CASE REPORTS

Intravascular ultrasound to assess left main stem coronary artery lesion

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Abstract

A man of 70 underwent coronary arteriography for the assessment of angina. The appearance of the left coronary main stem was slightly abnormal but no definite stenosis could be delineated. Intracoronary ultrasound examination with a 4.8 French intravascular ultrasound probe showed an extensive plaque in the distal left main stem and proximal left anterior descending coronary artery, with a shelf-like projection causing 60% narrowing at one point in the distal left main stem. Since coronary bypass surgery the patient has been free of angina.

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Intravascular ultrasound examination is a new method of vascular imaging that shows the lumen and cross sectional anatomy of the vessel wall. Intravascular ultrasound probes are now small enough to enter the coronary arterial tree. Several reports have shown the research potential of intracoronary ultrasound but its clinical usefulness has yet to be defined. We report the use of intracoronary ultrasound to demonstrate left main stem disease not visualised satisfactorily on diagnostic fluoroscopy.

Case report

A fit 70 year old medical practitioner presented to casualty with persistent severe chest pain at rest. Over the preceding three months he had experienced short episodes of chest pain that was not consistently related to physical exertion and occasionally had occurred at rest, lasting 5-10 minutes. The chest pain became less severe but no less frequent after he started to take diltiazem and long-acting nitrate regularly. He had smoked 20 cigarettes per day until two months before; there was no family history of myocardial infarction or angina.

Physical examination was unremarkable, with no stigmata of hyperlipidaemia and no signs of cardiac failure. The electrocardiogram recorded in the casualty department during chest pain showed atrial tachycardia with non-specific ST-T changes (fig 1A); a

normal electrocardiogram was recorded later when the patient was pain free (fig 1B). The chest x ray was normal.

Coronary arteriography showed only a suggestion of abnormality of the distal left main stem coronary artery in one view (right anterior oblique 30°), other views were normal in appearance. The left anterior descending, circumflex, and dominant right coronary arteries were normal. Left ventriculography in the right anterior oblique projection showed normal contraction.

Because of the suspicious appearance of the left main stem, further investigation was performed to assess the possible need for coronary artery surgery. Cardiac catheterisation was performed via the femoral approach and the left coronary ostium was intubated with a 9 French short-tipped left Judkins guiding catheter (Medtronic, UK). Heparin 5000 units and diazepam 5 mg were given intravenously. High resolution digital angiograms (Siemens Digitron III) acquired during contrast injection showed a fine line of reduced contrast density extending obliquely across the diameter of the distal left main stem, best visualised in the right anterior oblique projection with caudo-cranial angulation (fig 2).

A 0.014 inch high torque floppy guide wire was passed into the left anterior descending artery. A 4.8 French monorail intravascular ultrasound probe (Sonicath 90-2273, Boston Scientific, Watertown, Massachusetts) was connected to a Dasonics ultrasound machine (Dasonics, Milpitas, California) modified for the acquisition and display of intravascular ultrasound images. The ultrasound probe was advanced over the guide wire and cross sectional images were obtained of the entire left main stem and proximal left anterior descending artery (fig 3). These showed an eccentric plaque extending from the distal left main stem into the proximal left anterior descending artery. In the distal left main stem the plaque was shelf-like and at the point of maximum encroachment reduced the lumen by approximately 60% over an axial distance of 1 mm. The axial extent of the whole plaque was approximately 10 mm.

The patient tolerated the procedure well and returned to the ward without any chest discomfort or electrocardiographic changes. Because of the history of episodes of anginal

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Figure 1 (A) Electrocardiogram during an episode of chest pain. (B) Electrocardiogram without chest pain.

pain at rest together with the ultrasound appearances of clinically significant left main stem disease, elective coronary artery surgery was performed. Vein grafts were inserted into the mid-portion of the left anterior descending artery and into a large anterolateral circumflex branch. The patient made an uncomplicated recovery and was discharged eight days postoperatively. There have been no further episodes of angina.

Discussion

The requirement for precise and immediate knowledge during performance of interventional vascular techniques has led to the development of intravascular ultrasound. Resolution of intimal dissections, the detail of the vessel wall, and the nature of the material

Figure 2 Digital angiography of the left coronary artery in the right anterior oblique projection with caudo-cranial angulation.

Figure 3 Intracoronary ultrasound appearances of the left coronary artery: (A) proximal left main stem; (B) distal left main stem, with eccentric plaque; (C) distal left main stem showing the origin of the circumflex artery and an eccentric plaque.

causing the stenosis or obstruction still elude the operator who relies on the x ray image.

Contrast arteriography is the currently accepted method for defining the presence and severity of disease in peripheral and coronary arteries. This technique has limitations: it underestimates the extent and severity of disease,¹ it has significant intra and inter observer error, it may be difficult to assess tortuous segments of vessel, overlying vessels may obscure disease, and it may be difficult to obtain high quality images during interventional procedures.²

The case for ultrasound, rather than direct visualisation with a fiberoptic angioscope in this case, is made by the fact that ultrasound can pass through blood and the technique does not require blood replacement during visualisation. This may not be very important for peripheral vessels but is critical in the coronary and cerebral circulations, particularly if frequent images are required. This patient had no demonstrable collateral supply from the right coronary artery and we did not know whether he would have tolerated an extensive period without oxygenated fluid in the left coronary system.

Sound waves can penetrate tissue and show vessel wall structure in depth. Morphological detail can be seen and it is possible to discriminate between elastin and muscular arteries and to see lipid (hypo-echoic), fibromuscular tissue (soft echoes), collagen

rich fibrous tissue (bright echoes), and calcified tissue (bright echoes with shadowing behind).^{3,4} It is easy to discern tissue differences within the pathological area in this patient's images. No pathological correlation is available in this case but a hypo-echoic area was discerned behind the echo-dense luminal surface (fig 3C), that was compatible with a lipid lake behind collagen-rich fibrous tissue. This appearance suggests a newer plaque.

Ultrasound has other advantages—it is safe and the images are readily understood by the operator. It can be incorporated with treatment technologies and may therefore become the on-board diagnostic element of combination devices such as directional atherectomy and laser. It can be combined with Doppler images and pictorial three dimensional flow-field representation is already possible.⁵

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3 Gussenhoven WJ, Essed CE, Frietman P, *et al.* Intravascular echographic assessment of vessel wall characteristics: a correlation with histology. *Int J Card Imaging* 1989;4:105-16.

4 Gussenhoven WJ, Essed CE, Lancee CT, *et al.* Arterial wall characteristics determined by intravascular ultrasound imaging: an in vitro study. *J Am Coll Cardiol* 1989;14: 947-52.

5 Burrell CJ, McDonald AH, Rothman MT, *et al.* 3-D computer visualisation of arteries and blood flow—in vitro and in vivo. *Comput Cardiol* 1990;122:41-6.