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DIAGNOSTIC ACCURACY OF CT ANGIOGRAPHY AND SURGICAL OUTCOME OF CEREBRAL ANUERYSMS

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ABSTRACT

Introduction: Digital subtraction angiography (DSA) is considered the gold standard for diagnosis and pre-treatment planning of cerebral aneurysms, but it is invasive and carries a certain degree of mortality and morbidity. Three-dimensional computed tomographic angiography (3D-CTA) is an advancement in aneurysm diagnosis. This study evaluated accuracy of 3D-CTA for diagnosing aneurysms and assessing outcome of surgical treatment. **Materials and Methods:** A total of 8 patients harboring 13 aneurysms were studied. CTA revealed aneurysms concurrent with other clinical and radiological findings. Accuracy of CTA for diagnosis, and the anatomical characteristics of aneurysms (such as blebs, lobes and surrounding vascular anatomy) were compared with surgical findings. Post-op CTA was done in 4 cases. **Results:** CTA findings regarding aneurismal morphology and vascular anatomy were confirmed at surgery in all cases (100% diagnostic accuracy). In 7 patients, aneurysms were successfully clipped. One patient underwent carotid ligation. Aneurysm clipping was not possible in 1 case, while 1 case of carotid aneurysm failed to reveal an associated small posterior communicating artery aneurysm. Recovery was excellent in 6 patients, good in 3 patients, and 1 patient died due to chest complications. **Conclusion:** CTA is a simple, less invasive, rapid, and reliable first-line diagnostic modality for diagnosis and early microsurgical intervention. It also avoids the complications associated with DSA. CTA may be the only angiographic modality to conclusively determine aneurysm occlusion in cases of carotid ligation.

Despite remarkable advances in management, aneurysmal subarachnoid hemorrhage (SAH) continues to be associated with high rates of morbidity and mortality. Aneurysms usually remain silent and get noticed only when they rupture and present with spontaneous subarachnoid hemorrhage. When dealing with a ruptured aneurysm, time is critical as death rate in the initial 15 hrs is 10-15%, reaching almost 50% within 30 days of hemorrhage.

Three mechanisms are proposed for the mortality associated with aneurysmal subarachnoid hemorrhage - acute hydrocephalus, re-bleeding, and cerebral ischemia due to vasospasm.[1] Timely diagnosis is the key to decreasing mortality and morbidity in all three situations. Currently, three diagnostic modalities are available for diagnosing an intracranial aneurysm - Digital Subtraction Angiography (DSA), Magnetic Resonance Angiography (MRA), and Computed Tomographic Angiography (CTA). DSA has hitherto been considered the gold standard for diagnostic and pretreatment planning. However, it is a time-consuming and invasive modality associated with a certain risk of complications, and is not an ideal technique in emergent conditions.

Advent of new modalities such as MRA and CTA has changed the protocol of aneurysm management. MRA, although noninvasive, has logistic problems and provides inferior resolution compared with CTA. On the other hand, CTA has opened up new horizons in the management of intracranial aneurysms. It offers certain advantages over DSA. Not only is it readily available, it is also noninvasive and generates sufficient information to enable effective therapeutic decision-making.

This study was performed to determine the role of 3D-CTA in the management of intracranial aneurysms. Our hypothesis was that 3D-CTA is able to correctly establish surgical indications in patients with intracranial aneurysms, and that CTA-guided surgery can be performed without preliminary conventional angiography.

MATERIALS AND METHODS

Study design

This is a clinical case series based on purposive and convenient sampling.

Operational definitions

Cerebral aneurysm was defined as a saccular outpouching from a parent artery, having a clearly definable sac and neck. Diagnostic accuracy referred to the accuracy of identifying cerebral aneurysms, their surrounding vascular anatomy, the presence of vasospasm, and whether the aneurysm had a clearly definable sac and neck. Outcome was defined as surgical outcome of aneurysm post-clipping, as assessed by the Glasgow Outcome Scale and categorized as excellent, good or poor.

Inclusion criteria

Inclusion criteria were age between 15 - 70 years who underwent CTA and were diagnosed with intracranial aneurysm(s) that were subjected to clipping. Patients who had already been diagnosed with cerebral aneurysm on the basis of some other modality were excluded from the study.

Data Collection

After taking informed consent, patients were explained the risks and benefits of investigation. Computed tomography was performed using a 60-slice scanner. Scanning consisted of an initial head CT study followed by a CT angiogram. Patients presented at various post-ictal stages of SAH and underwent CTA after a variable time period, extending between 5 to 30 post-ictal days. Effective surgical planning was done on the basis of CTA images (and in one case, on DSA). Intra-operative findings and difficulties encountered were recorded and compared with the CTA data.

Analysis

Data was analyzed on SPSS v. 13.0. Data were tabulated as frequencies. Diagnostic accuracy of CTA was calculated by simple yield, as confirmed by surgical observations.

RESULTS

Between December 2005 and October 2007, 8 patients presented harboring 13 aneurysms. Mean age was 46.38 + 10.59 years; 75 % were male and 25 % female. All patients underwent microsurgical clipping in the neurosurgery department of Jinnah Hospital, Lahore. Clinical symptoms were as follows: 87.5% presented with headaches; 62.5% had vomiting; 25% had fever; 25% had aphasia; 25% had hemiperesis or hemiplegia; and 50% of patients presented with unconsciousness.

