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Analysis of postpartum reversible cerebral vasoconstriction syndrome in China

A case report and literature review

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Abstract

Reversible cerebral vasoconstriction syndrome (RCVS) is a rare clinical syndrome accompanying with severe headache as its main symptom. Postpartum reversible cerebral vasoconstriction syndrome (PPRCVS) refers to RCVS occurring in the puerperium, in which it has a low incidence, and that is easily missed diagnosed and misdiagnosed in clinical practice.

By searching in CNKI and Wanfang databases, 9 published articles reported PPRCVS were found, totally including 12 cases with PPRCVS. The clinical data of these 12 cases were accordingly analyzed and summarized. The characteristics of these cases were compared with those reported in other countries, and eventually the clinical characteristics of Chinese PPRCVS patients were summarized.

The clinical characteristics of Chinese PPRCVS patients were basically as same as those found in other countries, while the onset age was earlier, PPRCVS often occurred earlier after delivery, with higher proportions of concomitant symptoms and abnormal laboratory and imaging examinations; moreover, and fewer patients were diagnosed by digital subtraction angiography (DSA).

Abbreviations: CRP = C-reactive protein, CSF = cerebrospinal fluid, CT = computed tomography, CTV = CT venography, DIC = disseminated intravascular coagulopathy, DSA = digital subtraction angiography, EEG = Electroencephalography, FLAIR = fluid-attenuated inversion recovery, HBDH = hydroxybutyrate dehydrogenase, INR = international normalized ratio, LDH = lactate dehydrogenase, MRI = Magnetic resonance imaging, PPRCVS = Postpartum reversible cerebral vasoconstriction syndrome, RCVS = reversible cerebral vasoconstriction syndrome, SAH = subarachnoid hemorrhage, T1WI = T1-weighted image, TCD = Transcranial Doppler.

Keywords: Call-Fleming syndrome, postpartum, reversible cerebral vasoconstriction syndrome, thunderclap headache

1. Introduction

Reversible cerebral vasoconstriction syndrome (RCVS) is a rare clinical syndrome, mainly manifesting intolerable thunderclap headache with or without focal neurological deficit or epileptic seizures. Cerebrovascular imaging in typical cases have indicated multifocal and segmental stenosis of large blood vessels in the brain, and it typically returns to normal level within 12 weeks after onset of symptoms. There is no enough reliable data on the incidence of RCVS, thus it is considered as a rare disease. Puerperium is an important risk factor for RCVS, and has its unique clinical characteristics, therefore it can be independently diagnosed as postpartum reversible cerebral vasoconstriction syndrome (PPRCVS). Regarding the incidence of PPRCVS, Gian et al conducted a prospective study in 2017,[1] and followed-up 900 cases for 1 month after delivery of a baby, in which found only one case of confirmed PRCVS, demonstrating that its incidence was 0.1%. However, to date, no relevant study has reported the incidence rate of PPRCVS in China. According to the published papers in China, it can be estimated that the incidence rate was extremely limited. There are a small number of researches concentrating on PPRCVS, and it was revealed that PPRCVS is a disease that is easily missed diagnosed or misdiagnosed; moreover, compared with non-postpartum RCVS, PPRCVS is more likely to have concomitant symptoms and sequelae because of patient's special physical condition, and the mortality rate is higher as well. Therefore, clinicians should highly pay attention to PPRCVS. In the present study, a case of PPRCVS was reported, previous studies related to PPRCVS were reviewed, and also case reports of PPRCVS in China were collected and analyzed to summarize the clinical characteristics of Chinese PPRCVS patients by comparing with those reported in other countries.

2. Materials and methods

Clinical data of a Chinese patient with PPRCVS were collected, and they were shared after the patient's consent and authorization. After searching for case reports with PPRCVS on Chinese databases (CNKI and Wanfang databases), 12 cases were

Editor: Giovanni Tarantino.

Ethics approval and consent to participate: Ethical approval and informed consent is not applicable in this study.

The authors have no conflicts of interest to disclose.

