The whole nine yards: Multiple cardiac surgical and percutaneous interventions in a patient during 30 years of care

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A 38-year-old man underwent coronary artery bypass graft surgery for angina pectoris following myocardial infarction. During the following 28 years, he required two repeat coronary artery bypass graft surgical procedures, nine percutaneous coronary interventions and 17 coronary angiograms. His treatment included saphenous vein, left internal mammary artery and gastroepiploic artery grafting, percutaneous transluminal coronary angioplasty and intragraft thrombolytic therapy, directional coronary atherectomy, cutting balloon angioplasty, intracoronary stenting with bare-metal and drug-eluting stents, treatment for in-stent restenosis, stenting of the left main and circumflex coronary arteries and saphenous vein graft as well as intracoronary pressure wire diagnostics. In addition to his statin therapy, antiplatelets and angiotensin-converting enzyme inhibitors, he also underwent biventricular automatic implantable cardioverter-defibrillator implantation and atrioventricular node radiofrequency ablation for his impaired left ventricular function, ventricular tachycardia and rapid atrial fibrillation. The present unusual case represents almost 'the whole nine yards' of treatment that has become available to patients with coronary artery disease during the past 30 years of technological development.

Key Words: Ablation; Angioplasty; Coronary; Defibrillator; Pacing; Stent; Surgery

Many patients worldwide have benefited from one or more of the many therapeutic interventions that have developed in cardiology and cardiac surgery over the past four decades. However, the present case report illustrates how an individual patient received an unusually wide range of these interventions for several aspects of his coronary artery disease over nearly 30 years of technological development.

CASE PRESENTATION

In June 1980, a 38-year-old man with familial hypercholesterolemia and tuberous xanthomata on his hands, heels and elbows suffered an acute myocardial infarction; another episode occurred four months later and, subsequently, he suffered postinfarct angina pectoris. His total cholesterol was 8.1 mmol/L and he was initially treated with cholestyramine. Coronary angiography showed occlusion of the right coronary artery (RCA) and left anterior descending coronary artery (LAD), and mild disease in the left circumflex (LCx) coronary artery. In January 1981, he underwent coronary artery bypass graft surgery (CABG) with saphenous vein grafts (SVGs) to the LAD, RCA and first diagonal coronary artery (Table 1). However, in 1982, 1984 and 1985, he suffered further myocardial infarctions and in June 1986, repeat coronary angiography showed occluded LAD, RCA and all SVGs, and severe stenoses in the LCx artery. He had difficulty tolerating both cholestyramine and gemfibrozil, and controlled his total

Toute la panoplie : De multiples interventions cardiaques et percutanées chez un patient, réparties sur 30 ans de soins

Un homme de 38 ans a subi un pontage aortocoronarien en raison d'une angine de poitrine suivant un infarctus du myocarde. Pendant les 28 années qui ont suivi, il a subi deux nouveaux pontages aortocoronariens, neuf interventions coronaires percutanées et 17 coronarographies. Il a subi des greffes à la veine saphène, à l'artère thoracique interne gauche et à l'artère gastroépiploïque, une angioplastie coronaire transluminale percutanée et une thérapie thrombolytique intragreffe, une athérectomie coronaire directionnelle, une angioplastie par ballonnet, l'installation d'une endoprothèse intracoronaire à métal nu et d'endoprothèses à élution de médicament, un traitement de nouvelle sténose dans l'endoprothèse, l'installation d'une endoprothèse de l'artère coronaire gauche principale, de l'artère circonflexe et de la greffe de la veine saphène ainsi que des diagnostics de pression sur les fils intracoronaires. Outre une thérapie aux statines, aux antiplaquettaires et aux inhibiteurs de l'enzyme de conversion de l'angiotensine, le patient a également reçu un défibrillateur à synchronisation automatique biventriculaire, subi l'ablation de la radiofréquence du nœud auriculoventriculaire en raison de la défaillance de la fonction ventriculaire gauche, une tachycardie ventriculaire et une fibrillation auriculaire rapide. Ce cas inhabituel représente presque toute la panoplie des traitements offerts aux patients atteints d'une coronaropathie en 30 ans de progrès technologiques.

