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Comparison of the efficacy of surgical clipping and embolization for oculomotor nerve palsy due to a posterior communicating artery aneurysm

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Abstract. – OBJECTIVE: To aim at the efficacies of surgical clipping and endovascular embolization for oculomotor nerve palsy (ONP) as treatments for posterior communicating artery aneurysm (PcoAA), and the comparison and various influencing factors of the treatments.

PATIENTS AND METHODS: An analysis of the clinical data of 52 enrolled PcoAA patients with ONP who had treatment in the Department of Neurosurgery in Anhui Provincial Hospital from January 2011 to June 2015 was conducted. There were 23 patients among a total underwent surgical clippings and others 29 patients received endovascular embolization treatment. Then, the age, gender, aneurysm size and rupture status, onset duration, preoperative ONP severity and postoperative recovery degree of ONP of patients in the two groups were compared.

RESULTS: The final ONP outcomes of the 52 PcoAA patients consisted of 27 full recovery patients (51.9%), 21 partial recovery patients (40.4%), and 4 no recovery patients (7.7%). (1) Within the 23 patients in the surgical clipping group, subarachnoid hemorrhage (SAH) occurred in 16 patients, and no SAH occurrence in the other 7 patients; the final ONP evaluation showed 18 patients fully recovered (78.3%) and 5 patients partially recovered (21.7%). Within the 29 patients in the endovascular embolization group, SAH occurred in 18 patients, and no SAH occurrence in the other 11 patients; the final ONP evaluation showed 9 patients fully recovered (31%), 16 patients partially recovered in 16 patients (55.2%) and 4 no recovery patients (13.8%). (2) The postoperative ONP recovery was analyzed with multivariate logistic regression, and the treatment method was an independent factor for ONP recovery (OR = 0.041, 95% CI: 0.007-0.261, $p < 0.01$).

CONCLUSIONS: When compared with the endovascular embolization, the surgical clipping showed a better efficacy in the recovery from PcoAA related ONP.

Key Words:
Intracranial aneurysm, Oculomotor nerve palsy, Posterior communicating artery aneurysm, Surgical clipping, Endovascular embolization.

Introduction

Isolated oculomotor nerve palsy (ONP) is a well-known symptom of microvascular infarction and intracranial aneurysm. However, unilateral ONP as a rare symptom caused by upward compression of a posterior communicating artery aneurysm (PcoAA), may also be the sign of nerve damages in PcoAA patients. The pulsatile stimulation of an aneurysm on the oculomotor nerve may be the major cause of ONP[1]. In several researches[2-9], the ONP patients enrolled who received surgical clipping or embolization treatment showed both fully or partially recoveries. However, the efficacies of the two treatment modalities regarding the degree of recovery of ONP caused by a PcoAA are still controversial. In this study, the clinical data collected from the patients with a PcoAA accompanied by ONP who received craniotomy clipping or endovascular treatment were analyzed, and the efficacies of the two treatment modalities regarding the recovery of ONP caused by a PcoAA were also compared.

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Patients and Methods

Patients

From January 2011 to June 2015, 978 cases of patients with an intracranial aneurysm who received treatment in the Department of Neurosurgery, Anhui Provincial Hospital (Hefei, Anhui, China) were analyzed. Among all patients, 295 cases of patients resulted from a PcoAA, including 52 cases of ONP. Within the 52 consecutive patients recruited with ONP caused by a PcoAA in this study, 18 cases consisted of unruptured aneurysms, and 34 cases consisted of ruptured aneurysms. Craniotomy clipping was performed on 23 patients (20 cases of unilateral complete ONP), and endovascular embolization was performed on 29 patients (25 cases of unilateral complete ONP). The 23 patients in the clipping group included 7 males and 16 females, with ages ranging from 31-69, average 53.9 ±11.5 years old. Sudden severe headache with ONP as the main symptom at admission occurred in 16 cases, while ONP alone occurred in 7 cases. The 29 patients in the endovascular embolization group included 1 male and 28 females, with ages ranging from 38-70, average 54.1 ± 10.0 years old. Sudden severe headache with ONP as the main symptom at admission occurred in 18 cases, while ONP alone occurred in 11 cases. All aneurysms were confirmed by computed tomographic angiography (CTA) and (or) a digital subtraction angiography (DSA) examination. The general information of the ONP patients in the two groups was shown in Table I. This study has been proved by Ethical Committee of Anhui Provincial Hospital, and all patients have signed informed consents.

