

Arch Aortography

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Most radiologists are finding that the demand for X-ray examinations is increasing steadily and this is especially true in relation to the more elaborate and sophisticated procedures such as angiography. This process appears to follow Parkinson's Law; as better facilities are provided, the demand for investigations increases to make use of the added facilities. Radiologists consider that many investigations they are requested to carry out do not always contribute enough to the management of the clinical problem to justify the time taken and the cost involved, to say nothing of the risks entailed. This is most likely to be true when a clinician makes the occasional request for a specialised investigation in a subject outside his own main interest.

Consultation between clinician and radiologist is highly desirable when specialised procedures are requested in high-risk patients, and difficult problems can usually be settled in this way. Radiologists feel perfectly justified and, in fact, obliged to refuse a request where, for technical or other reasons, they consider that a procedure would be unduly hazardous for a particular patient. On the other hand, all would agree that the clinician responsible for the care of a patient is entitled to ask for such investigations as he considers necessary. Radiologists therefore try as far as possible to meet all requests (provided there is no feature present that makes the examination unduly risky) although they may feel that some are not strictly necessary.

Chamberlain and Gleeson (1965) recorded their experience of renal angiography carried out as part of the investigation of patients with hypertension. In only four of 107 patients examined in this way did the findings of the examination lead to beneficial surgical intervention. They questioned the value of these investigations where the results of and the need for surgery are uncertain. Not everybody would agree with this view. For example, Robertson *et al.* (1969), writing of their experience of 1,750 renal angiograms carried out on patients with hypertension, challenged this attitude and went so far as to suggest that all cases of hypertension require this investigation and that it is not rational to treat hypertension without knowledge of the results of angiography. The present writers are in sympathy with the views of Chamberlain and Gleeson as regards renal angiography. Furthermore, they consider that the greatest care is required in the selection of all cases for the

other specialised radiological procedures, so that the benefits to be gained are not offset by the complications that may occur with them: ideally these elaborate and potentially dangerous investigations should not be requested unless the following conditions are satisfied—

1. The clinical history clearly indicates the need for the examination.
2. The patient is fit enough to have the examination and shows no features that would make the performance of the procedure especially hazardous.
3. The patient is fit enough to have the necessary surgery if the examination reveals the suspected lesion.
4. The clinician is prepared to act on the findings of the examination and to ask for surgery when a surgically treatable lesion is demonstrated.

Although other considerations arise in individual cases, we feel it is never justifiable to carry out these examinations merely to document a case, or in those circumstances where the treatment is not likely to be affected by the findings of the examination.

With these principles in mind we decided to review the history of those patients on whom these special procedures had been carried out at The London Hospital during the past five years. In this article we consider only those cases in which angiography of the aortic arch was performed by the Seldinger method of catheterisation via the femoral or axillary artery. Although less frequently requested than most of the other specialised radiological investigations, this examination involves the risk of serious complications, not only at the site of the arterial puncture and in the limb distal to it, but also to the brain by embolism or trauma to the cerebral vessels. (Not included are those cases where the injection was made into the ascending aorta or left ventricle as part of a cardiological investigation. These examinations were performed via brachial arteriotomy so that a blind-ended ventriculography catheter could be used for ventricular injections to avoid the risk of sub-endothelial injection.) In one case it proved impossible to pass the catheter round the arch. In all the others a satisfactory examination was carried out, the great majority of these via the femoral artery but a few via the axillary artery.

The indications for these investigations fell into five groups:

1. Suspected cerebral ischaemia due to extra-cranial vascular disease

48 cases

In nearly all these patients disease of the vertebro-basilar system was suspected. When predominant carotid artery disease was suspected, direct carotid puncture, keeping well below the bifurcation, was usually the investi-

gation carried out, although in a few cases arch angiography was used. Many would argue that even in apparently isolated lesions of the carotid artery the state of all four cerebral vessels, including their origins, should be studied.

