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Clinical Application of Non-Invasive Dynamic Monitoring of Cerebral Edema Combined with Refined Nursing in Patients with Cerebral Hemorrhage

Jinling Zhao, Tiantian Ye*

Department of Neurosurgery, BenQ Medical Center, Suzhou 215011, Jiangsu, China

Author to whom correspondence should be addressed.

Abstract: *Objective:* To investigate the clinical application effect of non-invasive dynamic monitoring of cerebral edema combined with refined nursing in patients with cerebral hemorrhage. *Methods:* A prospective study was conducted on 96 patients with cerebral hemorrhage who underwent surgery from October 2024 to January 2026. The patients were randomly divided into two groups using a random number table method. The control group (48 patients) received conventional nursing, while the observation group (48 patients) received non-invasive dynamic monitoring of cerebral edema and refined nursing for a continuous period of 2 weeks. The hematoma volume, cerebral edema volume, adverse emotions, and complication rate were compared between the two groups. *Results:* After 3 days, 1 week, and 2 weeks of nursing, the hematoma volume and cerebral edema volume in the observation group were lower than those in the control group ($p < 0.05$). After 2 weeks of nursing, the adverse emotion scores in the observation group were lower than those in the control group ($p < 0.05$). The complication rate in the observation group was lower than that in the control group ($p < 0.05$). *Conclusion:* Implementing non-invasive dynamic monitoring of cerebral edema and refined nursing in patients with cerebral hemorrhage surgery can reduce hematoma, cerebral edema, adverse emotions, and postoperative complications, demonstrating significant application value.

Keywords: Cerebral hemorrhage; Non-invasive dynamic monitoring of cerebral edema; Conventional nursing; Refined nursing

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1. Introduction

Cerebral hemorrhage is a highly prevalent neurological disease, primarily caused by the rupture of blood vessels within the brain parenchyma [1]. According to a survey, China witnesses over 2 million new cases of stroke annually, with up to 1.5 million deaths attributed to complications from cerebral hemorrhage [2]. Cerebral edema is a common postoperative manifestation in patients with cerebral hemorrhage, and its occurrence and progression directly affect the degree of neurological damage and prognosis. Cerebral hernia induced by cerebral edema is the leading cause of death in patients with cerebral hemorrhage [3]. Therefore, clinical attention should be heightened towards the monitoring, prevention, and intervention of cerebral edema in patients with cerebral hemorrhage. Combining high-quality nursing with active treatment can accelerate the resolution of cerebral edema, prevent the formation of cerebral hernia, and improve the survival rate of cerebral hemorrhage. Non-invasive dynamic monitoring of cerebral edema is a currently favored monitoring method for cerebral edema, being non-invasive and safe, and highly suitable for severely ill stroke patients [4]. Refined nursing is a novel approach based on traditional nursing, requiring the optimization of clinical nursing plans and refinement of nursing measures to alleviate cerebral hemorrhage symptoms and promote patient recovery through effective nursing. This study analyzed the combined application effect of non-invasive dynamic monitoring of cerebral edema and refined nursing.

2. Materials and methods

2.1. General information

Ninety-six patients with cerebral hemorrhage who underwent surgery at the hospital from October 2024 to January 2026 were included in the study.

2.1.2. Inclusion criteria

(1) Meeting the diagnostic criteria in the "Guidelines for the Prevention and Treatment of Cerebrovascular Diseases (2024 Edition)" [5];
(2) First onset and first surgical treatment;
(3) Able to undergo non-invasive dynamic monitoring of cerebral edema and communicate normally after regaining consciousness;
(4) Informed consent to participate in the study.

2.1.3. Exclusion criteria

(1) Concomitant malignant tumors;
(2) Concomitant cerebral infarction;
(3) Concomitant severe infections;
(4) Concomitant coagulation disorders;
(5) Audiovisual impairments;
(6) Death before the study.

2.1.4. Study design

The 96 patients were randomly divided into two groups using a random number table method, with 48 patients in each group.

(1) Control group

27 males and 21 females, aged 54–79 years (66.92 ± 3.11 years), with a hemorrhage volume of 8–30 mL (19.37 ± 3.06 mL), including 18 cases of ventricular hemorrhage, 16 cases of basal ganglia hemorrhage, 7

cases of lobar hemorrhage, and 7 cases of thalamic hemorrhage.

