

Application of three-dimensional reconstruction technique and intraoperative posture in the interventional treatment of cerebral aneurysm.

Meng Zhang^{*#}, Qiu-Sheng Zhang[#], Jian-Ming Wu, Wei-Ping Li, Yi He

Department of Neurosurgery, Shenzhen Second People's Hospital, Shenzhen, Guangdong, PR China

[#]These authors contributed equally to this paper.

Abstract

Objective: To investigate the three-dimensional reconstruction technique and intraoperative postural changes in the interventional treatment of cerebral aneurysm.

Methods: A total of 52 cases involving patients with a definite CT diagnosis of cerebral aneurysm in our hospital were selected from July 2014 to August 2015. The cases were randomly and equally divided into observation and control groups using the random number table method. The patients in the two groups underwent interventional embolization. The observation group underwent three-dimensional CT angiography and the control group underwent rotational angiography with three-dimensional reconstruction (3D R-DSA). The correlation between aneurysm neck and adjacent parental arteries was investigated.

Results: The aneurysm longitudinal diameter 6.65 ± 2.21 and neck width 4.24 ± 1.21 in the observation group were significantly higher than those in the control group 5.54 ± 1.12 and 3.11 ± 1.01 , respectively, and the difference was statistically significant ($p < 0.01$). In the >3 mm and ≤ 3 mm aneurysm diameter groups, the correlations between the aneurysm neck and adjacent parental arteries of patients showed statistical significance ($p < 0.05$). Overall results of the aneurysm neck and adjacent parental arteries of the patients in the two groups showed a statistically significant difference ($p < 0.05$).

Conclusion: Rotational DSA combined with three-dimensional vascular reconstruction and appropriate intraoperative position changes enables machineries to reach complicated angles and ensures the clear display of the relationships between the aneurysm and adjacent parental arteries and between aneurysm neck and size. These effects improve the success rates of operations.

Keywords: Three-dimensional reconstruction technique, Intraoperative posture, Interventional treatment of cerebral aneurysm.

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Introduction

Cerebral aneurysm is a common disorder. Most patients show no obvious clinical symptoms or they may experience epilepsy, headaches, peripheral nerve compression, and other symptoms [1]. The rupture of an aneurysm may lead to intracranial hemorrhage, which is one of the important causes of subarachnoid hemorrhage. Conventional DSA is the "gold standard" of vascular examination [2]. However, it can be limited by the overlaps of vascular images and cannot reflect the overall perspective of lesions, display accurate pathways in interventional therapy, and fully meet the needs of interventional therapy; moreover, it may prolong treatment time [3,4]. The rotating DSA with three-dimensional reconstruction can clarify the presence of aneurysm, aneurysm neck and tumor size, aneurysm structure, and their adjacent relationships with peripheral vessels [5]. This way, this technique can provide accurate image and data for interventional diagnosis and treatment. On the basis of

cerebrovascular DSA rotating collection and three-dimensional reconstruction, related calculation was performed in the present work. The result showed that the head rotation angle could not be reached due to the mechanical angle. Thus, the display of aneurysm neck and parental artery could be optimized. This result is expected to play an important role in improving the success rate of surgery.

General Information and Methods

General information

A total of 52 cases of patients with a definite CT diagnosis of cerebral aneurysm in our hospital were selected from July 2014 to August 2015. Among these 52 cases, 32 cases involved males, and 20 cases involved females; the average age was 26-76 y 51.7 ± 11.1 . Regarding lesion location, two cases involved basilar artery aneurysms, 10 cases involved middle cerebral artery bifurcation aneurysms, 18 cases involved

posterior communicating aneurysms and 23 cases involved anterior communicating aneurysms, as confirmed by surgery. Initial symptoms and signs were as follows: 8 cases reported disturbance of consciousness, 27 cases reported neck resistance, 12 cases reported vomiting and headache, and 5 cases reported cranial nerve palsy. Patients were randomly and equally divided into observation the control groups using the random number table method. Patients in the two groups underwent interventional embolization. The observation group underwent three-dimensional CT angiography (3D CTA). The control group underwent rotating angiography with three-dimensional reconstruction (3D R-DSA). The inclusion criteria in accordance with the diagnostic criteria of cerebral aneurysm formulated by the Neurosurgery Institute of the Chinese Medical Association were as follows: the aneurysm was definitely diagnosed by relevant laboratory examinations and imaging examination combined with clinical symptoms. General data of the patients from the two groups were compared and difference was not significant ($p>0.05$).

