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CAPABILITIES OF COMPUTER TOMOGRAPHIC ANGIOGRAPHY IN THE DIAGNOSIS OF CEREBRAL ANEURYSMS

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ABSTRACT

This paper presents a retrospective analysis of patients from a multidisciplinary hospital named after prof. H.J. Makazhanov, where diagnostic results of 126 patients with cerebral arterial aneurysms from September 2018 to February 2019 were studied. Computed tomography was performed for all patients to visualize subarachnoid and intraventricular hemorrhage, determine the volume and location of intracerebral hematoma, followed by contrast enhancement. Most frequently, in 63.5% of the examined patients, single aneurysms were detected. In 36.5% of patients, multiple aneurysms were diagnosed, in 22.9% of cases, aneurysm of the anterior connecting artery was diagnosed. This research method allows to determine the shape, size, localization, relationship with the surrounding anatomical structures, which contributes to the quality planning of surgical intervention.

АННОТАЦИЯ

В работе освящен ретроспективный анализ больных многопрофильной больницы имени проф. Х.Ж. Макажанова. Изучены результаты диагностики 126больных с артериальными аневризмами сосудов головного мозга в период с сентября 2018 по февраль 2019 гг.. Всем больным проводилась компьютерная томография для визуализации субарахноидального и внутрижелудочкового кровоизлияния, определения объема и расположения внутримозговой гематомы, с последующим контрастным усилением.Чаще всего, у 63,5% обследованных больных, выявлены одиночные аневризмы.У 36,5% больных диагностированы множественные аневризмы, у 22,9% - аневризма передней соединительной артерии. Данный метод исследования позволяет определить форму, размеры, локализацию, взаимоотношение с окружающими анатомическими структурами, что способствует качественному планированию оперативного вмешательства.

Keywords: cerebral aneurysms, cerebral vessels, computed tomographic angiography, CTA, three-dimensional reconstruction, 3D reconstruction.

Ключевые слова: аневризмы сосудов головного мозга, сосуды головного мозга, компьютерно-томографическая ангиография, КТА, трехмерная реконструкция, 3D реконструкция.

INTRODUCTION

Cerebral aneurysms represent a limited or diffuse protrusion of the artery wall or the expansion of its lumen due to its thinning or extension. They are a fairly common pathology, occurring from 0.7% to 9% of cases in the population. The development of neuroimaging methods and their wider use in clinical practice has led to a higher level of detection of unruptured cerebral aneurysms. Rupture of arterial aneurysm leads to subarachnoid, intracerebral and intraventricular hemorrhages, followed by the incapacitation of a person.

Cerebral angiography (CAG), the traditionally used method for diagnosing visualization of cerebral aneurysms, is prone to having such disadvantages as invasiveness, the need for intra-arterial selective administration of microconductors and catheters, a load of contrast agent, which exacerbates cerebral angiospasm. Computed tomographic angiography (CTA) has clear advantages over traditional CT, which include:

- increase in scanning speed - the concentration of contrast agent in the vessels decreases rapidly and it is possible to obtain an image of small segments of contrasted vessels only. With CT, the gentry level of the test layer can be moved at the same speed as the intravascular column of the contrast medium is advancing. The number of dynamic artifacts that are present in the study of severe and non-contact patients is sharply reduced;

- primary digital data obtained as a result of scanning reflects the structure of the whole volume, and therefore, there occurs the effect of volume scanning. Thus, it became possible to construct fundamentally new three-dimensional (3D) images of the structures under study with respect to both the vascular segments themselves and the anatomical structures of the skull and brain.

BACKGROUND

To determine the capabilities of CTA with 3D reconstruction in the preoperative diagnosis of cerebral aneurysm.

METHODS

The results of the diagnosis of 126 patients with 205 cerebral aneurysms were retrospectively studied in the multidisciplinary hospital named after prof. H.J. Makazhanov. The age of patients ranged from 29 to 79 years. There were 52 men and 74 women. All patients underwent research on a Siemens SOMATOM Perspective 64 computer tomograph, followed by x-ray contrast examination of the cerebral vessels with axial sections 0.6 cm thick, with intravenous injection of contrast through the peripheral vein, using the Ulrich Medical automatic injector at a rate of 4 ml/sec. The total study time did not exceed 30 minutes.

