflation pressure of 17 atm. Final angiograms revealed a small dissection with a 20% residual stenosis post-PTCA. The patient has remained asymptomatic.

CLINICAL IMPLICATIONS

These cases illustrate that extremely high balloon inflation pressures can be safely performed and may be necessary in selected cases to fully inflate the balloon. Optimal balloon inflation pressure during angioplasty is unknown. There is limited data to suggest that higher balloon inflation pressures are associated with more favorable early hemodynamic results [3–5]. Two small retrospective human restenosis studies [6,7] showed a significant association between restenosis and high (>7 atm) inflation pressures, however others have reported no significant increase in restenosis among patients requiring higher balloon infaltion pressures [8,9]. A recent prospective animal model compared the effects of balloon-oversizing and inflation pressure on initial increase in luminal diameter, medial necrosis, restenosis, and intimal hyperplasia [10]. They compared the results (immediately and at 28 days) among four groups: 1) oversized balloon and low inflation pressure (5 atm), 2) oversized balloon and high inflation pressure (10 atm), 3) appropriately-sized balloon and low inflation pressure, and 4) appropriately-sized balloon and high inflation pressure. The immediate results showed that high inflation pressures resulted in significantly larger luminal diameters; however, it was also significantly associated with a higher incidence of mural thrombus, dissection, and more extensive medial necrosis than lower inflation pressures. Results at 28 days showed no significant difference among groups in restenosis rates although there was a trend for increased restenosis rates among the groups using oversized balloons. There was also a significant increase in intimal hyperplasia by morphometric

Fig. 2. Left panel: Right anterior oblique projection showing a prominent "waist" in the balloon at 11 atm. Right panel: Same projection showing full expansion of the balloon at 20 atm.

analysis in all groups, including primary angioplasty failures. These findings support the time-honored practice of incrementally increasing balloon inflation pressures to eliminate the "waist" in an appropriately sized balloon.

In our experience, the vast majority of lesions can be successfully dilated using conventional balloons with burst pressures of approximately 12 atm. However, as illustrated by this report, rigid calcified lesions may occasionally require extraordinarily high inflation pressures in order to fully inflate the balloon and eliminate the "waist." In such cases, a non-compliant polyethylene terephthalate balloon should be used because it will allow very high inflation pressures while maintaining nominal balloon diameter. Because higher inflation pressures may be associated with more extensive intimal damage and/or dissection, one should probably lean toward undersizing the balloon when extraordinarily high inflation pressures are employed. When a polyvinyl chloride balloon is used, and incremental expansion to 10 atm fails to resolve the "waist," we believe that exchange for a polyethylene terephthalate balloon is indicated (prior to expanding the initial balloon to the burst point). Alternatively, one should consider starting the case with a polyethylene terephthalate balloon when the lesion appears heavily calcified on fluoroscopy.

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