Treatment

A treatment plan was considered and developed according to the treatment methods recommended by the International Study of Unruptured Intracranial Aneurysms (ISUIA) and the guidelines for the management of aneurysmal subarachnoid hemorrhage (SAH) for treating unruptured and ruptured aneurysms. The treatment program included intravenous infusion of nimodipine (Bayer, Leverkusen, Germany) for SAH patients occurred at admission to prevent vasospasm and the intravenous infusion of tranexamic acid for hemostasis until the surgery.

Craniotomy clipping for an aneurysm was performed by using an ipsilateral standard pterional approach. After the lateral fissure has been isolated, the chiasmatic cistern and the internal carotid artery cistern were opened to release the cerebrospinal fluid and expose the proximal portion of the internal carotid artery in the preparation for temporary shut off. The aneurysmal neck was fully disassociated. The appropriate aneurysm clip (Braun, Tuttlingen, Germany) was selected according to the width of the aneurysmal neck. At meanwhile, the surrounding posterior communicating artery and the anterior choroidal artery were carefully protected. Patients with preoperative hydrocephalus underwent intra-operative lamina terminalis fenestration. As the top of the aneurysm, which usually closely adheres to the oculomotor nerve, only clipping on the aneurysmal neck was needed, and the deliberate separation was not performed to avoid damages to the oculomotor nerve.

For the endovascular embolization, a 6F-guiding catheter (ENVOY, Johnson & Johnson, New Brunswick, NJ, USA) was firstly placed in the ipsilateral carotid artery. Following the guiding map, the microcatheter (Echelon-10, EV3 Co., Irvine, CA, USA) was then carefully placed in the aneurysm mal cavity. Upon confirmed by angiography, the coils with appropriate sizes (EV3 Co., Irvine, CA, USA, or Microinvention Inc., Tustin, CA, USA) were selected and inserted into the aneurysm cavity one by one until the angiography gradually showed no aneurysmal imaging. For wide-necked aneurysms, an auxiliary stent

Table I. Comparison of the clinical data of the patients with PcomAA

Group	Number of cases	Age (mean ± SD, y)	Gender (case) Male: Female	Size of the aneurysm (mean, range, mm)	SAH cases and rate (%)	Preoperative complete ONP cases and rate (%)	Duration from paralysis to treatment (mean, range, d)	Recovery time after treatment (mean, range, d)
Clipping	23	53.9 ± 11.5	7:16	7.1 (4.5-13.9)	16 (69.6%)	20 (87%)	12.9 (2-90)	73 (20-145)
Embolization	29	54.1 ± 10.0	1:28	6.4 (4.4-14.0)	18 (62%)	25 (86.2%)	11.6 (3-92)	111 (35-180)
p-value		0.929	0.16	0.213	0.573	1.000	0.329	0.012

(EV3 Co., Irvine, CA, USA) was placed. 300 mg Aspirin and 300 mg Clopidogrel (Bayer, Leverkusen, Germany) were administered for the patients with stent-assisted coil embolization in the morning of the operation while 100 mg of aspirin (oral) and 75 mg of clopidogrel were administered daily for six months after surgery.

Criteria of ONP and Determination of Recovery

The criteria for complete ONP included (1) drooping eyelids; (2) ophthalmoplegia; (3) diplopia; (4) ipsilateral mydriasis with the direct or indirect loss of the pupillary light reflex. If the symptoms in (1) - (3) occurred, patients were classified as having partial ONP. If the symptoms were completely eliminated after surgery, the patient was classified as having a full recovery. If the symptoms in (1) - (3) were remained, including mild symptoms such as diplopia, the patient was also classified as having a partial recovery[3,4].

