3-D CT Angiography For Diagnosis And Specification Of Cerebral Aneurysms

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Abstract : Three-dimensional Computed Tomography (3-D CT) was performed in 21 patients for characterization of 29 aneurysms of various sizes and locations, and determining the relationship between the vascular and bony structures. These findings are compared with results of axial CT, digital subtraction angiography and operative observations. 3-D CT is a useful method for obtaining information about the detailed anatomy of cerebral vascular structures and aneurysms.

Key Words: Cerebral aneurysm, three dimensional computed tomography.

INTRODUCTION

Until recent years, cerebral angiography was the only imaging technique available for visualizing intracranial vascular structures. It is an invasive, time-consuming, and expensive technique which requires multiple contrast injections, thus leading to a relatively high complication rate (1,14).

In several recent articles, magnetic resonance angiography has been described as a sensitive imaging technique for cerebrovascular diseases, but turbulence and its slow flow rate make it difficult to demonstrate cerebral aneurysms (7,8,11,13). Schmid and co-workers showed that 97.4% of aneurysms can be diagnosed with high resolution axial CT (12).

3-D reconstruction of computed tomography images has been used in patients with brain tumours, anomalies of face, vertebra, temporal bone and pelvic fractures, and for hepatic volume measurement. But in the literature, there is no detailed study of cerebrovascular diseases and aneurysms by 3-D CT (2,3,5,6). The aim of this study was to investigate the usefulness of 3-D CT for demonstration of cerebral aneurysms when compared with conventional axial CT and Digital Subtraction Angiography (DSA). All patients underwent operation and afterwards 3-D images and videotape made at operation were reviewed.

MATERIAL AND METHOD

In 21 patients with subarachnoid haemorrhage, 29 aneurysms were identified by DSA. 3-D CT was taken in 16 patients by GE 9800 HLA. After 10 mm of routine angled Willis polygon slices, intravenous injection of 1.5 ml per kilogram of non-ionic contrast (Ultravist 300®, Schering) was performed over a maximum of 2 minutes (1ml/sec). Then 20-30 slices were taken of 1.5 mm thickness and with 1.5 mm distances by 3.5 seconds inter scan delay in 2 seconds per slice in a maximum period of 2.5 minutes. A 512X512 matrix, 25cm FOV, 120kV and 120-140 mA parameters were used. In 3-D reconstruction, 80-100 HU was used for threshold value and reconstructions were performed by GE 9800 HLA software.

In 13 patients, DSA was performed before 3-D CT . Aneurysms were compared with DSA and 3-D CT according to their location, size, neck specifications, direction and relationship with osseous structures. The findings were observed intraoperatively and all the information was retrospectively compared with neuroradiological images and video records.

RESULTS

Cases are summarized in table 1. Two aneurysms located at the middle cerebral artery, one at the middle cerebral artery bifurcation, the other at the distal middle cerebral artery, could not be visualized by 3-D CT. But the sizes, neck specifications, directions and relationship of the aneurysms with the normal vascular structures of the Willis polygon of all the other aneurysms were easily seen (Fig 1-4). In 7 cases, aneurysms, 5-8 mm in diameter, not appearing in conventional 2-D CT, could be demonstrated by 3-D CT and the relationships with the osseous structure were shown.

There were no false positive aneurysms by 3-D CT, except distal MCA location, all could be demonstrated, and basilar and posterior communicating artery aneurysms especially visualized significantly better than two-dimensional CT. In one case DSA revealed an aneurysm mimicking an anterior communicating artery, but 3-D CT showed that its location was at the A1-A2 junction, and the operative findings confirmed the 3-D CT finding.

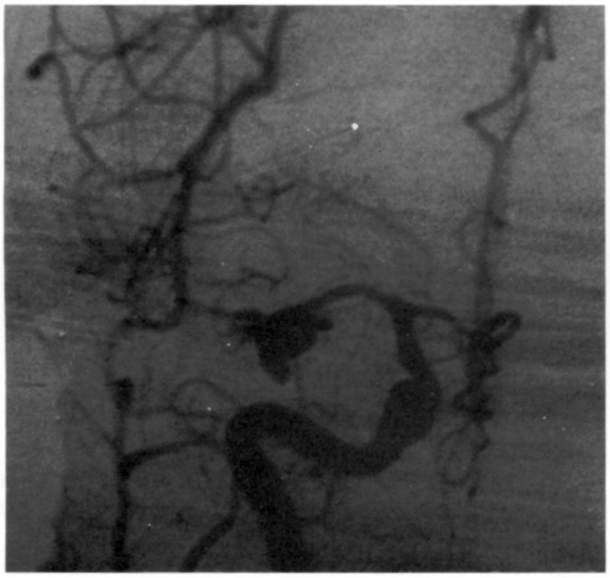

Fig.1: Angiographic view of a MCA aneurysm

Fig.2: 3-D CT of the same case (Arrows indicate the aneurysm)

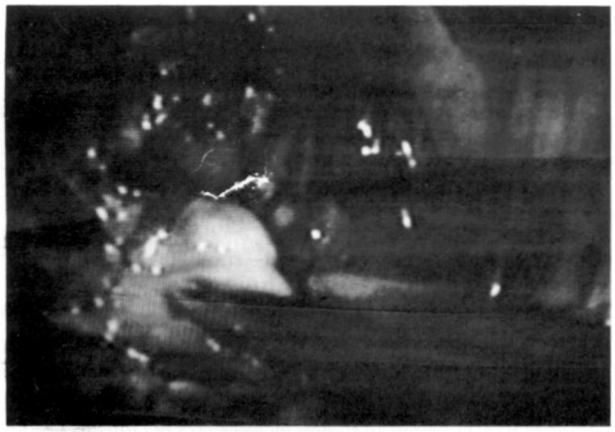

Fig.3: Operative view of the aneurysm before clipping.