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How to cite this article: Liu L, Tan Q, Huang R, Hu Z. Analysis of postpartum reversible cerebral vasoconstriction syndrome in China. Medicine 2019;98:45 (e17170).

Received: 11 April 2019 / Accepted: 21 August 2019

http://dx.doi.org/10.1097/MD.0000000000017170

obtained including the case reported in this study. The clinical characteristics of these cases were summarized and compared with those observed in other countries.

3. Case collection

In this study, "reversible cerebral vasoconstriction syndrome", "Call-Fleming syndrome", and "thunderclap headache" were used as keywords to search for in the CNKI and Wanfang databases in recent 20 years. As a result, 11 cases of PPRCVS were obtained, including 1 case report on nursing and 1 case report on imaging that were excluded as clinical data provided were seriously insufficient. The remaining 9 published researches[2–10] provided 11 cases of PPRCVS. Finally, there were a total of 12 cases with PPRCVS involving 1 case provided in this study. The clinical data of these 12 cases were collected and subsequently analyzed.

4. Results

A Chinese 27-year-old woman was admitted to the Department of Neurology, Dongguan Donghua Hospital (Dongguan, China) on the 4th May, 2016 because of "headache for 1 d, and disturbance of consciousness and convulsion for more than 2 h". On the 1st May, 2016, the patient delivered a full-term baby girl in a local hospital, in which the production process was smooth. After delivery, the patient used hemostatic drugs (unknown). Besides, 4 d after delivery, the patient suddenly had headache when bending down to pick-up heavy objects. The headache was lightning strike-like pain in the whole head. The pain was severe and unbearable. The patient fell on bed and had a slight relief after 5 minutes. After 7 hours, the patient's vision had double shadows, that accompanied by involuntary twitching of the left lower limb. Several seconds later, the patient lost consciousness and developed tonic-clonic seizures. The seizures stopped within 1 minute, and the patient became conscious after half an hour.

The patient was normal during pregnancy, and denied the history of migraine. There was no particular health problem in the patient's medical history, personal history, marriage and childbearing history (no pregnancy in the past), menstruation history, and family history.

Physical examination at the time of admission revealed that blood pressure was 142/89 mmHg, and there were no positive signs in the heart, lung, and abdomen examinations. Physical examination of nervous system showed that the right nasolabial sulcus was slightly shallow, and there were no positive signs.

Auxiliary examinations: Routine blood test at the time of admission: leucocytes increased to 14.51 G/L; biochemical examination: the levels of lactate dehydrogenase (LDH), hydroxybutyrate dehydrogenase (HBDH), globulin, and alkaline phosphatase increased to 342 U/L, 229 U/L, 40.3 g/L, and 112 U/L; no obvious abnormalities in renal function, electrolyte, and troponin were observed; disseminated intravascular coagulopathy (DIC) screening: the concentrations of D-dimer and fibrinogen were 2.83 mg/L and 4.61 g/L, respectively. The cerebrospinal fluid (CSF) pressure was normal, and there were no abnormalities in routine, biochemical, and smear examinations of CSF. Electroencephalography (EEG) showed slight abnormality, decreased distribution of α-frequency domain, and slightly higher distribution of β-frequency domain. Transcranial Doppler (TCD) disclosed bilateral stenosis of middle cerebral artery and anterior cerebral artery. There was also no cranio-cerebral abnormality in computed tomography (CT) scan images. Magnetic resonance imaging (MRI) of the brain a relatively strong signal on fluid-attenuated inversion recovery (FLAIR) in bilateral parietal, posterior margin of occipital lobe, and lateral ventricle, as well as a relatively poor signal on T1-weighted image (T1WI) and strong signal on T2-weighted image (T2WI). Reversible white matter lesions were considered as well. There was no obvious cranio-cerebral abnormality in CT venography (CTV) images. Hence, it was suggested that MRA or digital subtraction angiography (DSA) was further performed, however, the patient and her family declined this suggestion.

