Demonstration of the ascending aorta in infective endocarditis by intravenous digital subtraction angiography

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SUMMARY Four patients with infective endocarditis were examined by digital subtraction angiography immediately before operation. In three a root abscess was suspected and the remaining patient was believed to have a false aneurysm at an infected aortic cannulation site. In all the cases digital subtraction angiography showed the structure in several projections and confirmed the presence of a cavity. Subsequent operation confirmed the site and nature of the lesions.

Endocarditis of a native cardiac valve develops in about 16 patients per million population per year in the United Kingdom. The overall mortality is 35%. After the exclusion of patients who die before treatment can be started, the mortality in adequately treated patients is 24%. The overall cumulative risk of developing either early or late infective endocarditis after the insertion of a prosthetic heart valve is about 5%. About 75% of patients with this complication die if medical treatment alone is used. Mortality falls to approximately 50% if operation and valve replacement are performed promptly. Medical treatment is much less likely to be successful if the infection has spread through the aortic wall to produce abscess cavities or false aneurysms, which like aneurysms increase in size. This increases the risk of operation, but this treatment offers the best prospect of cure. First degree heart block in these patients suggests the presence of a septal abscess but is not a sufficient definitive sign to prompt a change from medical to surgical treatment at an unpropitious time. The objective demonstration of a root abscess is important and it has been attempted by arterial arteriography, echocardiography, and computed tomography. Root aortography gives the best evidence but this procedure can displace friable infected material from the valve or abscess cavity and requires arterial puncture. The suitability of computed tomography has not yet been established for this purpose. Echocardiography is a valuable screening tool but may give an equivocal picture in many cases.

Intravenous digital subtraction angiography does not require intra-aortic injection of contrast. It gives good quality images of the aortic root and any abnormal cavities, and it can be used even in ill patients.

Patients and methods

Four patients with infective endocarditis were studied within a period of 20 months. In three patients there were electrocardiographic changes suggestive of abscess formation in the aortic root or interventricular septum. One had native valve endocarditis and two had prosthetic valve endocarditis. The fourth patient had widening of the mediastinum after replacement of the aortic valve and an infected cannulation site on the ascending aorta.

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Accepted for publication 31 May 1988

Fig 1 Electrocardiograms showing a normal PR interval before infective endocarditis developed in patient 1.
Aortic abscess shown by digital subtraction angiography

![Lead II and Lead III waveforms](image)

**Fig 2.** Electrocardiograms showing a prolonged PR interval in patient 1 taken after infective endocarditis developed.

Aorta was suspected. Intravenous digital subtraction angiography was performed to show the structure and confirm the presence of a cavity. Cardiac images were obtained with the Technicare DR 960 digital subtraction angiography unit. Data were acquired at a frame rate of between 2.5 and 5 frames/s with a 12 pulse three phase smoothed generator. Pixel resolution was between 0.3 and 0.6 mm. The equipment and techniques are described in detail elsewhere.\(^{15,16}\)

In this series, a 5 French gauge straight catheter with multiple side holes was inserted into the superior vena cava or right atrium by means of a percutaneous modified Seldinger approach through the median cubital vein of the right arm. Data were acquired in the left anterior oblique and in the right anterior oblique orientation. A bolus of 40 ml of non-ionic contrast material was injected at 25 ml/s and images were obtained over the region of interest. The size of the image intensifier (22 cm) allowed most of the aortic arch to be included in the field of view. Patients were asked not to breathe during the acquisition of the image series. Diagnostic images were obtained in all cases, though some image processing was necessary to obtain the best combination of mask and data images to produce the optimal subtraction image.

**CASE REPORTS**

**Case 1**

A 58 year old man presented with a one week history of malaise, fever, and rigors seven months after he had undergone aortic valve replacement for tight aortic stenosis. A new early diastolic murmur was present at the left sternal edge. Infective endocarditis was confirmed by a blood culture which grew *Staphylococcus epidermidis*. Treatment with benzylpenicillin and gentamicin was started. A previous electrocardiogram showed a normal PR interval (fig 1). But on this admission the electrocardiogram showed first degree heart block, suggesting the presence of an aortic root or septal abscess (fig 2). The intravenous digital subtraction angiogram showed a large anterior aortic root cavity (fig 3). Additional cavities were excluded by a review of the digital subtraction cine sequence. Subsequently the patient underwent operation to eliminate this focus of infection. During the operation we confirmed that the site and nature of the abscess accorded with the digital subtraction angiogram; a photograph taken at operation shows the extent of the cavity (fig 4).