(2) Observation group

26 males and 22 females, aged 56–78 years (67.38 ± 3.25 years), with a hemorrhage volume of 8–31 mL (19.78 ± 3.17 mL), including 20 cases of ventricular hemorrhage, 16 cases of basal ganglia hemorrhage, 6 cases of lobar hemorrhage, and 6 cases of thalamic hemorrhage. No significant differences were observed in the comparison of various data between the two groups ($p > 0.05$).

2.2. Methods

2.2.1. Control group

(1) Conventional nursing

Close monitoring of changes in consciousness and mental state was conducted. If symptoms such as restlessness and mental confusion were observed, physicians were immediately notified for treatment. Maintaining airway patency and timely oxygen administration were essential, while precautions were taken to prevent complications such as asphyxia and aspiration pneumonia. For comatose patients, their heads were required to be turned to one side, and they were assisted in changing positions regularly. During the acute phase, patients were required to abstain from food completely. Once their condition stabilized, they were provided with full-liquid and semi-liquid foods, with dietary types adjusted according to their condition. Patients were also encouraged to drink plenty of water to dilute their blood and prevent rebleeding adequately. After stabilization, patients were encouraged to engage in early rehabilitation exercises to restore bodily functions through passive and active limb exercises.

2.2.2. Observation group

(1) Non-invasive dynamic monitoring of cerebral edema

Continuous dynamic monitoring was performed using a non-invasive cerebral edema monitor. Two electrode patches were affixed to the left and right temporal regions, respectively. The center (button) of the rear electrode patch was aligned with the highest point of the auricle above the external auditory meatus, with the lower edge of the electrode patch coinciding with the extension line of the outer canthus. The front electrode patch was placed adjacent and parallel to the rear one, adhered using the "rice character" method. Before adhesion, the skin was carefully cleaned, hair was removed, and the area was thoroughly dried. The four electrode patches were symmetrically placed on both sides, with the front right electrode patch connected to the brown lead wire and the rear right electrode patch connected to the green lead wire; the front left electrode patch was connected to the black lead wire, and the rear left electrode patch was connected to the white lead wire. The cerebral electrical impedance perturbation coefficient was recorded, with normal values ranging from 6 to 8, cerebral edema formation from 9 to 12, and severe cerebral edema/cerebral hernia formation exceeding 12. The difference in detection values between the left and right cerebral hemispheres was less than 0.3.

(2) Refined Nursing

Vital Sign Management: After surgery, vital signs such as blood oxygen saturation, body temperature, heart rate, and blood pressure were closely monitored. Measurements were taken and recorded every 30 minutes until stability was achieved, after which they were monitored every 2 hours. Depending on the patient's condition, the frequency of monitoring was gradually reduced to once every 2 days. - Position

Management: After surgery, patients were transferred to the ward and required to rest in bed. The most appropriate position was selected based on the severity of the condition and the size of the surgical incision. The head of the bed was elevated by 15° to 30°to promote venous blood return, reduce intracranial pressure, and alleviate cerebral edema. If the patient had not regained consciousness, a horizontal supine position with the head slightly turned to the side was required to prevent aspiration and asphyxia. - Emotional Management: After the patient regained consciousness, their emotional state was actively evaluated to identify adverse emotions and analyze their causes. Doubts were actively addressed, emotions were soothed, and potential issues were eliminated. Daily communication with the patient helped alleviate adverse emotions, and successful rehabilitation cases were cited to boost treatment confidence. Once the patient's condition permitted, family members were encouraged to accompany them, providing care and affection to regulate their emotional state continuously. If necessary, successfully operated and well-rehabilitated patients were invited to share their experiences to enhance rehabilitation confidence. If the patient's adverse emotions were severe and persisted, a professional psychologist was invited to intervene and regulate their psychological state. - Complication Prevention: Close attention was paid to the patient's postoperative performance, and effective measures were actively taken to prevent complications such as infection, pressure injuries, and deep vein thrombosis. Nurses evaluated the risk of complications daily and adjusted nursing measures based on the assessment results to ensure targeted care.

2.3. Observation indicators

(1) Hematoma volume

The largest hematoma area was selected, and the major and minor diameters were measured. Hematoma volume = π/6 × major diameter × minor diameter × slice thickness × number of hematoma slices.