After admission, the patient was given sedation (intravenous injection of diazepam (10 mg)), dehydration (intravenous drip of mannitol (125 ml) or glycerin fructose (250 ml), q8 h), anti-coagulation (intramuscular injection of low molecular weight heparin (0.4 ml), q2 h), and nimodipine (50 mg). Within 8 h after admission, the patient had recurrent attack of tonic-clonic seizures for three times, each time lasted for about 1 minute, and intravenous injection of diazepam (10 mg) was given at the time of seizure, in which a severe headache occurred once again. After 12 hours, the patient became conscious. After awakening, the patient cannot recall the events before and after the convulsion, while the other memories were not abnormal, there was no obvious headache, and the patient's vision did not have double shadows. In addition, 1 week after admission, there were no abnormalities in routine blood test, liver and kidney function, electrolyte, myocardial enzymes, and coagulation. Routine blood test showed that total leukocyte count was 10.31 (G/L). Thereafter, no severe headache or convulsions occurred, and TCD was normal 3 months after discharge. Besides, the patient was followed-up until 6 months ago by telephone, and no recurrence of symptoms and sequelae were observed.

Clinical characteristics of 12 PPRCVS patients are listed in Table 1.

From Table 1, it can be seen that the age of 12 patients ranged from 21 to 41 years, with a median of 26.5 years. The onset of the symptoms was within 9 d postpartum, with a median of 3.5 d. Besides, 5 patients had headache during pregnancy; of the 12 patients, 11 patients underwent cesarean section, and the case reported in this study was found with spontaneous delivery; only 1 patient had no headache symptoms, as confirmed by DSA. The headache characteristics descripted by the patients was thunder strike-like, lightning strike-like, explosion-like, and pulsatile. The majority of the headaches were observed in the whole skull (4 cases), as well as in the bitemporal (2 cases), the top of the head (1 case), and the left frontal top (1 case). All the patients had concomitant symptoms, including epileptic seizures (9 cases), blurred vision (5 cases), limb fatigue (6 cases), limb numbness (4 cases), speech disorder (2 cases), and fever (1 case). The majority of the patients (7 cases) had elevated blood pressure. Of the 12 patients, 3 patients were unaware about drug consumption in the near future, and 6 of the remaining 9 patients used pressor agents, hemostatic drugs, analgesic agents, hormone, Chinese patent medicine (Shuanghuanglian), magnesium sulfate, and penicillin before onset. Only 1 of the 12 patients had a clear history of migraine. The family history of these patients was unknown, and 2 cases had no specific family history.

Abnormal laboratory examination results were found in more than 90% of patients (11 cases). These abnormalities included elevated leukocytes (5 cases), positive urinary protein (4 cases), increased erythrocyte sedimentation rate (4 cases), elevated D-dimer (4 cases), elevated CSF protein (2 cases), electrolyte

Table 1

Clinical characteristic of 12 PPRCVS patients.