A total of 8 CTA studies were obtained pre-operatively, showing 13 aneurysms. CTA was able to diagnose 12 aneurysms out of 13 (sensitivity 92.3 %). The feasibility of clipping was correctly assessed in 12 out of 13 targeted aneurysms (sensitivity 92.3%). Clipping was planned for 11 aneurysms, the exception being an anterior communicating artery (A-comm) aneurysm, which on CTA images showed a fundus of 5.5 mm x 3.2 mm and a neck of 2.2 mm. Intra-operatively, this was found to have a broad neck along the A-comm with a large perforator arising from its fundus that was attached to basal dura and optic nerve. The lesion was not feasible for clipping, and was therefore reinforced with a muscle patch. In another case of A-comm aneurysm, there was an incidental finding of an additional small posterior communicating artery (P-comm) aneurysm not seen on CTA; this, too, was also clipped.

Post-operatively, all aneurysms were clearly obliterated in the CTA images, but aneurysmal necks were not clearly outlined as they were masked by clip artifact. In 8 patients (62.5%) there was excellent recovery as measured by the Glasgow Outcome Scale, while 3 patients showed good recovery. One patient (8.3%) died, attributable to nosocomial pneumonia.

DISCUSSION

In this modern era of aneurysmal subarachnoid hemorrhage management, even with the availability of multiple treatment modalities, morbidity and mortality rates have not appreciably declined. Re-hemorrhage and brain ischemia are the major causes of death among initial survivors. Reduction in the time to diagnose the aneurysm may lead to quicker definitive treatment.

A possible reason for failure to improve outcome is the lack of a practical modality to diagnose aneurysms that would enable expeditiously proceeding to early management. A non-invasive tool that can reliably and accurately detect aneurysms is therefore needed. DSA, although considered the gold standard, faces certain limitations. Firstly, it is not readily available in many local centers, and hence not useful in emergency conditions. Secondly, it is an invasive procedure with associated morbidity and mortality. Moreover, as many of our patients present late after SAH when cerebral vasculature is in vasospasm, performing DSA at this stage may aggravate the clinical condition. Finally, DSA does not provide the relation of vascular anatomy with surrounding bony structures.[2-6]

MRA is also used to evaluate cerebral aneurysms but it entails logistic problems as it requires a free magnetic field. The image produced is also not as sharp as with CTA and it, too, does not provide relationship of vascular anatomy to bony structures. MRA is also time-consuming.

3D-CTA is a relatively new technique that has been studied extensively in patients with acute SAH. It has the advantage of being less invasive, readily available and convenient. Furthermore, unlike DSA, it can also be used to visualize the relation of vascular anatomy with surrounding bony structures.

In this study, we have demonstrated the usefulness of CTA in the diagnosis of cerebral aneurysms presenting both in acute and delayed stages of SAH. CTA was used as the diagnostic and pretreatment planning study. Surgery was planned and performed on the basis of CTA images. Per-operative findings were compared and post-operative follow-up was also done, showing CTA to be an accurate diagnostic modality with over 90% sensitivity and 100% specificity. It also provides the necessary anatomical information for a better surgical approach. CTA is particularly useful in treatment planning, and the choice of endovascular coiling or clipping can be made solely on the basis of CTA images.[7-15] DSA should be reserved in those cases where CTA shows equivocal results.[16,17]

Given the recent emergence of CTA, studies on the utility and accuracy of this technique in detecting and managing an aneurysm have been carried out all over the world. A study from Germany reported that 92% cases of acute SAH can be managed with the help of CTA without additional invasive testing.[4]

CTA has proven its role in detection of cerebral vasospasm following acute subarachnoid hemorrhage.[2,18,19] It also establishes the indications for embolization, determines the side of insertion for guiding catheters, and helps choose the appropriate coil size, thus proving its significance in embolization.[7,10]

Our study has certain limitations. First, because it was performed retrospectively it suffers from the errors inherent in any retrospective analysis. Second, the patient population is relatively small.

Although CTA seems to be an accurate and useful modality for detecting cerebral aneurysms, it faces minor drawbacks which should be considered for every patient. There can be an allergic reaction to contrast dye. Another disadvantage is radiation exposure. In addition, CTA can miss lesions less than 3 mm in size.[20] Finally, interpretation of CTA images can be difficult in cases in which a metal artifact is encountered, such as after surgical clipping.

In the future, the new investigative technology of 4D-CTA will facilitate choice and execution of an optimal treatment even more effectively, as it has the power to provide information about dynamic aneurysmal features such as flow, dome pulsations, blebs and growing aneurysms.

CONCLUSION

We have demonstrated that CTA is a reliable, practical modality in detecting intracranial aneurysms, with a sensitivity of 92.3 %. It is non-invasive and readily available. Therapeutic decisions may be taken and surgery planned on the basis of CTA alone. In an emergent situation such as a deteriorating patient, it is superior to either empiric exploration or DSA because it delineates the orientation and configuration of the aneurysm and its associated vascular anatomy, and allows pretreatment planning. It reduces pretreatment evaluation time critically.

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