European Review for Medical and Pharmacological Sciences 2015; 19: 402-405

Clinical evaluation of the efficacy of the combination of aneurysm embolization and cerebrospinal fluid replacement in the treatment of aneurysmal subarachnoid hemorrhage

W. DING, N. GAO, M.X. LI, L.J. DING, F.F. LI, L. MOU

Rizhao Hospital of Traditional Chinese Medicine, Rizhao City Shandong Province, China

Abstract. – OBJECTIVE: To explore the clinical efficacy of aneurysm embolization and cerebrospinal fluid (CSF) replacement in the treatment of aneurysmal subarachnoid hemorrhage (SAH).

PATIENTS AND METHODS: Seventy-nine patients with grade III-IV aneurysmal subarachnoid hemorrhage, who were treated in the hospital from Jan. 2012 to Jan. 2014, were included in this study. These patients were treated with different methods based on the cause of disease and the treatment chosen by their families. In the treatment group, 42 patients received aneurysm embolization and cerebrospinal fluid replacement, while 37 patients in the control group received simple aneurysm embolization. The treatment efficacy and the occurrence of complications in both groups were compared.

RESULTS: The occurrence of cerebral vasospasm and hydrocephalus in the treatment group was significantly lower than the control group, and the difference was statistically significant. However, the mortality rate was decreased in both groups.

CONCLUSIONS: Both methods had the advantage of minimal invasiveness and rapid post-operative recovery. But using combination of these two methods is clinically rational and could decrease the rate of disability and mortality.

Key Words:
Subarachnoid hemorrhage, Cerebrospinal fluid replacement, Aneurysm embolization.

Introduction

Subarachnoid hemorrhage (SAH) is a common critical illness in Neurology Department[1,2]. And it is an acute hemorrhagic cerebrovascular disease of surface vessel rupture in pavimentum cerebri, brain and spinal cord, which is produced by multiple causes. The hemorrhage flows into subarachnoid space. The onset of the disease is acute and progresses quickly with a high mortality rate. The efficacy of craniotomy or conservative medicine treatment is unsatisfactory[3-6]. The main cause of aneurysmal subarachnoid hemorrhage is cerebral aneurysm rupture. The key therapy is to prevent rehaemorrhagia in the aneurysm and a precise treatment should be performed at a specific time after the identification of the aneurysm. The treatment methods include: cranial aneurysm occlusion and invasive aneurysm coil embolization[7,8]. In this study, we treated aneurysmal subarachnoid hemorrhage with minimally invasive coil embolization and cerebrospinal fluid replacement, as well as evaluated the efficacy of these treatments.

Patients and Methods

General Information

Seventy-nine patients with grade III-IV aneurysmal subarachnoid hemorrhage, who were treated in the hospital from Jan. 2012 to Jan. 2014, were included in this study. These patients were treated with different methods based on their family's will and the cause of illness. In the treatment group, 42 patients received aneurysm embolization and cerebrospinal fluid replacement, and 37 patients in the control group received simple aneurysm embolization. Treatment group included grade III (22) and grade IV (20) patients, whereas control group included 20 (grade III) and 17 (grade IV) patients. The stratification of patient's condition was not statistically significant ($p > 0.05$). Treatment group included 26 male and 16 female patients, with a age range of 27-74 years and mean age of 45.2 ± 6.5 years. Control group included 21 male and 16 female patients, with a age range of 28-73 years

Corresponding Author: Mou Lei, MD; e-mail: mlwws0633@163.com

and mean age of 46.8 ± 7.8 years. General factors including age in both groups were balanced, and the difference was not statistically significant ($p > 0.05$). Exclusion criteria were: (1) patients with other nervous system diseases; (2) patients with severe complications of diseases of other organs; heart, kidney and liver, etc; (3) patients with complications of circulatory system diseases[9,10].

