Original article

Persistent headache during the cerebral vasospasm period following radical treatment of ruptured cerebral aneurysm

Izumi SAITO[1)], Natsue NOZAKI[2)], Maki ZENKE[3)], Yasuko YOKOI[4)], Takako MINAGAWA[4)], Ayako TAMURA[4)]

1) former Aichi nursing association

2) Tokushima university hospital

3) Aichi medical university hospital

4) Tokushima university of graduate school

Journal of Japanese Academy of Neuroscience Nursing 5 (1)

31 December 2018

Original article

Persistent headache during the cerebral vasospasm period following radical treatment of ruptured cerebral aneurysm

Izumi SAITO[1)], Natsue NOZAKI[2)], Maki ZENKE[3)], Yasuko YOKOI[4)], Takako MINAGAWA[4)], Ayako TAMURA[4)]

1) former Aichi nursing association

2) Tokushima university hospital

3) Aichi medical university hospital

4) Tokushima university of graduate school

Abstract

Objective: We aimed to determine the state of a persistent headache that lasted during the cerebral vasospasm period (4–14 days after the rupture) following radical treatment of a ruptured cerebral aneurysm. We also aimed to demonstrate the factors associated with this headache that persisted following radical treatment of a cerebral aneurysm to support nursing aid.

Research methods: We enrolled 134 patients who underwent radical treatment for a cerebral aneurysm within 72 hours of the onset of the ruptured cerebral aneurysm at two institutions equipped with stroke care unit (SCU) treatment facilities and similar numbers of beds. Observations were made using both medical records and nursing records from the cerebral vasospasm period. The basic attributes that we studied included age, sex, cerebral aneurysm sites, and the World Federation of Neurosurgical Societies (WFNS) grading for the severity of cerebral aneurysm. Data associated with headache included the presence or absence of headache, site, severity, duration, use of analgesics during a headache, administration method of analgesics, and degrees of fluctuation in the systolic blood pressure before and after analgesic administration. The headache severity was defined by the highest severity reported during the cerebral vasospasm period, using the numerical rating scale (NRS). For analysis, the Mann-Whitney U test was used for quantitative data, and the Fisher's exact test was used for qualitative data. We used the statistical analysis software, IBM SPSS Ver.25, for analysis; the level of significance was set at <5%.

Results: A total of 134 subjects, with a median age of 64 years were enrolled; 66.4% of the subjects were women. As per the WFNS grading of ruptured cerebral aneurysms, most subjects (31.3%) were classified with Grade I. The most common method of radical treatment was endovascular treatment (52.2%), followed by direct surgery (47.8%). A total of 98 subjects (73.1%) complained of a headache in the cephalic region. The mean NRS score for the headache severity was 7 (median NRS score), and the headache duration was 4 days (median day). The most common method of analgesics administration was temporary (75 subjects: 76.5%). The difference in the systolic blood pressures before and after administration was within 20mmHg. The study subjects (n = 112) were divided into two groups by the presence or absence of headaches. The factors associated with headache were compared. There were 60 subjects in the presence of headache group who treatment of endovascular, which was considered to be significantly high (p = 0.008). The study subjects (n = 98) were divided into two groups as per their headaches of 1–7 NRS score or 8–10 NRS score. The factors associated with headache were compared.

Received 14 November 2018
Accepted 20 December 2018

The duration of severe headache (NRS 8–10) group was significantly longer (p = 0.000); 9 days, and the number of administration of analgesic was also significantly greater (p = 0.000); 11 times.

Conclusions: During the cerebral vasospasm period following the rupture of cerebral aneurysm, a total of 98 subjects (73%) complained of a headache, patients experienced continuous headache for a median of four days in the cephalic instead of in the nuchal region. The headache was so severe that the administration of analgesics was necessary for pain relief. This research showed a significantly higher percentage of patients who complained of pain after endovascular treatment than those who complained of headache associated with craniotomy; the duration of severe headache of NRS 8–10 score patients was significantly longer. The number of administration of analgesic was also significantly higher in their headaches of 8–10 NRS score. It was indicated that nursing aid for these factors is necessary for providing good support during the cerebral vasospasm period.