	Published year	Age	Onset time	Cause of the disease	Fertility way	Headache	Headache site	Headache characteristics	Other symptoms	Elevated blood pressure	Medication before onset	Past history	Family history	Whether combined with intracranial hemorrhage	Vascular imaging	TCD	Laboratory examination	Treatment regimen	Whether or not there is sequelae
1	2009	21	Three, nine, ten months of pregnancy, 5 days postpartum	None	Cesarean section	Yes	Bitemporal	Lightning strike-like	Clumsy language, blurred vision, left limb numbness, epileptic seizures, breathing laborious	No	Not described	unspecified	unspecified	No	DSA		abnormal	Methylprednisolone and nimodipine	Remnants of memory and disturbance of calculation
2	2012	21	33 weeks of pregnancy, 9 days postpartum	None	Cesarean section	Yes	Left frontal top	pulsatile	Numbness and fatigue of the right upper limb	Yes	Shuanghuanglian, Penicillin and Magnesium Sulfate	Nromal	No special	Yes	MRA	decreased blood flow velocity	abnormal	Mannitol and Nimodipine	No
3	2016	35	3 days postpartum	Unknown	Cesarean section	Yes	Not described	unspecified	Blurred vision and convulsion	Yes	pressor agents	History of migraine	unspecified	No	MRA		abnormal	unspecified	Yes
4	2016	28	1 day postpartum	Unknown	Cesarean section	Yes	Not described	unspecified	Blurred vision and convulsion	No	pain-killer tablet	unspecified	unspecified	No	MRA		abnormal	unspecified	No
5	2016	23	9 days postpartum	Unknown	Cesarean section	Yes	Not described	unspecified	Limb fatigue and convulsion	No	No	unspecified	unspecified	No	MRA		abnormal	unspecified	No
6	2016	26	Late pregnancy, 5 days postpartum	None	Cesarean section	Yes	top of the head, bitemporal	Pulsatile	Left limb weakness, right limb numbness and weakness	Yes	Magnesium sulfate	unspecified	unspecified	No	CTA	increased blood flow velocity	abnormal	Antiplatelet and nimodipine	No
7	2018	28	Late pregnancy, 1 day postpartum	Unknown	Cesarean section	Yes	Not described	Not described	Blurred vision, aphasia, convulsion	Yes	Progesterone and Naphazoline	unspecified	unspecified	No	MRA		abnormal	Anticoagulation, dehydration, nimodipine, anti-infection	No
8	2012	41	6 days postpartum	Unknown	Cesarean section	Yes	Whole skull	Explosion-like	convulsion and right limb fatigue	Yes	No	Normal	unspecified	No	DSA	increased blood flow velocity	abnormal	Nimodipine, dehydration	No
9	2016	26	5 days postpartum	Fever	Cesarean section	Yes	Whole skull	Lightning strike	Fever, twitching	Yes	No	Normal	unspecified	No	MRA		abnormal	Nicardipine, magnesium sulfate, antihypertensive drug, antiepileptic drugs	No
10	2013	27	6, 8 months of pregnancy, 2 days postpartum	Unknown	Cesarean section	Yes	Not described	Severe	Right limb numbness and blurred vision	Yes	Not described	unspecified	unspecified	No	MRA		Not provided	unspecified	Right upper limb dysfunction
11	2015	26	1 day postpartum	Unknown	Cesarean section	Yes	Whole skull	Explosion-like	Limb weakness, convulsion	No	Not described	unspecified	unspecified	No	CTA		abnormal	Nimodipine	No
12	Case in this study	27	4 days postpartum	Bend down to pick up heavy objects	natural labour	Yes	Whole skull	lightning strike-like	convulsion	No	hemostatic drugs	Normal	No special	No	No	increased blood flow velocity	abnormal	Nimodipine, anticoagulant, mannitol	No

disturbance (low sodium level, 1 case), and elevated anti-rheumatoid factor (1 case). Additionally, 91.67% of the patients (11 cases) suffered from posterior reversible encephalopathy syndrome (PRES, 7 cases), cerebral infarction (3 cases), and subarachnoid hemorrhage (1 case).

The majority of the patients (7 cases) were treated with nimodipine, and the other treatment strategies included dehydration drugs (mannitol), hormones (methylprednisolone), antihypertensive drugs, magnesium sulfate, anti-platelet-aggregation drugs, etc.

Of the 12 patients, there were no deaths, 2 patients had sequelae (poor memory and limb dysfunction), while the remaining 10 patients had no sequelae.

5. Discussion

It is noteworthy that RCVS is considered a rare phenomenon that was first reported by Call and Fleming in 1988,[11] and PPRCVS, as reported previously, is an important type of RCVS, possessing unique clinical characteristics.