Data Collection and Follow-up Method

There were various related factors that may affect the ONP recovery. Such factors which including the aneurysm characteristics, different treatment modalities, pre-operative SAH, pre-operative ONP severity, the duration from ONP onset to treatment and the aneurysm size were compared with the extent of the recovery of ONP. For patients who received a craniotomy, CTA was performed at 7 days after the surgery to evaluate the occlusion of the aneurysm. For the patients who received endovascular treatment, DSA was performed to evaluate the efficacy of the interventional treatment at 6 to 12 months after hospitalization. Follow-up by outpatient service or telephone interview was conducted for all patients at 1, 3, 6 and 12 months postoperative to evaluate the recovery of ONP.

Statistical Analysis

The SPSS16.0 software package (SPSS Inc., Chicago, IL, USA) was used for the statistical analysis. Independent sample *t*-tests were performed for measurable indicators with a normal distribution, while a rank sum test was applied to factors with a no normal distribution. X^2-test (or Fisher's exact test) was used to analyze the categorical variables in the table. Multivariate analysis was performed by using logistic regression. Differences with a value of $p < 0.05$ were considered statistically significant.

Results

Characteristics of Aneurysms in the Two Groups

In the patients underwent surgical clipping, the tumor diameters of the PcoAA were 4.5-13.9 mm with an average size of 7.1 mm. Among the patients in the embolization group, the aneurysmal diameters were 4.4-14.0 mm with an average of 6.4 mm. The difference between the two groups was not statistically significant ($p > 0.05$). Complete ONP was observed in 20 patients from the clipping group and 25 patients from the embolization group, and partial ONP was observed in 3 patients from the clipping group and 4 patients from the embolization group. Preoperative SAH occurred in 16 (total 23) patients in the craniotomy clipping group (69.6%) and 18 (total 29) patients in the embolization group (62.1%). The difference between the two groups was not statistically significant ($p > 0.05$).

Treatment Efficacy

No treatment-related deaths occurred in either group. Postoperative aneurysmal-occlusion occurred in all 23 patients (100%) in the craniotomy-clipping group without any patient displaying a residual aneurysmal neck. Postoperative aneurysmal occlusion occurred in 28 (96.6%) of the 29 patients in the endovascular group. The rates of complete aneurysmal-occlusion for the two groups were not significantly different ($p = 1.0$).

Postoperative Complications

For the craniotomy-clipping group, the complications included two cases of obvious cerebral vasospasm, one case of incomplete hemiparesis and aphasia, and one case of hydrocephalus. For the endovascular embolization group, the complications included one case of cerebral vasospasm, one case of incomplete hemiplegia, and one case of hydrocephalus. After the release of bloody cerebrospinal fluid by lumbar drainage, the complications were resolved in all cases, except in one patient who received a ventriculoperitoneal shunt.

Follow-up Results

In the 12-month postoperative follow-up, 48 patients showed recovery from ONP when compared to the preoperative symptoms, including: 18 patients from the clipping group and 9 patients from the embolization group with a full recovery; 5 pa-

tients from the clipping group and 16 patients from the embolization group with a partial recovery; only 4 patients from the embolization group, that showed no recovery. Among the 20 patients from the clipping group and 25 patients from the embolization group with complete ONP, there were: 15 patients from the clipping group and 5 patients from the embolization group that showed a full recovery; 5 patients in the clipping group and 16 patients in the embolization group that had a partial recovery; only 4 patients in the embolization group with no recovery. Among the 7 patients with partial ONP, all 7 patients exhibited a full recovery, including 3 patients of the clipping group and 4 patients of the embolization group. Based on the statistics for the recovery time after treatment, the average time for full or partial recovery in the patients receiving a craniotomy was 73 (20-145) days while that in the patients receiving the endovascular treatment was 111 (35-180) days. The difference was statistically significant ($p < 0.05$). The multivariate analysis of postoperative ONP recovery indicated that the treatment method was the only independent influencing factor. Results of the multivariate logistic regression analysis were shown in Table II.