Fig.4: After the MCA aneurysm is clipped.

DISCUSSION

3-D CT can proceed at the same time as routine cranial two-dimensional CT. During the non-enhanced slice procedure, the Willis polygon level must be observed carefully and while taking contrast enhanced slices at that level, bolus contrast injection must be performed. Reconstruction of the slices is done later. 3-D CT images of the aneurysms are significantly helpful for planning the operation. The shape, size, direction and relationship of the aneurysm to bony and other vascular structures are well defined, so positioning of the head, direction of the retraction of cerebral tissue and the dissection strategies can be planned before the operation, thus hopefully reducing peroperative complications.

Slices are planned according to the orbitomeatal line and at the level of the eyes, radiation dose is minimized to avoid injury. Gholkar et al. (4) reported that the cutaneous surface radiation dose in 3-D CT is 10-30 mGy. This amount of radiation is equal to routine cranial CT and lower than that of cerebral angiography. In DSA, to demonstrate details of the neck of the aneurysms multiple frames are taken and the total radiation dose increases. But 3-D CT slices are taken only once, and then reconstruction and multipositional images are obtained later by computer.

Schmid et al. reported that high resolution axial tomography is sensitive (97.4%) in demonstrating cerebral aneurysms (12). We believe that 3-D CT is more sensitive than routine CT, because it can demonstrate small aneurysms (<5 mm) and those located at the distal segments of the arteries. DSA plus 3-D CT is more suitable in planning the operation.

One of the limitations of this technique is multiple aneurysms. The dynamic investigation area is 5 cm in height and it is difficult to show both anterior and posterior circulation aneurysms in a single procedure (1). Besides, the movements of the patient alter the quality of images. So, it may be used in addition to DSA for more information about the aneurysms.

MR angiography is another technique for visualizing the cerebral aneurysms. Masaryk could demonstrate 17 of 19 aneurysms (89%) by spin echo and MR angiography (9,10). MR angiography is not sensitive for low flow rate aneurysms, and turbulence affects information about the size. The advantage of this technique is that extra-cellular methemoglobine in the thrombus gives short T1 signals and is seen as a hyperintense area. But MRI is insufficient for bony structures and it is difficult to show the relationship of the arteries with the bones.

In this study, we did not want to erase the bone signals during the reconstruction. Therefore, some of the cranial viewing directions could not be used, but the best results for visualizing the bone-artery relationship could be obtained this way and it was proven that these images are more helpful for planning the operation.

As a result, 3-D CT is an imaging technique that can be routinely used to get more detailed information about cerebral aneurysms and their bony-vascular structural relationships. Three-dimensional anatomical images are helpful for aneurysm surgery.

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TABLE 1

case	age	sex	location	diameter (mm)	diameter (CT vs Angio)	false (+)	false (–)
1	65	M	ACoA	12	A	–	–
2	74	M	ACoA	10	A=CT	–	–
3	37	M	ACoA	10	A=CT	–	–
4	68	M	ACoA PCoA	5 8	A=CT A>CT	– –	– –
5	25	F	ACA	7	A=CT	–	–
6	58	F	ICA	10	A=CT	–	–
7	68	F	ACoA	4	A=CT	–	–
8	68	F	ACoA MCA	9 5	A<CT ?	– –	– (+)
9	51	F	MCA	4	?	–	(+)
10	59	M	ACA	20	A<CT	–	–
11	50	F	ICA MCA	25 4	A=CT A=CT	– –	– –
12	47	F	MCA	23	A<CT	–	–
13	15	F	VJ(R) VJ(L)	25 18	A=CT A=CT	– –	– –
14	38	F	MCA	10	A<CT	–	–
15	47	F	MCA	11	A=CT	–	–
16	56	M	BT	28	A=CT	–	–
17		F	MCA-M1(R) M1-2(R) M3-4(R) M1-2(L) ACoA	6 4 10 4 8	A>CT A>CT A<CT A>CT A=CT	– – – – –	– – – – –
18	26	M	ACoA	19	A<CT	–	–
19	20	M	BA	14	A=CT	–	–
20	66	M	ACoA	10	A=CT	–	–
21	58	F	ICA	14	A<CT	–	–

ACoA= Anterior communicating artery
PCoA= Posterior communicating artery
MCA = Middle cerebral artery
ACA = Anterior cerebral artery
ICA = Internal carotid artery
BA = Basilar artery
VJ = Vertebral junction