The sizes of cerebral aneurysms were measured using 3D reconstruction. Based on the results, the localization, quantity, shape and size of aneurysms, as well as the relationship with surrounding anatomical structures were evaluated.

RESULTS

According to the results of the study, 42 (33.3%) patients were diagnosed with subarachnoid hemorrhage, 38 (30.2%) had an intraventricular hematoma, 29 (23%) had a supratentorial intracerebral hematoma, and 17 (13.5%) had a subtentorial intracerebral hematoma. Secondary occlusal hydrocephalus was detected in 47 (37.3%) patients (table 1).

Table 1

The distribution of the examined patients depending on the nature of the hemorrhage and the presence of occlusive hydrocephalus

Nature of hemorrhage	The number of patients, abs. (%)
Subarachnoid hemorrhage	42 (33,3%)
Intraventricular hematoma	38 (30,2%)
Supratentorial intracerebral hematoma	29 (23%)
Subtentorial intracerebral hematoma	17 (13,5%)
Secondary occlusal hydrocephalus	47 (37,7%)

Single aneurysms were detected in 80 (63.5%) examined patients, multiple - in 46 (36.5%) (table 2). In 47 (22.9%) patients, aneurysm of the anterior communicating artery (AcoA) was revealed, in 33 (16.1%) in the supraclinoid segment of the internal carotid artery (ICA), in 11 (5.4%) the cavernous segment of the ICA, in 8 (3.9%) - in the ICA bifurcation, in 31 (15%) - in the middle cerebral artery (MCA) bifurcation, in 16 (7.8%) - in the M1 segment of the MCA, in 13 (6.3%) - in the posterior communicating artery (PcoA), in 8 (3.9%) - in the A1 segment of anterior cerebral artery (ACA), in 12 (5.9%) - in the pericallosal artery, in 4 (2%) - in the proximal portion of the posterior cerebral artery (PCA), in 3 (1.5%) - in the distal portion PCA and 19 (9.3%) in the vertebrobasilar basin (table 3).

Table 2

The distribution of the examined patients depending on the number of aneurysms

Number of aneurysms	The number of patients, abs. (%)
1	80 (63,5%)
2	25 (19,8%)
3	12 (9,5%)
4	6 (4,8%)
5	3 (2,4%)
Total	126 (100%)

Table 2

Distribution of the examined patients depending on the localization of aneurysms

Localization	The number of patients, abs. (%)
AcoA	47 (22,9%)
Supraclinoid division of the ICA	33 (16,1%)
Cavernous segment of the ICA	11 (5,4%)
ICA bifurcation	8 (3,9%)
A1 segment ACA	8 (3,9%)
Pericallosal artery	12 (5,9%)
M1 segment of the MCA	16 (7,8%)
MCA bifurcation	31 (15%)
PCoA	13 (6,3%)
Proximal portion of the PCA	4 (2%)
Distal portion of the PCA	3 (1,5%)
Vertebrobasilar system	19 (9,3%)

In 114 (90.5%) patients, saccular aneurysms were found, in 12 (9.5%) - fusiform. Aneurysm sizes were measured after 3D reconstruction. The maximum size of the aneurysm was 48.6 mm, the minimum was 2.0 mm, on average, the size of the aneurysms was 8.5±6.8 mm.

3D reconstructions using the Neuro Digital Subtraction Angiography (DSA) and Maximum Intensity Projection (MIP) options make it possible to reproduce the spatial and topographic relationships of cerebral vessels (fig. 1).