Keyword: persistent headache, cerebral vasospasm period, radical treatment of ruptured cerebral aneurysm

Introduction

Subarachnoid hemorrhage (SAH) refers to bleeding into the intracranial subarachnoid space, and 70%–80% of such cases are caused by the rupture of a cerebral aneurysm (Fujinaka and Yoshimine, 2017). The average age at onset is 65 years, younger than that for intracerebral hemorrhage or cerebral infarction (Kobayashi, 2015). However, approximately 40% of the patients have a poor outcome and require long-term care (Nieuwkamp, Setz, Algra, Linn, Rooij, and Rinkel, 2009); therefore, treatment and management in daily life are important issues for improving the patients' activities of daily living (ADL) and quality of life (QOL). SAH caused by the rupture of a cerebral aneurysm is accompanied with severe headache (Ohta, 2016). Sedatives (Diazepam) and non-narcotic analgesics (Pentazocine) are generally used in Japan for treating this severe headache immediately after the onset (Fukui, Takagi, and Komuro, 2018). Nursing documents in Western countries recommend the active use of non-steroid anti-inflammatory analgesics (Acetaminophen)(Hickey, 2014).

In contrast, in the subacute phase that follows the radical treatment within 72 hours of a ruptured cerebral aneurysm, the efficacy of ventricular drainage (Kodama, Sasaki, Kawakami, Sato, and Asari, 2000) and prophylactics for cerebral vasospasm (Dorhout Mees, Rinkel, Feigin, Algra, van den Bergh, Vermeulen, et al., 2007) has reportedly prevented delayed cerebral vasospasm with a high level of evidence. However, some patients complain of constant headache following radical treatment, with some reporting headaches of severe intensity. To our knowledge, no study has reported on the treatments and symptoms of this continuous and severe headache that occurs during the cerebral vasospasm period. From a nursing viewpoint, few papers have discussed the challenges involved in responding to severe headaches that interfere with ADL and compromise the QOL. One study reports a case wherein continuous headache interfered with appetite (Sugie, 2017); in this case, frequent use of analgesics was necessary due to headaches that differed from nuchal rigidity (Sasae, 2018). Alleviating such a headache that persists after a radical treatment of cerebral aneurysm will improve patients' ADL and QOL. From the nursing perspective, it is necessary to determine the cause and means of improvement for this type of headache.

Thus, this research aims to elucidate the pathology of the headache that lasts during the cerebral vasospasm period after a radical treatment of SAH caused by cerebral aneurysm rupture. Additionally, factors associated with headaches that last after radical treatment of a cerebral aneurysm, which were not previously identified, are elucidated upon to provide nursing aid support. The cerebral vasospasm period following SAH was defined as 4 to 14 days after onset (Ohta, 2016).

Research methods

Research design

Multi-facility retrospective observational study.

Research subjects

Subjects were patients who had undergone radical treatment for a cerebral aneurysm within 72 hours of the onset of SAH (direct surgery: craniotomy and clipping or wrapping or endovascular treatment: coil embolization or endovascular surgery) and were in the cerebral vasospasm period. Two institutions, which were equipped with a stroke care unit (SCU) treatment facilities and had a similar number of beds, were chosen because of the difficulty in obtaining statistically necessary number of the subjects at one institution. Patients who were ≤40 years at the time of onset and those undergoing conservative treatment were excluded.

Research period

The Research period was from April 2013 to March 2018 for both institutions.

Survey items and analytical methods

Survey items included the basic attributes and data associated with headaches, analgesics, and blood pressure that were obtained from the medical and nursing records. The basic attributes were age, sex, sites of cerebral aneurysm onset, and WFNS grading. Data associated with headache included the presence or absence of headache during the cerebral vasospasm period, sites and severity of the headache, duration, use of analgesics for the headache, administration methods for analgesics, and degree of fluctuations in the blood pressure before and after the administration of analgesics. The classification of the sites of cerebral aneurysm was based on the classification provided by the Stroke Data Bank 2015. The severity of cerebral aneurysm was classified on the basis of the diagnosis established at the time of admission, using the WFNS grading. Cases of cerebral aneurysms were divided into two groups on the basis of the radical treatment used: direct surgery and endovascular treatment. For the radical treatment, patients who underwent radical treatment within 72 hours of admission were enrolled (Japanese Guidelines for the Management of Stroke 2015, 2017). The presence of intracranial pressure control method was assumed for the ventricle, cisternal or spinal cord drainage treatment group. Headache complaints were classified according to the presence or absence of headache, while the chief headache complaints were as classified by Ito (1977). The severity of headache was determined as per the most severe complaint reported during 4–14 days after the radical treatment. Severity was classified per an 11-point (0–10) numeric rating scale (NRS) recommended by the Japan Society of Pain Clinicians, where an NRS score of 10 indicates the worst pain imaginable. Analgesics were classified per the selection criteria for chronic pain other than cancer (Urabe, Shimada, and Kawai, 2018). The change in blood pressure after the administration of analgesics was obtained using the following: the systolic blood pressure (mmHg) before administration–the systolic blood pressure (mmHg) after administration.