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| 2. Ischaemic lesions of the upper limb including the thoracic outlet syndrome | 10 cases |
| 3. Co-arctation of the aorta | 4 cases |
| 4. Intra-thoracic masses (to help differentiate between aneurysms and tumours) | 10 cases |
| 5. Suspected dissection of the aorta | 4 cases |

The results of these investigations were as follows:

1. *Extra-cranial Vascular Disease*

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| (a) No abnormality demonstrated | 23 cases |
| (b) One or more significant lesions—atheromatous plaques with or without ulceration, stenosis or complete occlusion of one or more major vessels | 25 cases |

Of the 25 cases showing significant lesions, only 9 were submitted to surgery. In one of these exploration only was possible. In 2 cases the operation was of a 'salvage' nature in that only one, the worst of several atheromatous lesions, could be tackled in the hope of checking further deterioration. In the other 16 cases operation was not advised despite the presence of significant lesions.

2. *Ischaemia of the Upper Limbs including the Thoracic Outlet Syndrome*

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| (a) No abnormality demonstrated | 6 cases |
| (b) Atheromatous or other cause of narrowing of the subclavian artery | 4 cases |

Surgical treatment was carried out in five cases. Two of these patients had successful scalenotomies in spite of normal angiograms. One patient with subclavian occlusion and a subclavian steal did not require immediate surgery. Unfortunately, he developed claudication and loss of peripheral pulses in one leg following angiography.

Weibel and Fields (1967) have shown that in cases of compression of the subclavian artery in the root of the neck, angiography may have to be carried out with the arm in four or more positions before the site of compression can be demonstrated. A single negative angiogram, therefore, does not help

the management of the case, since it may be due merely to a failure to reproduce the precise conditions that reveal a compression, which can usually be demonstrated convincingly on clinical examination. It is doubtful, therefore, if this investigation is always necessary in young patients with typical signs and symptoms of compression. Where atheromatous narrowing, with or without thoracic outlet compression, is suspected in older patients the situation is quite different and arch aortography is well worth while.

3. *Co-arctation of the Aorta*

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| (a) Co-arctation demonstrated | 2 cases |
| (b) Co-arctation suspected on clinical examination but diagnosis in some doubt. Arch angiography revealed normal aortic arch | 1 case |
| (c) No evidence of stenosis at site of excision of co-arctation one year previously | 1 case |

4. *Intra-thoracic Masses*

The distinction between tumours and aneurysms can usually be made by simple radiographic procedures, but occasionally the diagnosis is difficult and arch angiography provides an accurate answer. Furthermore, in cases of aneurysm precise definition of the anatomy of the lesion is required in preparation for surgical intervention.

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| (a) Normal aortic arch (i.e. the suspected lesion was shown to be a neoplasm) | 6 cases |
| (b) Aortic arch tortuous (i.e. the suspected mass was due partly to aorta and partly to kinked innominate artery) | 3 cases |
| (c) Aneurysm | 1 case |

5. *Suspected Dissection of the Aorta*

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| (a) Normal aortic arch and descending aorta demonstrated | 2 cases |
| (b) Aortic dissection demonstrated | 2 cases |

Of the two patients with dissection, one died during surgery, while the other, treated conservatively, recovered. A recent review of 24 cases of dissection of the aorta by Thompson *et al.* (1969) strongly advocates treating dissection by hypotensive therapy for 6–8 weeks, postponing angiography and any surgical treatment, if this is indicated, until that time. The arguments advanced in this paper are very convincing and suggest that there is little, if any, justification for performing a potentially dangerous angiogram in the acute phase of this very serious lesion unless there is clinical evidence suggesting involvement of the cerebral or renal vessels.

COMPLICATIONS OF ARCH AORTOGRAPHY

When considering the question of arch aortography in any patient, the possible risks must be balanced against the potential gain. Even in the most experienced hands the procedure is not completely safe, and although experts such as Sutton and Davies (1966) record large series with a very small incidence of serious complications, it must be remembered that, quite apart from technical competence in performing this procedure, care in selecting suitable cases and, more importantly, in rejecting unsuitable cases, is essential if the complication rate is to be kept low. Sutton and Davies (1966) believe that a fall in blood pressure during the procedure is an important factor in causing the thrombotic complications and for this reason strongly advocate avoiding general anaesthesia if possible. Although no objective data are quoted in support of this opinion, it seems a reasonable suggestion. The main risks associated with this examination are:

1. Local thrombosis at the puncture site or embolism resulting from thrombus, formed on the surface of the catheter and/or guide wire, being stripped off and released into the circulation as it is withdrawn through the puncture site in the artery. The importance of this danger is well described in an excellent treatise by Jacobsson (1969).