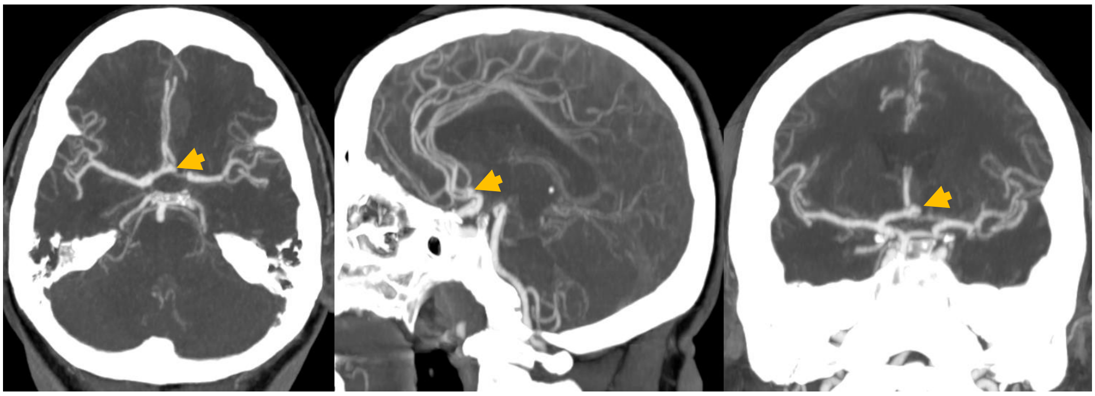

Figure 1. MIP mode. The arrow indicates aneurysm of the anterior communicating artery in three planes

Neuro DSA mode allows you to remove the image of bone structures from the CTA data set, even in such difficult places as the base of the skull (fig. 2). This improves the quality of visualization of vascular structures.

Figure 2. Neuro DSA mode. The arrow indicates aneurysm of the anterior communicating artery

When constructing a projection with a maximum MIP intensity, the final image is very close to the CAG. In addition, the use of 3D reconstructive CTA anatomy allows rotation in 3D space of the observation point, which makes it possible to study the object from any angle, which allows timely preoperative planning to select the angle of attack, measure angles and distances of the target zone from the surrounding anatomical structures, namely the bone and surrounding vessels of the aneurysm in 3D space (fig. 3), as well as determine the amount, shape and size of the clips used.

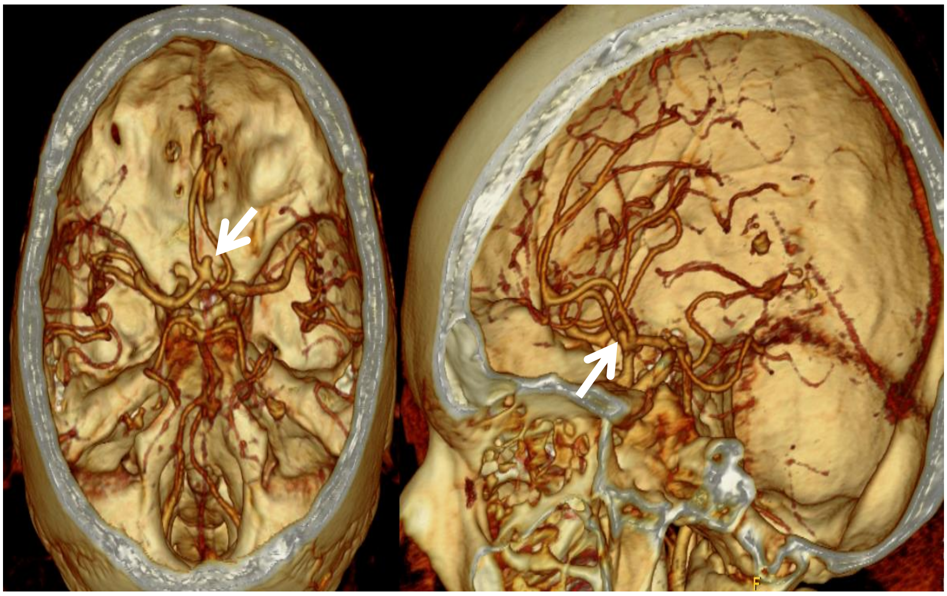

Figure 3. 3D reconstruction mode with focused study of the area of interest.
The arrow indicates aneurysm of the anterior communicating artery

CONCLUSIONS

1. The method of computed tomographic angiography allows non-invasive and with high accuracy to evaluate the vascular structures of the brain.

2. In the diagnosis of cerebral aneurysm, CTA proved to be highly informative. In addition to identifying the localization and size of the aneurysm, it is possible to determine the relative position of the arteries and the neck of the aneurysm, which is necessary for planning and choosing the method of surgical treatment.

3. 3D reconstruction of cerebral vessels, a polygonal interpretation of the data allows neurosurgeons to visualize the anatomy of the vessels in a format more familiar to them than with CAG, which allows better planning of surgical intervention. Performing CTA significantly reduces the need for such an invasive study as traditional CAG.

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