Discussion

ONP is a common clinical symptom of a PcoAA. Currently, which treatment method, craniotomy clipping or interventional embolization is more favorable for ONP recovery is under debates[2,6]. A relatively commonly recognized opinion is that both treatment modalities are conductive to the recovery of ONP and the craniotomy clipping may produce slightly better odds for a full recovery of ONP.

The mechanism of PcoAA related ONP remains unclear. Previously, it was thought that ONP was caused by direct mechanical compression of the aneurysm[1]. After surgical clipping, the compression effect of the aneurysm is released. However, the endovascular embolization treatment cannot be eliminated completely but to some extent increases the compression effect. Nevertheless, Yerramneni et al[5] reported that the recovery of ONP was observed in patients after endovascular embolization treatment for PcoAA. It was considered that the elimination of the aneurysmal pulsation could improve the recovery of the oculomotor nerve. Also, PcoAA related ONP may be the result of both aneurysmal oppression and aneurysmal pulsation. Stimulation of the oculomotor nerve can easily cause some other symptoms[4]. When patients were treated without associated ONP, since the oculomotor nerve can be stretched to expose the aneurysmal neck, the occurrence of intraoperative exposure of the oculomotor nerve may be possible, followed by postoperative ONP with varying degrees of severity.

In this study, the age, the aneurysm size, the treatment time, and the preoperative ONP severity were similar in the patients from the craniotomy clipping group and the embolization group. The multivariate regression analysis suggested that the ONP recovery was not correlated with the aneurysm size, the treatment time, the preoperative ONP severity, the duration from the onset to the treatment, and the SAH symptoms. Studies have reported that the full recovery rate of ONP was 32%-85%. After early surgical treatment with a craniotomy, the full recovery rate could reach to 88%[10], compared that the full recovery rate after receiving embolization was 0%-50%[11]. For either treatment modality, the full recovery rate from ONP in patients with partial ONP was higher than that in the patients with complete ONP. In our study, for patients suffered from complete ONP at admission, the full recovery

Table II. Multivariate Logistic regression analysis of postoperative recovery after unilateral ONP.

Factor	Regression coefficient	Standard zerror	Wald value	*p*-value	OR	95% CI
Gender	-0.194	1.356	0.020	0.886	0.824	0.058-11.742
Age	-0.026	0.040	0.421	0.516	0.974	0.901-1.054
Size of the aneurysm	-0.397	0.254	2.451	0.117	0.672	0.409-1.105
Rupture of the aneurysm	-0.175	0.999	0.031	0.861	1.192	0.118-5.945
Preoperative severity of ONP	-5.336	3.638	8.247	0.912	3.034	0.159-19.734
Treatment time	-0.043	0.029	2.240	0.134	0.958	0.905-1.014
Treatment method	-3.188	0.941	11.479	0.001	0.041	0.007-0.261

rate of the patients with surgical clipping (78.3%) was significantly higher than that of patients receiving intravascular therapy (31%, $p < 0.01$). This suggested that the mechanism of postoperative recovery in embolization patients was related to the formation of a thrombosis in the aneurysm sac after embolization, leading to the weakened aneurysmal pulsatility. Thus, mitigating the stimulation on the oculomotor nerve even when the compression effect on the aneurysm was not relieved. However, surgical clipping can eliminate the influence of both aneurysmal compression and pulsatility on the oculomotor nerve[12].

Results of ONP recovery and the early treatment of a PcoAA after the onset of ONP reported in the literature have not been consistent. Some scholars[13] have reported that early aneurysmal treatment resulted in better ONP recovery efficacy. Our results showed that the duration from the onset of ONP to treatment was not significantly correlated with the postoperative ONP recovery, which was similar to the findings of Hanse et al[14]. Typically, ONP improvement occurred within the first year after the onset of symptoms and treatment, and the improvement one year after treatment has not been reported.

Conclusions

To determine that which type of treatment is more favorable to the recovery from ONP, a larger sample size is demanded to more objectively assess the efficacy of each treatment modality. According to the results of our retrospective analysis, craniotomy clipping is more favorable to the recovery from ONP.

Conflict of Interest

The Authors declare that there are no conflicts of interest.

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