Methods

After admission, patients received imaging examinations including CT and regular medical treatments: e g. absolute bed rest, keeping quiet, keeping bowels open, and the change of consciousness. Pupil and vital signs were closely monitored, and patients also received medical treatment, such as oxygen inhalation, anti-hypertension, spasmolysis and dehydration. Subsequent to confirmed diagnosis, corresponding preoperative preparation was performed. Pre-, peri- and post-operatively intravenous infusion of Nimodipine was performed to prevent potential cerebral vasospasm in the patient[5,11-1].

In control group, the patient was in dorsal position pre-operatively and received conventional sterile barrier precautions. Femoral artery puncture was performed under local anesthesia; catheter sheath was indwelled for angiography to confirm the aneurysm and the size of the aneurysm was measured. The aneurysm neck was exposed after general anesthesia, and a micro-coil of appropriate size was chosen for aneurysm. The femoral artery puncture site was sutured by blood vessel suture instrument after embolization. The lower limb in the punctured side was immobilized for 24 h.

In the treatment group, the patient received aneurysm embolization and then CSF replacement. Dexamethasone (5 mg) was added into saline (250 ml) to prepare the replacement solution, and then conventional lumbar puncture was performed aseptically. Initial pressure was measured after puncture. When the pressure was higher than 250 mmHg, a small amount of CSF could be released slowly, and the needle tip was then obstructed with a core needle. Cerebrospinal fluid replacement was performed when the pressure decreased to lower than 250 mmHg. Equivalent-volume replacement or reduced-volume replacement was used. Firstly, bloody cerebrospinal fluid (5 ml) was released slowly, and then infused with replacement solution to perform equivalent-volume (5 ml) or reduced-volume (4 ml) replacement. The repeated replacement of CSF was performed every 5-10 min and 4-6 replacements until the CSF became yellow. Equivalent-volume replacement or reduced-volume replacement of CSF were performed daily or every other day, or discontinued the replacements once the replaced CSF became clear. Postoperatively, the consciousness, pupil and 4 vital signs of patients were observed, and enhanced the patient care was applied.

Observational Indicators

Occurrence of the post-operative complications including cerebral vasospasm, hydrocephalus and re-hemorrhage was compared.

Statistical Analysis

Statistical software SPSS 19.0 (SPSS Inc., Chicago, IL, USA) was used for the data analysis. The *t*-test was used for measurement data, the chi-square test was used for enumeration data, and $p < 0.05$ indicated significant difference.

Results

When post-operative complications were compared in both groups: the prevalence of cerebral vasospasm and hydrocephalus after treatment was significantly lower than the control group ($p < 0.05$). However, the difference in the occurrence of rehaemorrhagia in the treatment and control groups was not significant ($p > 0.05$) as shown in Table I.

Table I. Comparison of post-operative complications in control and treatment groups (n/%).

Group	n	Hydrocephalus	Cerebral vasospasm	Rehaemorrhagia
Treatment group	42	1 (2.3)	2 (4.6)	1 (2.3)
Control group	37	4 (10.8)*	5 (13.5)*	1 (2.7)#

Note: *Indicates $p < 0.05$. #Indicates $p > 0.05$.

Discussion

Subarachnoid hemorrhage is one of the most acute cerebrovascular diseases, with the highest mortality rate, especially for grade II-IV aneurysmal subarachnoid hemorrhage, the rehaemorrhagia, disability and mortality rates are very high[14]. Earlier treatment includes prevention of rehaemorrhagia, cerebral vasospasm, hydrocephalus, cerebral ischemia, arachnoid adhesions and hernia[15]. The outcome of SAH patients is directly associated with earlier elimination of aneurysm cause and treatment and prevention of complications[16]. Aneurysm embolization is characterized with small trauma in patient, rapid post-operative recovery and very few complications, and currently it is a most commonly used therapy. The safety and efficacy of this method has been clinically proven[17-20]. With the development of technology and improvement of sacculus and heart bracket, interventional therapy has been widely used in the clinical treatment of intracranial aneurysms[21]. Cerebrospinal fluid replacement can drain CSF, release and dispose of inflammatory CSF. Cerebrospinal fluid replacement can reduce vasospasm and eliminate the induction factors during treatment[22], to decrease the level of hazardous substances, such as blood cell degradation products and bloody CSF, reduce the stimulus of omentum, relieve the symptoms, as well as decrease the intracranial pressure, relieve the blocked circulation due to a high intracranial pressure and improve the CSF circulation in the head and spine. It can also reduce the retention time of blood in the brain, reduce the stimulus of meninges by released substances after erythrocatalysis, and reduce the inter-omentum adhesion effectively, so as to reduce the occurrence of cerebral vasospasm and hydrocephalus. Infusion with saline can maintain the stability of intracranial pressure, meanwhile, dilute CSF and reduce the abnormal stimulus of meninges by cerebrospinal fluid. While, a simple cerebrospinal fluid replacement without aneurysm embolization may lead to the risk of rehaemorrhagia[33].