**Case 2**

A febrile illness developed in a 56 year old man

![Fig 3](image)  
(a) and (b) Single subtraction frame from the intravenous digital subtraction angiogram in patient 1 showing the extent of the aortic root abscess.
Fig 4  A peroperative photograph in patient 1 showing the origin of the paravalvar cavity (arrowed).

during convalescence after aortic valve replacement for tight aortic stenosis. A chest radiograph at the time showed a wide mediastinum (fig 5) and computed tomography of the chest was performed. An abnormal anterior mediastinal shadow was present, and injection of contrast showed that this was vascular (fig 6). Sagittal and coronal reconstruction of the computed tomographic scan showed an aneurysm of the ascending aorta (fig 7) but failed to provide adequate anatomical detail. An intravenous digital subtraction angiogram was performed and showed an abscess cavity adjacent to the ascending aorta (fig 8). This false aneurysm displaced the innominate artery and part of the anterior wall of the aorta just proximal to the origin of the innominate artery. The digital subtraction image (fig 8c) gave a clearer indication of a narrow neck than the computed tomographic image. Both techniques showed the site and size of the cavity. At operation an infected false aneurysm with a narrow neck was resected and the aorta was patched. Cultures of resected tissue grew Staphylococcus aureus.

Case 3
A 29 year old woman who had aortic valvotomy at the age of 12 was admitted with a history consistent with infective endocarditis. Blood cultures grew Staphylococcus sanguis. Treatment with benzylpenicillin was started. Serial electrocardiograms showed prolongation of the PR interval, and an aortic root abscess was suspected. Intravenous digital subtraction angiography showed a large cavity in the para-aortic region, close to the aortic valve ring (fig 9). Operation confirmed the site and extent of the cavity.

Case 4
A 60 year old man, who had undergone replacement of a calcified bicuspid aortic valve, presented six
months later with fever and rigors after dental treatment covered with amoxyillin. Infective endocarditis was confirmed by the growth in blood cultures of a micrococcus that was resistant to penicillin. Treatment was started with gentamicin and teicoplanin. The electrocardiogram at that time showed new first degree heart block, and an intravenous digital subtraction angiogram was performed which showed a small anterior aortic root cavity (fig 10) above the sinuses of Valsalva. The development of first degree heart block was probably caused by the formation of micro-abscesses within the intraventricular septum. At operation the valve was replaced and the aortic root was repaired.

**Discussion**

These four patients were the only patients seen in our unit in 20 months with aortic valve endocarditis who were thought to have an aortic root abscess on clinical grounds (long PR interval in 1, 3, and 4, and chest x ray in case 2). This small series cannot test the diagnostic accuracy of intravenous digital subtraction angiography of the aortic root, but an abscess cavity was demonstrated in all patients in whom it was clinically suspected.

The high mortality associated with complicated infective endocarditis may be reduced by prompt operation and replacement of the aortic valve (either native or prosthetic). Criteria for operation include (a) refractory heart failure caused by valvar regurgitation, (b) uncontrollable infection, (c) an increasing PR interval, and (d) septic embolism. In patients in whom the PR interval has increased and an abscess cavity is suspected preoperative confirmation is useful. Echocardiography is the least invasive of the available options but it does not always produce useful images. It is not always possible to get good images of the aortic root on echocardiography, and results may be equivocal.12-14 In one of our patients computed tomography scanning was an early investigation; despite reasonably good reconstructions the origin of the abscess was not demonstrated adequately, and in general the best resolution available with this technique is in the order of 4 to 5 mm. Because of this low resolution it is not the best investigation to show the features of the ascending aorta.

Digital subtraction angiography, even in very ill patients, can provide images of sufficient quality to be useful in confirming the site and size of a suspected abscess cavity. In the patients we studied, the extent
of the abscess was shown, as well as the size of its origin and track. In patient 4 the digital subtraction image showed a cavity well above the sinuses of Valsalva and the first degree heart block was probably the result of micro-abscess formation within the intraventricular septum. True intraseptal cavities would be missed by this technique. None of the patients needed an arterial study before operation, so the potential complications of direct injection of contrast into the aorta were avoided. Some post-processing of the image series is almost always necessary to obtain a combination of mask and data image that reduces the movement artefact in the region of interest to negligible proportions. The facility to choose the mask and data images independently of each other is a feature of the second generation of digital subtraction angiographic equipment. It is an essential part of producing diagnostic studies. Each of the images shown is a single frame from a digital subtraction cine sequence and much
**Aortic abscess shown by digital subtraction angiography**

Fig 9  Intravenous digital subtraction angiogram of patient showing aortic root and infected false aneurysm in the 40° left anterior oblique projection.

more information can be obtained from examination of the whole sequence rather than from a single frame.

Intravenous digital subtraction angiography gives high quality images of the ascending aorta in patients with suspected abscess formation without the need for arterial catheterisation. Such images may be sufficient to plan subsequent operation and avoid the possible complications of direct aortic root catheterisation and injection of contrast.

**References**

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