Intraoperative digital subtraction angiography in neurovascular disorders

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The importance of intraoperative DSA in the management of complex neurovascular disorders is explained. Both neurosurgeon and radiologist work in theatre as a team.

Abstract

Intraoperative digital subtraction angiography is useful for assessing the results of complex neurovascular procedures. Fifty-five patients with AVMs, aneurysms (Berry and bacterial), carotid-cavernous fistulae, spontaneous intracranial haemorrhages and penetrating head injuries had intraoperative angiograms. Sixteen of these patients had findings on the angiogram which altered the surgical procedure. There were no angiographic complications. We found intraoperative digital subtraction angiography a valuable adjunct to several neurovascular procedures.

Introduction

In the past neurosurgeons have relied mainly on direct visualisation or postoperative angiography to assess the results of complex neurovascular procedures. Advances in equipment have made it easier and faster to perform intraoperative angiography. Intraoperative angiography facilitates the immediate assessment of neurovascular procedures and allows the surgeon to correct any technical defects. We report our experience with intraoperative angiography at Wentworth Hospital.

Patients and methods

From April 1990 to December 1994 fifty-five intraoperative angiograms were performed at Wentworth Hospital. Angiograms were done via a transfemoral approach. A sheath was introduced preoperatively and flushed with heparinised saline (2000U/1000ml of normal saline at 30ml/hr).

The patient was then anaesthetised and placed in the required position for surgery. The theatre table had a radiolucent extension to facilitate screening of the aortic arch and neck vessels. The standard three-pin Mayfield-Kees head-holder was used as required. (Radiolucent carbon fibre head-holders are available).

Angiography was performed with a mobile digital subtraction imaging system (Ziehm Exposcop CB7-D). This consisted of a C-arm, digital processing unit, dual video monitors and an image storage unit.

The appropriate carotid or vertebral artery was catheterised during or at the end of the procedure as required by the surgeon. Contrast Iohexol (6-10ml) (Omnipaque, Nycomed) was injected by hand to delineate the relevant vascular anatomy. The images were reviewed immediately. If it was felt that the surgical procedure was in any way unsatisfactory or incomplete further surgery was performed under the same

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anaesthetic. The sheath was removed at the end of the procedure. Postoperatively the groin was monitored for the development of haematoma and peripheral pulses checked.

Routine postoperative angiography was not performed.

Results

Fifty-five intraoperative angiograms have been performed at Wentworth Hospital. The surgical procedures performed are detailed in Table I. There were no angiographic complications.

Table I: Intraoperative angiograms performed at Wentworth Hospital (1990-1994)

Aneurysms (Berry)	17
Arteriovenous malformations	17
Carotid-cavernous fistulas	5
Spontaneous haemorrhages	4
Traumatic haemorrhages	5
Bacterial aneurysms	3
Other	4
TOTAL	**55**

Although not strictly monitored the intraoperative angiogram added an additional forty-five to sixty minutes to the procedure (including the time required to place the femoral sheath preoperatively).

The four patients with spontaneous intracranial haemorrhage had intraoperative angiography, as their clinical condition necessitated immediate transfer to theatre for evacuation of the haematoma, precluding preoperative angiography. Intraoperative angiograms were used to localise pseudoaneurysms or arteriovenous fistulae in patients with traumatic haemorrhages following penetrating head injury. Patients with mycotic aneurysms had intraoperative angiograms to help localise the aneurysms. Intraoperative angiograms were used to monitor the successful surgical closure of carotid cavernous fistulae.

Table II: Cases with angiographic findings which altered the surgical procedure

Patient	Pathology	Angiographic findings and surgical action
4	R PCoAA	Residual neck-clip repositioned
8	L Parietal AVM	Residual feeder-removed
11	R Occipital AVM	Residual feeder
12	Spontaneous ASDH	Intraop angio demonstrated the cause of ASDH- MCAA- clipped
15	R Occipitoparietal AVM	Residual feeder-removed
16	L CCF	Residual CCF after packing-repacked three times
17	R C C F	Residual CCF after packing-repacked
25	Transected vessel following stab	Angio showed transected vessel which was then localised and clipped
27	L Occipital AVM	Three intraop angiograms done until complete excision
34	Bacterial aneurysms(3)	4th Aneurysm identified with intraop angio
35	R Occipital AVM	Residual feeder-removed
39	Inflammatory MCAA	Spontaneous thrombosis of aneurysm shown on intraop angio
40	Spontaneous ICH	Intraop angio demonstrated the cause of ICH- MCAA- clipped
50	R ICA Aneurysm	Non-filling of ICA following clipping - clip repositioned
53	R Paraclinoid Aneurysm	Non filling of PCoA following clipping - clip repositioned
55	L Frontal AVM	Residual AVM- removed

PCoAA - posterior communicating artery aneurysm
AVM - arteriovenous malformation
ASDH - acute subdural haematoma
MCAA - middle cerebral artery aneurysm
CCF - Carotid-cavernous fistula
ICA - Internal carotid artery

Sixteen of these angiograms revealed findings which altered the surgical procedure (TableII). Six of the patients with AVMs required further surgery to completely excise the AVM. Three of the aneurysms had to have clips repositioned, due to a residual neck in one case and occluded vessels in two cases. One mycotic aneurysm had thrombosed at the time of surgery. In a second patient with multiple mycotic aneurysms an additional aneurysm was detected on the intraoperative angiogram. Two patients with spontaneous intracerebral haemorrhages were found to have middle cerebral artery aneurysms. This finding enabled immediate clipping. In one of our patients a clip which was compromising the ICA was repositioned immediately due to the intraoperative angiogram finding.

Discussion

In the past, most intraoperative angiography was performed by using fluoroscopy or rapid serial-film angiography, following either direct puncture of the internal carotid or by retrograde catheterisation of the superficial temporal artery.[1] Several authors have reported the use of a mobile digital subtraction imaging system.[1,2,3] The advantages of this system are immediate review of subtracted images, high contrast resolution and superior spatial resolution (although not as good as conventional film

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