For the analysis, simple statistics and mean calculations were performed for basic attributes, radical treatment, presence or absence and severity of headache, duration of headache, administration method of analgesics, and change in the blood pressure. On the basis of the age distribution, subjects were divided into two groups: those aged 65–89 years and those aged 40–64 years. WFNS grading (two groups: Grade I with clear consciousness and no neurological symptoms, and Grades II–V with some symptoms), radical treatments, presence or absence of headache complaints, severity (two groups: NRS 1–7 and NRS 8–10), duration of headache, the number of times analgesics administered, and change in the blood pressure after the administration of analgesics were statistically analyzed using a nonparametric test (Mann-Whitney U test) for quantitative data and Fisher's exact test for qualitative data. Statistical analysis software, IBM SPSS Ver. 25, was used with a significance level of 5%.

Ethical considerations

This study was performed after obtaining approval from the Ethical Review Board of Tokushima University Hospital

(approval number: 3089-1). Since this research was carried out at multiple institutions, the data handled in this study was notified to the president of the hospital based on the ethics regulations of each institution. In addition, records of data transfer were strictly kept.

The consent from individuals was omitted by presenting information disclosure documents on a website in accordance with the ethics review committee regulations.

We decided to exclude the patient data from analysis for those unwilling to participate in this study, if any. By strictly keeping the records of the data transfer, we made a thorough ethical consideration for the subjects.

Results

1. Summary of subjects (Table 1)

The age of subjects ranged from 45–87 years; the median age was 64 years. Of the 134 subjects, 89 were women (66.4%); a similar trend was observed in the Stroke Data Bank (Kobayashi, 2015) data. Sites for the onset of cerebral aneurysm were A com for 39 subjects (29.1%), followed by IC-PC for 31 subjects (23.1%), and MCA for 25 subjects (18.7%). WFNS grading was Grade I for 42 subjects (31.3%), Grade II for 26 subjects (19.4%), Grade IV for 10 subjects (7.5%), Grade III for eight subjects (6.0%), and Grade V for eight subjects (6.0%). The type of radical treatment was similar in both groups, with endovascular treatment in 70 subjects (52.2%) and direct surgery in 64 subjects (47.8%). The groups with and without the intracranial pressure control were 31 subjects (23.1%) and 103 subjects (76.9%), respectively. Ninety-eight subjects (73.1%) complained of headache, and 14 subjects did not experience headache (10.4%).

Table 1. Characteristics of the participants

	Total n = 134 number (%)
Age (years)	
40–49	22 (16.4%)
50–59	31 (23.1%)
60–79	33 (24.6%)
70–79	28 (20.9%)
80–89	20 (14.9%)
Median [Quartile]	64 [55,74]
Sex	
Male	45 (33.6%)
Female	89 (66.4%)
Location of cerebral aneurysm	
A com	39 (29.1%)
IC-PC	31 (23.1%)
MCA	25 (18.7%)
IC	8 (6.0%)
BA	6 (4.5%)
VA	4 (3.0%)
VA & PICA	4 (3.0%)
PICA	4 (3.0%)
A com & MCA	3 (2.2%)
ACA	3 (2.2%)
The others	7 (5.2%)
WFNS (world federation of neurological surgeons) Grading scale	
Grade I	42 (31.3%)
Grade II	26 (19.4%)
Grade III	8 (6.0%)
Grade IV	10 (7.5%)
Grade V	8 (6.0%)
Unlabeled	40 (29.9%)
Radical treatment	
Direct surgery	64 (47.8%)
Endovascular treatment	70 (52.2%)
Intracranial pressure control treatment	
Presence(ventricular, cisternal, spinal drainage)	31 (23.1%)
Absence	103 (76.9%)
Headaches	
Presence	98 (73.1%)
Absence	14 (10.4%)
Unlabeled	22 (16.4%)

2. Presence or absence, sites, severity, and duration of headache (Table 2)

All 98 subjects who complained of headache reported the cephalic region as the main site of the headache. The NRS score 4 to 14 days after the radical treatment was 7 (median), indicating a relatively intense severity of headache. A total of 19 subjects (19.4%) complained of the worst pain imaginable (NRS 10). The median duration of headache was 4 days. In 12 subjects (12.2%), the headache lasted from 7–9 days, with 22 subjects (22.4%) experiencing headache for 10–11 days, and 34 subjects (34.6%) experiencing headache for one week or more.