Methods

A total of 52 cases of patients were randomly and equally divided into observation and control groups using the random number table method. Patients underwent examinations that involved the use of the Innova 3100 digital subtraction machine (American GE Company) and Aquillon 64 row spiral CT scanner (Toshiba).

Control group: Patients underwent interventional embolization and 3D CTA after the treatment. In the CTA examination, each patient was supine, with the head placed on the headstock. The median cubital vein was punctured, and a high-pressure syringe was connected. Enhanced scan was performed using the Ultravist contrast agent (370 mg/mL), with the scan ranging from the aortic arch level to the calvarium. After scanning, the image reconstruction data were transferred to the workstation and processed. The reconstructed enhanced image was subtracted with the plain image to obtain the original subtraction data. Bony and boneless 3D-volume reappearance reconstructions were performed using the reconstructed enhanced image and original subtraction image. The 3D cerebrovascular image reconstruction was performed using multi-planar reconstruction and Maximum Intensity Projection (MIP). Multi-direction and multi-angle observations were conducted and images were subsequently stored.

Observation group: Patients underwent interventional embolization therapy and 3D R-DSA. In 3D R-DSA, the rotating angiography was completed after 200 degrees rotation of the C-arm machine. X-ray exposure was 6.6 amplitude/s. Non-ionic contrast agent (300 mg/dL) was injected through the internal carotid artery. Contrast agent volume was 18 mL and the rate of injection was 3 mL/s for 6 s.

Reconstructed images included simulated vascular endoscopy, volume rendering display, surface shaded display and MIP display.

Image reconstruction

The optimum operating angle was selected after rotating the DSA reconstruction. The operating angle could not be reached by the reconstruction in patients with positive aneurysms, and the heads was rotated using skull fixations. With the head inclined, the C-arm was moved to the normal position under fluoroscopy.

Statistical method

The data were transcribed, analyzed, and processed using SPSS 19.0. The t-test and chi-square test were performed. $\alpha=0.05$ indicated that the difference was significant.

Result

Comparison of aneurysm longitudinal diameter and neck width indexes of patients between the two groups

Aneurysm longitudinal diameter 6.65 ± 2.21 and neck width 4.24 ± 1.21 of the patients in the observation group were significantly larger than the aneurysm longitudinal diameter 5.54 ± 1.12 and neck width 3.11 ± 1.01 of those in the control group, and the differences were statistically significant ($p<0.01$) (Table 1).

Table 1. Comparison of aneurysm longitudinal diameter and neck width indexes of patients between the two groups.

Group	Aneurysm diameter	longitudinal	Aneurysm neck width
Observation group	6.65 ± 2.21		4.24 ± 1.21
Control group	5.54 ± 1.12		3.11 ± 1.01
T	3.56		3.78
P	0.002		0.001

Correlation between aneurysm neck and adjacent parental arteries of patients between the two groups

In the >3 mm group and ≤ 3 mm aneurysm diameter groups, the correlation between the aneurysm neck and adjacent parental arteries showed statistical significance between the two groups ($p<0.05$). The relationship between the aneurysm neck and adjacent parental arteries of the patients from the two groups showed a statistically significant difference ($p<0.05$) (Table 2).

Comparison of therapeutic effects on patients between the two groups

Patients in the two groups underwent their respective operations successfully. Intraoperative blood loss and postoperative drainage of the patients in the observation group

Application of three-dimensional reconstruction technique and intraoperative posture in the interventional treatment of cerebral aneurysm

were significantly lower than those in the control group, and the difference was statistically significant ($p < 0.05$).

Table 2. Correlation between aneurysm neck and adjacent parental artery (n (%)).

Group	>3 mm		≤ 3 mm		Total detection result	
	+	++	+	++	+	++
Observation group	0 (0)	32 (71.1%)	0 (0)	13 (28.9%)	0 (0)	45 (100.0%)
Control group	8 (25.8%)	15 (48.4%)	4 (12.9%)	4 (12.9%)	12 (38.7%)	19 (61.3%)
χ^2	15.43		18.54		21.34	
P	0.002		0.012		0.003	

Table 3. Comparison of therapeutic effects of patients between the two groups ($\bar{x} \pm S$).