cholesterol between 5.6 mmol/L and 6.4 mmol/L by strict dietary measures. In January 1987, he underwent a second CABG operation with a left internal mammary artery (LIMA) graft to the LAD and a new SVG to the RCA (SVG RCA). In 1992, he was started on simvastatin and since then, his total cholesterol level has been between 3.4 mmol/L and 4.4 mmol/L (currently 3.4 mmol/L on 80 mg atorvastatin). He was healthy until 1993 when he developed rest angina. Repeat coronary angiography showed a significant ostial left main artery stenosis and a normal LIMA but the SVG RCA was occluded by thrombus. Recombinant tissue-type plasminogen activator (rt-PA) (50 mg) was injected down the SVG RCA before and following percutaneous transluminal coronary angioplasty (PTCA), which re-established antero-grade flow down the graft. Ventricular fibrillation on reperfusion was corrected by direct current cardioversion. PTCA was performed to a distal anastomotic stenosis and he remained angina-free for two months. Recurrent symptoms warranted repeat angiography, which showed reocclusion of the SVG RCA by extensive thrombus. The vein graft was reopened by serial balloon dilatations along the graft and streptokinase (800,000 U) was infused in boluses directly into the graft. This produced an excellent acute result but a persistent focal discrete lesion was evident at the site of graft occlusion in the proximal one-third. Directional coronary atherectomy with a 7F-SCA-EX atherectomy device (DVI Inc, USA) was used to remove the lesion,

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TABLE 1
Range of medical and surgical procedures

Date	Investigation	Percutaneous coronary intervention	Surgery	Pacing/electrophysiology
November 1980	Coronary angiography	—	—	—
January 1981	—	—	SVG to LAD/RCA/DG1	—
June 1986	Coronary angiography	—	—	—
January 1987	—	—	LIMA to LAD; SVG to RCA	—
February 1993	Coronary angiography	Intracoronary rt-PA to SVG RCA; PTCA to distal SVG RCA	—	—
April 1993	Coronary angiography	Intracoronary SK/PTCA to SVG RCA/DCA to SVG RCA proximal lesion	—	—
July 1993	Coronary angiography	PTCA to distal SVG RCA restenosis	—	—
February 1994	Coronary angiography	PTCA to distal SVG RCA restenosis	—	—
June 1996	Coronary angiography	Palmaz-Schatz*/NIR stent† to distal SVG RCA restenosis	—	—
April 1998	Coronary angiography	—	—	—
July 1998	—	—	Right gastroepiploic to distal RCA/PDA + SVG OMCx	—
March 2000	Coronary angiography	—	—	—
November 2000	Coronary angiography	PTCA to distal SVG RCA ISR	—	—
January 2004	Coronary angiography	Ultra stents‡ × 2 to proximal lesions of SVG RCA	—	—
March 2004	Coronary angiography	Barath cutting balloon§/Cypher Select stent¶ to ostial LMS stenosis	—	—
July 2004	Coronary angiography	—	—	—
June 2005	Coronary angiography	—	—	—
March 2006	Coronary angiography	—	—	—
November 2006	Coronary angiography	RADI PressureWire** study to SVG RCA proximal/distal lesions	—	—
December 2007	—	—	—	Biventricular AICD implant
January 2008	Coronary angiography	—	—	AVN ablation

*Manufactured by Johnson & Johnson, USA; †Manufactured by Boston Scientific Ltd, USA; ‡Manufactured by Guidant Ltd, USA; §Manufactured by InterVentional Technologies, USA; ¶Manufactured by Cordis Corporation, USA; **Manufactured by RADI Medical Systems Ltd, United Kingdom. AICD Automatic implantable cardioverter defibrillator; AVN Atrioventricular node; DCA Directional coronary atherectomy; DG1 First diagonal coronary artery; ISR In-stent restenosis; LAD Left anterior descending coronary artery; LIMA Left internal mammary artery graft; LMS Left main stem; OMCx Obtuse marginal circumflex artery; PDA Posterior descending artery; PTCA Percutaneous transluminal coronary angioplasty; RCA Right coronary artery; rt-PA Recombinant tissue-type plasminogen activator; SK Streptokinase; SVG Saphenous vein graft

which histology showed to be organized thrombus. A recurrence of angina three months later revealed restenosis at the distal anastomotic site in the SVG RCA. PTCA with a Europass balloon (Cordis Corporation, USA) produced an excellent angiographic result. Seven months later, in February 1994, a recurrence of angina appeared to be due to further restenosis in the distal anastomotic site, which was treated successfully by PTCA with a Streak balloon (ACS, USA). After being asymptomatic for 28 months, in June 1996, he developed further angina, and further restenosis at the distal anastomotic site in the SVG RCA was demonstrated by angiography. The rest of the graft was free of obvious stenoses. The lesion was treated by PTCA and stent implantation with a 15 mm-long Palmaz-Schatz stent (Johnson & Johnson, USA) on a 3.0/3.5 mm CAT balloon (Cardiovascular Dynamics Inc, USA). Because of residual stenosis at the 'hinge point', a 9 mm-long NIR stent (Boston Scientific Ltd, USA) was placed within the Palmaz-Schatz stent with an excellent angiographic result. He remained well for 22 months before developing angina again in April 1998. Angiography showed severe in-stent restenosis (ISR) in the distal SVG RCA, with distal intraluminal thrombus, severe ostial left main stenosis and a patent LIMA. In July 1998, he underwent a third CABG operation with an SVG to the obtuse marginal circumflex artery and a gastroepiploic artery graft to the distal RCA.