3. Administration methods for analgesics and the number of administrations (Tables 3, 4, and 5)

Administration methods for analgesics were temporary in 75 subjects (76.5%), followed by periodic and temporary administration at the time of headache in 18 subjects (18.4%), and routine administration in four subjects (4.1%). The average number of analgesics administered per patient was 82 times via an oral or via nasogastric tube and 49 times via an intravenous drip. There were few cases of

Table 2. Sites, severity, and duration of headache

	Total n = 98 number (%)
Main headache sites between 4–14 days after onset	
Cephalic region	98 (100%)
nuchal region	0 (0.0%)
Eye region	0 (0.0%)
Face region	0 (0.0%)
Degree of headaches NRS (numeric rating scale)	
Maximum headaches for 4–14days	
NRS 1	0 (0.0%)
NRS 2	1 (1.0%)
NRS 3	2 (2.0%)
NRS 4	1 (1.0%)
NRS 5	11 (11.1%)
NRS 6	20 (20.4%)
NRS 7	19 (19.4%)
NRS 8	12 (12.2%)
NRS 9	2 (2.0%)
NRS 10	19 (19.4%)
Unlabeled	11 (11.2%)
NRS Median [Quartile]	7 [6.0, 8.8]
Duration of the headache between 4-14 days after onset (day)	
1–3	42 (42.9%)
4–6	21 (21.4%)
7–9	12 (12.2%)
10–11	22 (22.4%)
Unlabeled	1 (1.0%)
Duration of the headache(day), Median [Quartile]	4 [2, 9]

Table 3. The administration methods of analgesics.

	Total n = 98 number (%)
Administration methods for analgesics	
Routine administration	4 (4.1%)
Routine administration + Temporary administration when pain occurs	18 (18.4%)
Temporary administration	75 (76.5%)
Unlabeled date	1 (1.0%)
The average number of analgesics administered per patient	Total n = 155
Via an intravenous one shot	7
Via an intravenous drip	49
Via a suppository	17
via an oral or via nasogastric tube	82

Table 4. General name (product names®) of the administered analgesics and the total number of administrations

Generic name using the medium category [product name®]	Total n = 781 number (%)
Non-narcotic opioid [Pentazine® Sosegon® Tramar® Tram set combinedtablet®]	42 (5.4%)
Acetaminophen [Caronar® Antiniferous Suppository® Aserio®]	366 (46.9%)
NSAIDs propionic acid type [Ropion® Loxonin® Loxoprofen®]	320 (41.0%)
Non-steroid anti-inflammatory agents [Celecox®]	14 (1.8%)
NSAIDs arylacetic acid type [Diclofenac sodium Suppository® Voltalene Suppository®]	34 (4.4%)
Analgesic supplement [Neutropin®]	5 (0.6%)

Table 5. Difference in the systolic blood pressure before and after the administration of analgesics

	number	Difference in systolic blood pressure, (mmHg) Median [Quartile]
Acetaminophen	366	-3.0 [-11.8,5.0]
NSAIDs propionic acid series	320	-3.0 [-1.0,5.0]

suppository or intravenous injection.

The most frequently administered analgesic was acetaminophen (366 times, 46.9%), followed by NSAIDs propionic acid (320 times, 41.0%). The use of non-narcotic opioids, NSAIDs arylacetates, non-steroid anti-inflammatory agents, and adjuvant analgesics was limited. The difference in the mean systolic blood pressure before and after the administration was -3.0(median) mmHg with acetaminophen and -3.0 (median) mmHg with NSAIDs propionic acid, indicating a fluctuation of 20 mmHg.

4. Comparison of the factors associated with the presence or absence of headache (Table 6, 7)

Subjects (112) were divided into two groups (presence and absence) for a comparison of the factors associated with headache. A significant difference was confirmed in the radical treatment.

There were 60 subjects (95.2%) in the presence of headache group who treatment of endovascular, which was considered to be significantly high (p = 0.008).