5.1. Cause of disease

The cause of RCVS is still unknown, it may be primary and mainly secondary related to the use of vasoactive substances and postpartum. In order to prevent massive hemorrhage, the pregnant and lying-in women often accept ergot derivatives or selective serotonin reuptake inhibitors, therefore the proportion of RCVS caused by vasoactive drugs is higher than postpartum medication. Skeik et al[12] analyzed the clinical characteristics of 98 PPRCVS patients, of whom, 32 patients (32.65%) used at least once a kind of vasoactive drugs. Moreover, it was reported that up to 50% to 70% of patients used vasoconstrictors.[13] Among the data collected in the present study, 50% of the patients (6 cases) used suspicious drugs, while only 3 cases definitely used vasoactive drugs, and their proportions were less than those in foreign countries. Regarding the fewer cases collected and the less detailed information of cases in China, it is noteworthy that 1 of the cases in this study used Shuanghuanglian. Whether this drug or other Chinese patent medicines have an impact on PPRCVS is still unknown, and therefore further clinical data collection and statistical analyses need to be carried out.

5.2. Epidemiology

According to previous findings, RCVS is more frequent in middle-aged women than men. The mean age of patients in four large-scale clinical case studies on RCVS was 42 to 47.7 years,[14–17] however, there were also reports with contribution of 10-year-old[17] and 70-year-old[14] RCVS patients. According to a previous study, the age of PPRCVS patients ranged from 15 to 43 years, with a median of 32 years, which was lower than that RCVS patients. It was probably because the fertility rate of women aged 20 to 34 years was higher than those who were over 40 years.[12] In the present study, the age of patient ranged from 21 to 41 years, with a median of 26.5 years. Compared with data reported in other countries, the median age of our case is smaller, that might be related to the early childbearing age of Chinese women.

5.3. Clinical manifestations

Among the reported cases in other countries, 71% of the patients developed PPRCVS within 7 days postpartum, and only 6 cases developed PPRCVS 2 weeks later. Skeik et al[12] studied 98 PPRCVS patients, and PPRCVS cases observed within 0 to 30 days postpartum, with a median occurrence of 5 days. Previous researchers showed that onset of postpartum occurred within 0 to 9 days, with a median occurrence of 3.5 days. Compared with the results achieved in other countries, the findings obtained in China showed that onset of prenatal occurred in some patients, and the onset in the early-, middle-, and late-pregnancy have also been reported, however, the pregnant cases were found by inquiring on the medical history.

Common causes of RCVS included physical labor, coughing, sneezing, laughing, defecation (stool and urine), sexual intercourse, bathing, swimming, sudden bending, and stress and emotional fluctuations, however, that is of great importance to consider that these causes may lead to increased abdominal pressure.[18] The main clinical manifestation is headache, that is a sudden thunderclap headache with severe degree. In addition to headache, some patients might have focal neurological deficits, such as blurred vision, dysarthria, aphasia, limb paralysis, limb numbness, ataxia, and epileptic seizures. These symptoms reflected intracranial complications, including transient ischemic attack, hemorrhagic stroke, cerebral infarction, and PRES. The clinical manifestations of PPRCVS are similar to RCVS, however, the incidence of concomitant symptoms is higher. It has been reported that 76.5% of the patients with PPRCVS had concomitant symptoms of neurological deficits or epileptic seizure.[12] The majority of the 12 cases enrolled in this study did not provide any cause of disease, indicating that Chinese doctors might have insufficient understanding of the disease. Furthermore, it was revealed that the 12 patients had no obvious headache symptoms, mainly TIA, the remaining patients had headache, and the description of headache's characteristics was similar to that of patients reported in other countries, while there was lack of the description of the duration of headache. Therefore, no statistical analysis was carried out in the present study. A more detailed inquiring about the history of the disease might be required to be conducted in this study. All the cases had concomitant symptoms, including epileptic seizures (9 cases), blurred vision (5 cases), limb weakness (6 cases), limb numbness (4 cases), speech disorder (2 cases), fever and (2 cases). Skeik et al[12] studied 98 cases of PPRCVS, of whom, 75 (76%) patients had concomitant symptoms. The proportion of concomitant symptoms in China is higher, that might be related to a limited number of Chinese cases reported and lack of attention or misdiagnosis of non-serious cases.