Group	n	Intraoperative loss (mL)	blood	Operation time (min)	Off-bed time (h)	Drainage indwelling time (d)	tube	Postoperative drainage (mL)
Control group	26	115.23 ± 8.72		72.34 ± 12.56	21.20 ± 3.65	14.20 ± 2.12		162.02 ± 12.21
Observation group	26	62.27 ± 5.22 ^a		56.78 ± 7.69 ^a	9.64 ± 2.47 ^a	8.05 ± 2.01 ^a		112.12 ± 10.12 ^a

Note: Compared with the control group, ^aP < 0.05.

Operation time, off-bed time, and indwelling drainage tube time of the patients in the observation group were significantly shorter than those in the control group, and the differences were statistically significant ($p < 0.05$) (Table 3).

Discussion

Aneurysm refers to the arterial wall expansion caused by the evagination of a part of vascular wall lesions. The incidence of aneurysm in the general population is 6%-10%. Aneurysm rupture may cause serious neurological disorders and even death. Studies have shown that aneurysm occurs in deep locations and its anatomical structure is complex and close to important structures; thus, the rupture of an aneurysm may lead to major health hazards [6]. Intracranial aneurysm is one of the most common cerebrovascular disorders. Its mortality rate is as high as 25%-60% and it is common in middle-aged and elderly patients. More than 50% of subarachnoid hemorrhage cases are caused by the rupture of an aneurysm. Moreover, the saccular artery is more prone to bleeding than the prismatic artery [7]. Most patient deaths are attributed to bleeding and severe vasospasm. Thus far, treating intracranial aneurysms has been divided into two types: surgical occlusion and stent-assisted endovascular embolization. The incidence of intracranial aneurysms is increasing annually [8].

The main task of intracranial aneurysm treatment is to completely remove the tumor tissue, enable the pituitary gland to maintain its normal function, reduce the adverse effects of the tumor on vision, prevent tumor recurrence, and minimally reduce complications. Drug therapy and chemotherapy are deficient for this disorder in many aspects [9]. For example, nasal bleeding, headache, hypopituitarism, diabetes insipidus, and other complications easily occur with these treatments. Therefore, surgical treatment has become the first choice for

treating intracranial aneurysms. Rotating DSA and 3D reconstruction techniques have been widely used in radiology. These techniques are relatively mature, that is, patients' original images can be clearly displayed after processing *via* computer applications. In the anteroposterior images obtained via the simple and conventional DSA technique, the correlation between the overlapping vessels and the tumor cannot be clearly displaced, thereby reducing the success rate of operations [10]. At present, rotating DSA is combined with 3D reconstruction to enhance the accuracies of intracranial aneurysm examination and treatment.

Results of this study showed that the aneurysm longitudinal diameter 6.65 ± 2.21 and neck width 4.24 ± 1.21 of the patients in the observation group were significantly larger than those of the patients in the control group 5.54 ± 1.12 , 3.11 ± 1.01 and the difference was statistically significant ($p < 0.01$). In the >3 mm group and ≤ 3 mm aneurysm diameter groups, the aneurysm neck and adjacent parental arteries of the patients showed statistical difference ($p < 0.05$). Correlations between the aneurysm neck and adjacent parental arteries of the patients from the two groups showed statistical significance as well ($p < 0.05$). This outcome suggested that combining rotating DSA and 3D reconstruction could display the relationships among aneurysm neck morphology, location, and size, as well as their relationship with adjacent parental arteries. This effective display is important in accurately diagnosing aneurysms, determining their shapes and types, and selecting the operation method of aneurysm embolization.

Conclusion

DSA examination combined with 3D vascular reconstruction and proper posture changes during operation can address the inability of machines to reach the target posture and clearly

display the relationships among the tumor, parental arteries, and aneurysm size. This outcome is important in improving the success rate of operations and is worthy of promotion and application in clinical settings.

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*Correspondence to

Meng Zhang

Department of Neurosurgery

Shenzhen Second People's Hospital

Shenzhen

Guangdong

PR China