Furthermore, the patients who have headache (98) were divided into two groups (NRS 1–7, NRS 8–10) for a comparison of the factors associated. Those with significant difference were the duration of headache and the number of analgesic doses. The severe headache duration of the NRS 8–10 group was significantly greater; 9 days (p=0.000), and the number of doses was significantly higher 11 times (p=0.000). There was no significant difference in any of the other parameters.

5. Comparison of the factors associated with headache based on the type of radical treatment (Table 8)

Subjects were divided on the basis of the type of radical treatment for ruptured cerebral aneurysms—direct surgery and endovascular treatment—to compare the factors associated with headache. A significant difference was confirmed only with respect to the presence or absence of

Table 6. Comparison of the factors associated with headache according to presence or absence

	presence of headache number (%)	absence of headache number (%)	*p* value
Age ¶	(n = 112)		0.577
40–64	51 (89.5%)	6 (10.5%)	
65–89	47 (85.5%)	8 (14.5%)	
Sex ¶	(n = 112)		0.381
Male	64 (85.3%)	11 (14.7%)	
Female	34 (91.9%)	3 (8.1%)	
WFNS grading ¶	(n = 82)		0.052
Grade I	42 (100%)	0 (0.0%)	
Grade II-V	36 (90.0%)	4 (10.0%)	
Radical treatment ¶	(n = 112)		0.008
Direct surgery	38 (77.6%)	11 (22.4%)	
Endovascular treatment	60 (95.2%)	3 (4.8%)	
Intracranial pressure control treatment ¶	(n = 112)		0.205
Presence	19 (82.6%)	4 (17.4%)	
Absence	79 (88.8%)	10 (11.2%)	

We noted the number of analytical subjects since there were missing values in the responses.
¶: Fisher's exact test

Table 7. Comparison of the factors associated with headache according to degree of NRS

	NRS 1-7	NRS 8-10	*p* value
Administration methods for analgesics ¶	(n = 72)		0.372
Routine administration or routine administration+ Temporary administration	7 (38.9%)	11 (61.1%)	
Temporary administration	17 (31.5%)	37 (68.5%)	
Duration of the headache(day) #	(n = 56)	(n = 31)	0.000
Median [Quartile]	3 [1.3, 5]	9[4,11]	
Number of doses of analgesics(times) #	(n = 56)	(n = 31)	0.000
Median [Quartile]	3 [2, 5]	11[5, 21]	
Difference in the systolic blood pressure before and after administration (mmHg) #	(n = 56)	(n = 31)	0.580
Median [Quartile]	-2.7 [-10.2, 2.9]	-3.2 [-7.8, 0.4]	

We noted the number of analytical subjects since there were missing values in the responses.
¶: Fisher's exact test
#: Mann-Whitney U test

the complaint of headache. A significantly higher proportion of subjects who underwent endovascular treatment complained of headache (n = 60, 61.2%) as compared with those who underwent direct surgery (p=0.008). However, the duration of headache was shorter in patients undergoing endovascular treatment (a median duration of 4.0 days) than that in patients of direct surgery (a median duration of 4.5 days). There was no significant difference in any of the other items.

Discussion

The 134 selected study subjects had undergone a radical treatment. After the radical treatment, strict observation of neurological symptoms, blood pressure control and intracranial control were performed to prevent cerebral vasospasm in an SCU for two weeks. However, even during careful treatment in the SCU, 70% of the patients complained of a headache that persisted for a median duration of four days. The headache developed despite strict observation of neurological symptoms and blood pressure control. The headache severity was intense, as indicated by median NRS score of seven. All the 98 subjects who complained of headache were administered analgesics for pain relief. During the cerebral vasospasm period following the rupture of a cerebral aneurysm, despite strict observation of the neurological symptoms and blood pressure control, headaches could continue for a median of four days; furthermore, the pain is so intense that it cannot be alleviated without the administration of analgesics.