2. Thrombosis or embolism due to damage to the artery wall as the catheter or guide wire is manipulated through the iliac vessels and round the arch of the aorta. In the latter case emboli can pass up into the cerebral vessels.

Both these risks increase in proportion to the severity of the atheroma and with tortuosity of the large vessels which tends to increase with age and with hypertension.

3. Many other complications, such as adverse reaction to the contrast medium, haematoma formation, fracture of the guide wire, perforation of a tortuous artery, are all real enough dangers but less worrying and more preventable than the complications described above.

Incidence of Complications in the Present Series

In the 76 attempted arch aortograms eight complications occurred. Four of these were of a minor nature and recovered with conservative treatment. In three cases there was haematoma formation, two in the groin and one in the axilla. In the fourth case infection occurred at the puncture site in the axilla. In addition to these minor incidents there were four serious complications.

1. A man of 42 gave a two-year history of attacks of numbness of the fingertips and the sides of the face, dizzy spells, bright lights in front of the eyes

and throbbing in the head. Examination revealed a loud bruit over the left subclavian artery and a diminished left radial pulse. Arch aortography showed atheromatous narrowing of the right vertebral and left subclavian arteries. Following the examination he was found to have a left inferior quadrantic hemianopia. Fortunately, the field defect cleared slowly in the months after the aortogram.

2. A woman of 34 complained of intermittent claudication in the right leg for two years. She also suffered from frequent headaches. On examination, the right femoral pulse was weaker than the left, and the left radial pulse was also thought to be diminished. Aortography showed no abnormality in the aortic arch or in the branches arising from it. The right common femoral artery was noted to be atheromatous. She developed a right femoral thrombosis after the examination and this required thrombectomy, vein graft repair, and sympathectomy. Fortunately, she made a good recovery.
3. A man of 53 who had suffered from intermittent claudication in both legs for five years, collapsed at work and on admission to hospital was found to have a spastic paraplegia and was cortically blind. His blood pressure was 210/100, there was grade II retinopathy and the blood urea was raised. Loud bruits were heard over both carotids and both femoral arteries and the distal pulses were absent in both legs. By the end of 72 hours there had been considerable recovery but six days later he suffered a second dense hemiplegia. Arch aortography was performed via the right axillary artery and showed occlusion of the right internal carotid artery near its origin, and almost complete occlusion of the right vertebral artery. The left carotid and vertebral arteries were all patent. Following the examination he became quadruplegic and later developed bulbar palsy. He died two weeks later from a pulmonary embolus. This patient was recognised as a high risk which was accepted in view of his poor clinical condition and very bad prognosis.
4. A man of 56 had complained of mild Raynaud's disease for many years. For three months before admission he had transient attacks of vertigo and pain in the left arm and hand on exertion, relieved by rest. Arch aortography via the right femoral artery showed occlusion of the left subclavian artery near its origin, with evidence of a subclavian steal. The right vertebral artery was partially occluded at its origin. Following the aortogram he developed claudication in the right leg with loss of all pulses.

The incidence of significant complications in the whole series is 5.2 per cent.

The incidence in cases of extra-cranial vascular disease is 6.3 per cent and in cases of vascular changes in the arm is 10 per cent. All the examinations in this series were carried out by consultants or registrars, experienced in arterial catheterisation. The number of cases examined in five years is relatively very small when compared with the many hundreds of other neuro-radiological and vascular investigations carried out in The London Hospital over the same period. This would suggest that considerable selection of cases had been carried out, yet the incidence of significant complications is far from negligible. Most of these examinations were done under general anaesthesia and possibly, if Sutton is right, some reduction might have been achieved by the use of local anaesthesia.