Aneurysmal subarachnoid hemorrhage is a common cerebrovascular disease, with a high disability rate; the 30-day mortality is 46%, while the disability rate and mortality of severe subarachnoid hemorrhage is much higher. Earlier mortality rate among severe subarachnoid hemorrhage is also very high. In this study, grade III-IV patients were included in 2 groups, with serious conditions, large hemorrhage volume, as well as high occurrence of hydrocephalus and cerebral vasospasm. In the treatment group, the combination of aneurysm embolization and cerebrospinal fluid replacement was used which resulted in the significantly decreased appearence of hydrocephalus and cerebral vasospasm compared to the control group, in which only simple aneurysm embolization was used. But the difference in rehaemorrhagia rate was not statistically significant between the two groups.

Conclusions

The combination of aneurysm embolization and cerebrospinal fluid replacement was a major effective therapy for aneurysmal subarachnoid hemorrhage. The advantage of aneurysm embolization was to eliminate the cause and reduce re-haemorrhagia. Cerebrospinal fluid replacement could adjust cerebral hemorrhage effectively and decrease the prevalence of complications, such as hydrocephalus and cerebral vasospasm. Both methods had the advantages of minimal invasiveness and rapid post-operative recovery. However, combination of both methods could clinically decrease the disability and mortality rate of aneurysmal subarachnoid hemorrhage.

Conflict of Interest

The Authors declare that there are no conflicts of interest.

References

1) Gerald WL, Rosai J. Desmoplastic small cell tumor with divergent differentiation. Pediatr Pathol 1989; 9: 177-183.
2) Ramakrishnan P, Yoo AJ, Rabinov JD, Ogilvy CS, Hirsch JA, Nogueira RG. Intra-arterial eptifibatide in the management of thromboembolism during endovascular treatment of intracranial aneurysms: case series and a review of the literature. Interv Neurol 2013; 2: 19-29.
3) Abd TT, Hayek S, Cheng JW, Samuels OB, Wittstein IS, Lerakis S. Incidence and clinical characteristics of takotsubo cardiomyopathy post-aneurysmal subarachnoid hemorrhage. Int J Cardiol 2014; 176: 1362-1364.
4) Wan H, Zhang SD, Li JH. Action of Schwann cells implanted in cerebral hemorrhage lesion. Biomed Environ Sci 2007; 20: 47-51.
5) Andereggen L, Neuschmelting V, Von Gunten M, Widmer HR, Fandino J, Marbacher S. The role of

microclot formation in an acute subarachnoid hemorrhage model in the rabbit. Biomed Res Int 2014; 161702.