In Japan, there is no textbook dealing with headache management after ruptured cerebral aneurysm treatment. In the Stroke Treatment Guideline for 2015, headache before onset is described, but headache after radical treatment is

Table 8. Comparison of the factors associated with headache as per the type of radical treatment

	Direct surgery number (%)	Endovascular treatment number (%)	*P* value
Age ¶	(n = 112)		0.707
40–64	26 (45.6%)	31 (54.4%)	
65–89	23 (41.8%)	32 (58.2%)	
Sex ¶	(n = 112)		0.228
male	36 (48.0%)	39 (52.0%)	
Female	13 (35.1%)	24 (64.9%)	
Headaches ¶	(n = 112)		0.008
presence	38 (38.8%)	60 (61.2%)	
absence	11 (78.6%)	3 (21.4%)	
WFNS grading ¶	(n = 94)		0.783
Grade I	16 (37.2%)	27 (62.8%)	
Grade II-V	20 (39.2%)	31 (60.8%)	
Degree of headaches (NRS) ¶	(n = 87)		0.950
NRS 1–7	20 (37.0%)	34 (63.0%)	
NRS 8–10	12 (36.4%)	21 (63.6%)	
administration method of analgesics ¶	(n = 97)		0.850
Routine administration or routine administration + Temporary administration	9 (40.9%)	13 (59.1%)	
Temporary administration	29 (38.7%)	46 (61.3%)	
Duration of the headache (day)#	(n = 98)		0.142
Median [Quartile]	4.5 [2.0, 9.3]	4.0 [2.0, 7.8]	
Number of doses of analgesics (times)#	(n = 98)		0.401
Median [Quartile]	5.5 [2, 12.3]	4.0 [2, 9]	
Difference in systolic blood pressure before and after administration (mmHg)#	(n = 98)		0.120
Median [Quartile]	-4.25 [-12.18, -0.25]	-2.94 [-6.96, 2.73]	

We noted the number of analytical subjects since there were missing values in the responses.
¶: Fisher's exact test
#: Mann-Whitney U test

not notated at all. The result of this study was to clarify that headaches occurring at the spasm stage radical treatment after rupture cerebral aneurysms appeared at 70%. There were two overseas papers dealing with headaches management after ruptured cerebral aneurysms, none of which addressed the inpatient period during hospitalization (Morad, Tamargo, and Gottschalk, 2016; Binhas, Walleck, and Bitar, 2006), and then the subject was different from our present research paper.

To identify a headache that develops immediately after the onset of cerebral aneurysm, the nape (posterior side of the neck) is indicated. However, in the present observation, headache was observed 4 to 14 days after the onset, rather than immediately after the onset. Therefore, only few patients reported pain in the nuchal region or the temple, with the most commonly reported pain site being the cephalic region (inside of the head). Blood that enters the subarachnoid space after a rupture reaches the dura matter that covers the anterior cranial fossa and the posterior cranial fossa, stimulating the pain sensitivity, causing a headache that spans across the entire cephalic region (Suzuki, 1998).

Significantly more patients complained of a headache after endovascular treatment than after craniotomy (p = 0.008). Patients treated with more invasive craniotomy were expected to experience more pain than those treated with less invasive endovascular treatment. However, contradictory results were observed. One of the causal factors for this finding may be that direct surgery included a procedure that removed the blood around the ruptured aneurysm, such as cisternal drainage.

As a related factor of headache, patients who had endovascular surgery complained of headache more than those who had direct surgery (p=0.008). The severe headache duration of the NRS 8–10 group was significantly greater; 9 days (p=0.000), and the number of doses was also significantly higher; 11 times (p=0.000). There was no significant difference in any of the other parameters.

Patient's pain relief support is one of the important cares of nurses and reaffirmed that we must also pay attention in

the cranial nerve area nursing.

The duration of action of analgesics used in this research was short (1–2 hours), with a half-life of 1.3 hours. Patients may experience a shorter duration of pain relief; however, it should be conveyed that the cerebral vasospasm period is a time when the blood pressure should be strictly controlled, and changes in the consciousness level must be confirmed as a neurological symptom. Nurses need to implement other methods of pain relief with the understanding that these analgesics have a short duration of action.

Narcotic and non-narcotic analgesics called opioids are effective in reducing moderate-to-severe pain. However, over-sedation and respiratory depression cause hypoxic brain injury and cerebral edema because of decreased oxygen supply to the brain (Uchino, Morota, Li, Takahashi, Kudo, Ikeda, Ishii, et al., 2006). Therefore, it is not commonly used for patients whose consciousness level must be confirmed during the acute phase. In the present observation, it was used in only 5% of the cases. Non-narcotic opioids were selected for pain alleviation.

During the cerebral vasospasm period, in addition to blood pressure management and observation of neurological symptoms, relatively severe headache that lasts for a median of four days must be assessed.