Considering the series from the point of view of the contribution that the examinations made to the overall management of the clinical problem, the main uncertainty clearly applies to those cases investigated for extra-cranial cerebrovascular disease or for thoracic outlet compression syndrome. In the other groups the examination was an essential part of surgical assessment, and these will not be considered further. Many cases of thoracic outlet syndrome can probably be treated surgically without angiography since a normal appearance does not rule out compression. Nevertheless, the surgeon may want to know if any luminal lesions are present in addition to or at the site of the compression, so that the examination can be fully justified in these cases, although a high proportion of negative examinations will result when young patients are investigated. This leaves the group of patients with suspected cerebrovascular insufficiency, and it is with these cases that radiologists find themselves wondering whether the examination is always worth while. It can obviously be argued that in all cases the clinician is in a better position to decide what treatment, if any, is required and to assess the ultimate prognosis when the results of a full angiographic study are available. Nevertheless, this gain must be viewed against a background of the risks of the examination, and one would also need to know the benefit to be expected from the two main methods of treatment, i.e. anti-coagulant therapy and surgery. It is very difficult to know precisely the value of anti-coagulant therapy. Even in cases of coronary artery disease where extensive documentation is available, uncertainty remains as to the precise value of this treatment. This is even more true of cerebrovascular disease in which this form of therapy has been less fully evaluated. It is equally difficult to form a clear picture of the true value of surgery in this disease from a study of much of the published work. The type of lesion considered suitable for surgery and the results to be expected vary with different authors. The present position is discussed in a recently published book edited by Gillespie (1969).

In our small series (which we believe represents only a small proportion of all the cases with cerebrovascular insufficiency seen at The London Hospital) nine patients were submitted to surgery. In one case, a simple exploration with no definitive treatment was all that was done; in two others the operation could best be described as a 'salvage' procedure. In the remainder a more curative type of operation was possible. These results are offset by the occurrence of three serious complications, including one death. Two examples from the surgical group of cases are as follows:

1. A man aged 52 gave a history of attacks of transient dysphasia and sensory disturbance affecting the right arm and face, and weakness of the right arm, for eight months. On examination a loud bruit was heard over the right carotid artery. Arch angiography revealed atheromatous narrowing of the right internal carotid artery near its origin, and complete occlusion of the left internal carotid at its origin. An ulcerated atheromatous plaque was removed from the right internal carotid artery with a view to preventing further deterioration as a result of thromboembolic incidents. The patient made a good recovery from the operation and his condition was satisfactory at follow-up.
2. A man aged 54 gave a history of claudication in the left calf for ten years. Previously he had a right mid-thigh amputation for ischaemia, and on another occasion an operation had been carried out, at another hospital, on the aorta. The precise details of this are not known. Recently he had suffered attacks of unconsciousness followed by slurred speech. He had angina on effort and complained of pain in both forearms. Bruits were heard over the carotids on both sides. Arch aortography showed widespread atheromatous lesions. The right common carotid, internal and external carotid arteries were all narrowed in the region of the bifurcation. The left common carotid was stenosed at its origin. There was no filling of the right vertebral, and the left vertebral was stenosed at its origin. A right carotid endarterectomy was performed in the hope of checking further deterioration of his already seriously impaired cerebral circulation. He is an alcoholic and failed to return for follow up.

In the final analysis, the true value of the contribution of angiography to the management of this common disease must be made by clinicians themselves and will depend to a large extent on what they consider to be the ultimate value of anti-coagulant therapy and surgery. Radiologists asked to carry out these procedures should exercise the greatest care by selecting only those cases they feel they can tackle without undue risks, and should be

prepared to abandon an examination if excessive tortuosity of the major vessels or other difficulties are met with during the catheterisation. It is a poor return to press on and achieve a series of nice pictures at the expense of serious local or distal complications that may make the patient worse off than before the examination, or require surgery of a nature possibly more extensive than that required to deal with the lesion for which he was investigated.

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John Hunter's Heart

John Hunter's fame made him the best known patient with angina. He wrote of it: 'I was attacked suddenly with a pain nearly about the pylorus; it was a pain peculiar to those parts, and became so violent that I tried every position to relieve myself, but could get no ease. I then took a teaspoonful of tincture of rhubarb, with thirty drops of laudanum, but still found no relief. As I was walking about the room, I cast my eyes on a looking-glass, and observed my countenance pale, my lips white, and I had the appearance of a dead man looking at himself. This alarmed me. I could feel no pulse in either arm. The pain still continuing, I began to think it very serious. I found myself at times not breathing; and being afraid of death soon taking place if I did not breathe, I produced a voluntary action of breathing, working my lungs by the power of my will. I continued in this state three quarters of an hour, when the pain lessened, the pulse was felt, and involuntary breathing took place.' His later death from coronary thrombosis occurred at St George's Hospital when, 'meeting with some things which irritated his mind and not being perfectly master of the circumstances he withheld his sentiments; in which state of restraint . . . he gave a deep groan and dropt down dead'.