5.4. Auxiliary examinations

5.4.1. Laboratory examinations. Laboratory examinations of RCVS patients showed normal results. The CSF examination of RCVS patients showed almost normal or near normal outcomes, and half of the patients had mild cerebrospinal fluid abnormalities. It was recommended that the CSF was reexamined after several weeks to ensure that the CSF returned to normal level.[18] Compared with non-puerperal RCVS, PPRCVS patients seemed to have a higher proportion of abnormal laboratory test results. A study showed that 34 out of 98 PPRCVS patients had abnormal laboratory test results, including elevated C-reactive protein (CRP), mild non-specific CSF abnormality, proteinuria, positive antinuclear antibodies, and elevated international normalized ratio (INR).[12] In this study, 91.67% of the patients had abnormal laboratory test results, which were higher than those of

other countries, considering that the patients reported in China were all in severe status.

5.4.2. TCD. TCD is widely used in clinical practice because of its non-invasive, being convenient, and economic advantages. Chen et al. used TCD to continuously and dynamically monitor RCVS patients, and they found that the blood flow velocity of intracranial vessels was normal at the beginning of the disease, and then that reached the peak around 3 weeks after onset; 81% of the patients had the highest mean velocity of middle cerebral artery blood flow exceeding 80 cm/s, and 47% of them had the highest velocity exceeding 120 cm/s, while being less than 200 cm/s.[19] There was no significant difference in TCD changes of RCVS between puerperium and non-puerperium. In this study, the results of TCD in PPRCVS patients were abnormal, including 1 case of slow cerebral blood flow and 3 cases of fast cerebral blood flow.

5.4.3. Medical imaging. To our knowledge, CT or MRI of RVCS patients can be normal. When subarachnoid hemorrhage, cerebral parenchymal hemorrhage, and cerebral infarction occur, there will be corresponding manifestations on CT or MRI. PPRCVS has more concomitant symptoms, thus its positive rate of imaging examination is higher. Some patients may have PRES, which is characterized by high signal intensity on FLAIR in temporal and occipital lobes.[14] The sensitivity of cranial CTA/MRA in the diagnosis of RCVS was about 80%.[18] DSA is still the gold standard for the diagnosis of RCVS. Typical cases are manifested as multifocal and segmental stenosis of intracranial artery with "string-of-beads" changes. Vascular changes often occur after 1 to 2 weeks of headache attack, which must be fully or almost fully restored within 3 months to support the diagnosis of RCVS.[20] Previously, we found that 91.67% of the Chinese PRCVS patients showed changes in brain parenchyma, which was higher than that in other countries. It might be related to insufficient attention paid by doctors to patients with simple headache, insufficient understanding of the disease, or lack of consultation for mild patients. PRES is the most common imaging change in patients. In fact, pathophysiological changes and pathogenesis of RCVS and PRES have significantly attracted scholars' attention. Although DSA is the gold standard in the imaging examination of blood vessels, however, this study found that only 2 of the 12 patients underwent DSA that might be related to the low acceptance rate of invasive operation by Chinese patients.

5.5. Diagnosis and differential diagnosis

The diagnostic criteria for RCVS were proposed by Calabrese et al in 2007.[13] The specific criteria are as follows:

1. acute severe headache (mostly thunderclap headache) with or without focal neurological deficits or epileptic seizures;
2. monophasic course without new symptoms after 1 month;
3. segmental cerebral artery contractions confirmed by medical imaging (MRA, CTA or DSA);
4. exclusion of SAH caused by aneurysm rupture;
5. normal or mild cerebrospinal fluid abnormality (leukocytes $< 15/mm^3$, protein $<$ l g/L, normal glucose);
6. 12 weeks later, medical imaging showed that the cerebral artery was fully or almost fully normal.

After 12 weeks of onset, the cerebrovascular imaging was reexamined, and RVCS could be definitely diagnosed only if the lesion vessels returned to normal level. The diagnostic criteria of PPRCVS were the same as RCVS as well.