He remained asymptomatic for 20 months when, in March 2000, he presented with rest angina followed by ventricular tachycardia and pulmonary edema. Angiography showed the persistent distal ISR in the SVG RCA and an occluded SVG obtuse marginal circumflex

artery. The gastroepiploic artery graft remained patent but with very poor flow into the distal RCA. Left ventricular angiography showed a dilated, impaired left ventricle. He was treated medically for eight months when his angina increased in severity. The distal ISR in the SVG RCA was treated by PTCA in November 2000. He again remained free of angina until January 2004 when repeat angiography demonstrated significant stenoses in the proximal SVG RCA and very severe ostial left main stenosis. He was treated by stent implantation to the proximal SVG RCA lesions using two Ultra stents (3.5 mm × 28 mm and 3.5 mm × 13 mm; Guidant Ltd, USA) with an excellent angiographic result but with little improvement in his anginal symptoms. Two months later, he underwent percutaneous coronary intervention (PCI) to the left main coronary artery. The lesion was predilated with a 2.5 mm × 20 mm Aqua T3 balloon (Cordis Corporation) before being dilated with a 3 mm × 10 mm Barath cutting balloon (InterVentional Technologies, USA) and stented with a 3.5 mm × 18 mm Cypher Select sirolimus drug-eluting stent (DES) (Cordis Corporation) extending into the proximal LCx to cover significant ostial disease. Repeat angiography because of mild angina in July 2004 and June 2005 only revealed mild ISR within the Ultra stents in the proximal SVG RCA but no ISR in the left main DES. Because of persisting mild angina, he underwent a PressureWire (RADI Medical Systems Ltd, United Kingdom) study to the proximal and distal stents in the SVG RCA. The flow within the graft was normal and further PCI was not performed. He remained free of angina. However, in November 2007, he developed sudden onset of palpitations, angina, breathlessness and syncope, and was found to have both

rapid atrial fibrillation and ventricular tachycardia. His resting electrocardiogram showed left bundle branch block. He was initially treated with intravenous and oral amiodarone, and in December 2007 by implantation of a Contak Renewal 4 RF (Guidant Ltd) biventricular automatic implantable cardioverter defibrillator. Repeat angiography showed no significant changes apart from mild to moderate ISR within the Ultra stents in the proximal SVG RCA. Figure 1 illustrates some of his many interventional procedures. In mid-December, he experienced a shock from his implantable device and interrogation showed that this was due to fast atrial flutter/fibrillation. He was therefore readmitted in January 2008 for atrioventricular node radiofrequency ablation, which was performed successfully. He is currently free of angina.

DISCUSSION

The present case demonstrates the extent to which modern interventional cardiological techniques can be applied to an individual throughout almost 30 years of his adult life and through the natural progression of his coronary artery disease and some of the treatments provided. It demonstrates the evolution of CABG surgery from SVG surgery to the use of LIMA and other arterial grafts such as the gastroepiploic artery graft when conduits become scarce. It also demonstrates the range of PCIs that have developed during the past 25 years including PTCA, intragraft thrombolytic therapy, directional coronary atherectomy, cutting balloon angioplasty, bare-metal and DES, as well as the useful intracoronary diagnostic procedures such as the RADI PressureWire. Left main coronary artery stenting with DES is becoming more reliable in clinical practice and clearly invaluable in situations such as in the present patient, who had already undergone three previous CABG procedures. Moreover, the present case illustrates how other interventional techniques aimed at improving left ventricular function and cardiac output such as biventricular pacing and implantable defibrillators can be essential in the management of the later effects of coronary disease, and how other techniques, such as atrioventricular node ablation, can deal with other troublesome arrhythmias that adversely influence cardiac function. Most of this treatment cannot be provided without high-quality diagnostic procedures and the present patient has so far had 17 coronary angiograms leading up to his nine PCI and three CABG procedures. Of course, the

Figure 1) Sternal wires and left internal mammary artery clips (small arrows) from the patient's previous coronary artery bypass graft surgery; and the right atrial, right ventricular and coronary sinus electrodes of his biventricular automatic implantable cardioverter defibrillator and the stents in the saphenous vein graft to the right coronary artery (arrow) and left main coronary artery (open arrow) are radiological evidence of some of the various interventional procedures the patient underwent. DC Distal coil; PC Proximal coil

concomitant use of angiotensin-converting enzyme inhibitors, statins and antiplatelets, and the implantable biventricular automatic implantable cardioverter defibrillator ensure other benefits and have added to 'the whole nine yards' of interventional therapy provided for this individual.