The limitations of the present research were such that, although it was an observational study conducted in two institutions equipped with an advanced treatment facilities (SCU), approximately 20% of the patients with ruptured cerebral aneurysms may not have been receiving treatment at specialized hospitals (Gijn and Rinkel, 2001). The relatively smaller sample size did not allow for a sufficient number of subjects who fell under WFNS Grade III to V; this may have introduced bias in the data. The analyses did not include parameters from a nursing viewpoint, such as the level of sleep and dietary intake. Future studies should examine these parameters.

Acknowledgments

We are deeply grateful to the SAH patients who participated in this study. This work was supported by JAPS KAKEN Grant Number 16K12065, 15H05079.

References

Binhas, M., Walleck, P., and E. L. Bitar, N. (2006). Pain management in subarachnoid haemorrhage: A survey of French analgesic practices. *Ann Fr Anesth Reanim*, 25: 935–939.

Dorhout Mees, S. M., Rinkel, G. J., Feigin, V. L., Algra, A., van den Bergh, W. M., Vermeulen, M., and van Gijn, J. (2007), Calcium antagonists for aneurysmal subarachnoid hemorrhage. *Cochrane Database Syst Rev*, 3: CD000277.

Fujinaka, T., and Yoshimine, T. (2017). *Pathology and diagnosis of subarachnoid hemorrhage (SAH)*. In Takashima, S., and Itoh, Y. (eds), *Handbook of Stroke 3rd ed.*, 326, Tokyo, Shindan to Chiryo Sha.

Fukui, T., Takagi, M., and Komuro, I. (2018). *Today's Therapy 2018*, 897. Tokyo, Igaku-Shoin.

Hickey, J. V. (2014). *The clinical practice of neurological and neurosurgical nursing 7th ed.*, 622, Philadelphia, Lippincott Williams & Wilkins.

Ito, Z. and Suzuki, A. (1977). Warning Signs Priority to Rupture and Re-rupture of International Aneurysms. *The medical frontline*, 32(12): 2241–2248.

Japanese Guidelines for the Management of Stroke 2015(2017), 195–197, Tokyo, kyowakikaku.

Kobayashi, S. (2015). *Stroke Data Bank*, 18, Tokyo, Nakayama Shoten.

Kodama, N., Sasaki, T., Kawakami, M., Sato, M., and Asari, J. (2000). Cisternal irrigation therapy with urokinase and ascorbic acid for prevention of vasospasm after aneurysmal subarachnoid hemorrhage. Outcome in 217 patients. *Surg Neurol*, 53: 110–118.

Morad, A. H., Tamargo, R. J., and Gottschalk, A. (2016). The Longitudinal Course of Pain and Analgesic Therapy Following Aneurysmal Subarachnoid Hemorrhage: A Cohort Study. *Headache*, 56: 1617–1625.

Nieuwkamp, D. J., Setz, L. E., Algra, A., Linn, F. H., de Rooij, N. K., and Rinkel, G. J. (2009). Changes in case fatality of aneurysmal subarachnoid hemorrhage over time, according to age, sex, and region: a meta-analysis, *Lancet Neurol*, 8: 635–642.

Ohta, T. (2016). *Neurosurgery 12th ed.*, 840–843, Kyoto, kinpodo.

Sasae, M. (2018). Nursing Management for patients with headache and difficulty falling asleep after subarachnoid hemorrhage—using headache record—, *FY 2018 Aichi Nursing Association the 10th Stroke Rehabilitation Nursing certified course, case studies*: 36–40.

Sugie, E. (2017). Acute Stage (1) In the vasospasm phase of subarachnoid hemorrhage, appetite is not felt. *Brain Nursing*; 33(9): 870–873.

Suzuki, N. (1998). Migraine pain and neurotransmitter. *Journal of the Japanese society of internal medicine*, 87(2): 365–372.

Urabe, A., Shimada, K., and Kawai, S. (2018). *Today's Drug Therapy in 2018*, 290, Tokyo, Nankodo.

Uchino, H., Morota, S., Li, C., Takahashi, T., Kudo, Y., Ikeda, Y., Ishii, N., et al. (2006). Mechanisms of Ischemic brain damage. *Japanese Journal of Reanimatology*, 25(1): 1–11.

Van Gijn, J., and Rinkel, G. J. (2001). Subarachnoid hemorrhage: diagnosis causes and management. *Brain*, 124, 249–278.