RVCS needs to be differentiated from the following diseases:

1. Subarachnoid hemorrhage (SAH): thunderclap headache can also be manifested. Craniocerebral CTA can identify whether SAH is caused by aneurysms, and angiography is still the gold standard for identification.
2. The clinical manifestation of intracranial venous thrombosis is similar to that of RVCS, while the intracranial pressure of patients with intracranial venous thrombosis is remarkably higher than that of RVCS patients. In addition, MRV, CTV, and cerebral angiography suggested that cerebral venous sinus thrombosis can be differentiated.
3. Primary angiitis of the central nervous system (PACNS) and RCVS are often difficultly distinguished. Differentiation can be assisted by the mode of onset, headache characteristics, craniocerebral MRI manifestations, and CSF examination. Angiography is still the gold standard for differentiation.
4. Other methods, such as carotid or intracranial dissection, giant cell arteritis, and pituitary apoplexy can also be presented as isolated thunderclap headache. Some cranial CT and CSF examinations may be showed normal outcomes. At this time, cranial MRI and compatible dual-echo arteriovenography are essential. The possibility of CSF leak should be taken into account in PRCVS patients undergoing spinal anesthesia, especially when the headache is obvious in the sitting position.

5.6. Treatments

Although there is lack of large-sample randomized controlled study, based on the pathogenesis of RCVS and PPRCVS, calcium channel blockers are recommended based on current experiences. Nimodipine is the preferred choice, while verapamil and nicardipine are the next choices. Symptomatic treatment included headache relief, blood pressure control and treatment of stroke, epileptic seizure, and cerebral edema.[21] In other general treatments, patients can be advised to rest and avoid possible headache-inducing factors. Although the majority of RCVS patients are self-limited, however, they need to be closely monitored to prevent the progression of the disease. Antiplatelet aggregation drugs and hormones are not recommended for RCVS and PPRCVS patients without complications.[13] Calcium channel blockers are often covered in the treatment regimens in China, mainly nimodipine, however, there are also cases of hormone use. Due to lack of evidence, and application of hormones can increase the difficulty of identification of RCVS/PPRCVS and PACNS, it should be highly avoided.

5.7. Prognosis

The majority of RCVS patients is self-limited and has a good prognosis. Patients with cerebral infarction or intracranial hemorrhage are more susceptible to have sequelae, and death is rare. However, 11 out of 98 PPRCVS cases reported by Skeik et al[12] died, with a higher mortality rate than that of non-puerperal RCVS patients.[13] There was no death among the 12 patients in this study; the majority of the patients had good prognosis, while 2 cases had sequelae. However, the available data are relatively limited, which might not accurately reflect the true situation.

RCVS is a syndrome with severe headache because of its main clinical manifestation. It is reversible and easy to be neglected in

clinical practice. Compared with non-puerperal RCVS, PPRCVS is more likely to have concomitant symptoms and sequelae, in which the mortality rate is higher. Therefore, clinicians should highly pay attention to PPRCVS. For severe headache, with or without neurological deficit symptoms and epileptic seizures within 1 week postpartum, especially with the history of taking vasoactive drugs, attention should be paid to exclude PPRCVS. After summarizing and analyzing the 15 cases of PPRCVS reported in China, the present study found that the clinical characteristics of Chinese patients with PPRCVS were basically as same as those in other countries, while the onset age was earlier, PPRCVS often occurred earlier after delivery, the proportions of abnormal concomitant symptoms, laboratory examinations, and imaging examinations were higher, and fewer patients were diagnosed with DSA. These differences might be due to insufficient understanding of the disease by Chinese clinicians, thus the understanding of the disease should be enhanced. In addition, invasive or large-scale examinations might be less used in China. Although TCD was abnormal in the majority of PPRCVS patients, however, TCD might be more helpful for the diagnosis of suspected patients having PPRCVS. As there are fewer cases of PPRCVS reported in China compared with other countries, our data have some limitations, therefore it is necessary to perform further studies and analyze the data in the further.

Author contributions

Conceptualization: Lin Liu.
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