6) Attenello FJ, Wang K, Wen T, Cen SY, Tenser MK, Amar AP, Sanossian N, Giannotta S, Mack WJ. Health disparities in time to aneurysm clipping/coiling among aneurysmal subarachnoid hemorrhage patients: a national study. World Neurosurg 2014; 82: 1071-1076.
7) Bae IS, Yi HJ, Choi KS, Chun HJ. Comparison of incidence and risk factors for shunt-dependent hydrocephalus in aneurysmal subarachnoid hemorrhage patients. J Cerebrovasc Endovasc Neurosurg 2014; 16: 78-84.
8) Chiriac A, Poeata I, Baldauf J, Schroeder HW. Aneurysmal subarachnoid hemorrhage. Rev Med Chir Soc Med Nat Iasi 2010; 114: 120-128.
9) Cooke D L, Stout CE, Kim WT. Cerebral arterial fenestrations. Interv Neuroradiol 2014; 20: 261-274.
10) Ding D. Predicting the course of aneurysmal subarachnoid hemorrhage with biomarkers: Molecular basis of delayed neurological deterioration. J Neurol Sci 2014; 345: 274-275.
11) Ding D. Delayed morbidity and mortality in aneurysmal subarachnoid hemorrhage patients: effect of attenuating cerebral vasospasm. Neurol Sci 2014; 36: 171-172.
12) Germans MR, Coert BA, Majoie CB, van den Berg R, Verbaan D, Vandertop WP. Spinal axis imaging in non-aneurysmal subarachnoid hemorrhage: a prospective cohort study. J Neurol 2014; 261: 2199-2203.
13) Behari S, Das RK, Jaiswal AK, Jain VK. Fronto-temporo-orbitozygomatic craniotomy and "half-and-half" approach for basilar apex aneurysms. Neurol India 2009; 57: 438-446.
14) Jartti P, Karttunen A, Isokangas JM. Chronic hydrocephalus after neurosurgical and endovascular treatment of ruptured intracranial aneurysms. Acta Radiol 2008; 49: 680-686.
15) Shirao S, Yoneda H, Ishihara H. Fate of clots in patients with subarachnoid hemorrhage after different surgical treatment modality: a comparison between surgical clipping and Guglielmi detachable coil embolization. Neurosurgery 2011; 68: 966-973.
16) Huang R. The treatment of subarachnoid hemorrhage based on the type and grade. Chinese J Med 2003; 38: 7-8.
17) Jvan G. The diagnosis and treatment of subarachnoid hemorrhage. Int J Med Cerebrovasc Dis 2004; 12: 161-177.
18) Bai W, Xue J, Zhao T. Exploration of the timing of intervention of intracranial aneurysms with subarachnoid hemorrhage. Chinese Journal of Cerebrovasc Dis On-line Version 2011; 5: 191-196.
19) Wang KC, Tang SC, Lee JE, Lai DM, Huang SJ, Hsieh ST, Jeng JS, Tu YK. Prognostic value of intrathecal heme oxygenase-1 concentration in patients with Fisher Grade III aneurysmal subarachnoid hemorrhage. J Neurosurg 2014; 121: 1388-1393.
20) Sun H, Zhang H, Ma J. Evaluating the diagnostic accuracy of CT perfusion in patients with cerebral vasospasm after aneurysm rupture: a meta-analysis. Turk Neurosurg 2014; 24: 757-762.
21) Sun C, Du H, Yin L, He M, Tian Y, Li H. Choice for the removal of bloody cerebrospinal fluid in post-coiling aneurysmal subarachnoid hemorrhage: external ventricular drainage or lumbar drainage?. Turk Neurosurg 2014; 24: 737-744.
22) Konczalla J, Schuss P, Platz J, Vatter H, Seifert V, Güresir E. Clinical outcome and prognostic factors of patients with angiogram-negative and non-perimesencephalic subarachnoid hemorrhage: benign prognosis like perimesencephalic SAH or same risk as aneurysmal SAH?. Neurosurg Rev 2015; 38: 121-127.
23) Wang W, Li A. Analysis of the efficacy in 30 cases of the treatment of primary subarachnoid hemorrhage by cerebrospinal fluid replacement. Proc Henan Med Univ 2011; 36: 354-356.
24) Chinchure SD, Gupta V, Goel G, Gupta A, Jha A. Subarachnoid hemorrhage with blister aneurysms: Endovascular management. Neurol India 2014; 62: 393-399.