(2) Cerebral edema volume

The total lesion volume was calculated using the same method as for hematoma volume. The difference between the total lesion volume and the hematoma volume represented the edema volume.

(3) Adverse emotions

The Hamilton Anxiety Scale and the Hamilton Depression Scale were used for evaluation [6,7]. Scores > 7 indicated the presence of anxiety/depressive emotions, with higher scores indicating more severe adverse emotions.

(4) Complication rate

The total incidence of infection, pressure injuries, and deep vein thrombosis was statistically analyzed.

2.4. Statistical methods

SPSS 27.0 was used for comparison. Measurement data (conforming to normal distribution) were presented as ($\bar{x} \pm s$) and subjected to *t*-tests. Count data were presented as frequencies (%) and subjected to χ^2 tests. A *p*-value < 0.05 was considered statistically significant.

3. Results

3.1. Comparison of hematoma volume and cerebral edema volume between the two groups

After 3 days, 1 week, and 2 weeks of nursing, the hematoma volume and cerebral edema volume in the observation group were lower than those in the control group ($p < 0.05$). See **Table 1**.

Table 1. Comparison of hematoma volume and cerebral edema volume between the two groups ($\overline{x} \pm s$, mL)

Group	Number of cases	Hematoma volume				Brain edema volume			
		Before nursing	3 d after nursing	1 week after nursing	2 weeks after nursing	Before nursing	3 d after nursing	1 week after nursing	2 weeks after nursing
Observation group	48	25.87 ± 2.66	21.06 ± 2.14[a]	17.85 ± 2.24[a]	12.01 ± 2.05[a]	10.12 ± 3.11	21.65 ± 3.56[a]	33.86 ± 4.25[a]	20.16 ± 4.34[a]
Control group	48	25.34 ± 2.50	23.15 ± 2.31[a]	20.08 ± 2.28[a]	16.53 ± 2.17[a]	10.56 ± 3.28	25.08±3.64[a]	37.65 ± 4.47[a]	25.37 ± 4.59[a]
t value	–	1.006	4.598	4.834	10.490	0.674	4.667	4.257	5.714
p value	–	0.317	< 0.001	< 0.001	< 0.001	0.502	< 0.001	< 0.001	< 0.001

Note: Compared with the pre-nursing state within the same group, [a]$p < 0.05$.

3.2. Comparison of adverse emotions between the two groups

After 2 weeks of nursing, the adverse emotion scores in the observation group were lower than those in the control group ($p < 0.05$). See **Table 2**.

Table 2. Adverse emotions in both groups (points)

Group	Number of cases	Anxiety		Depression	
		Before nursing	2 weeks after nursing	Before nursing	2 weeks after nursing
Observation group	48	10.98 ± 2.26	6.23 ± 1.53[a]	12.76 ± 2.49	7.05 ± 1.45[a]
Control group	48	10.54 ± 2.13	7.98 ± 1.74[a]	12.42 ± 2.35	8.66 ± 1.69[a]
t value	-	0.982	5.233	0.688	5.009
p value	-	0.329	< 0.001	0.493	< 0.001

Note: Compared with the pre-nursing care in the same group, [a]$p < 0.05$.

3.3. Comparison of complication rates between the two groups

The complication rate in the observation group was lower than that in the control group ($p < 0.05$). See **Table 3**.

Table 3. Complication rates in the two groups (n/%)

Group	Number of cases	Infection (n)	Pressure injury (n)	Deep vein thrombosis (n)	Complication rate (%)
Observation group	48	1	1	0	4.17
Control group	48	4	2	2	16.67
χ^2 value	-	-	-	-	4.019
p value	-	-	-	-	0.045

4. Discussion

Cerebral edema is a secondary change triggered by cellular energy metabolism disorders resulting from ischemia and hypoxia after brain tissue damage [8]. Severe cerebral edema can form a mass effect, impacting the function of normal brain tissue. If severe cerebral edema continues to progress, it can cause irreversible damage and threaten the patient's life. In the past, the severity of cerebral edema was often assessed through imaging examinations, symptom manifestations, and previous experience, which could easily delay the diagnosis and treatment. Previously, intracerebroventricular catheterization was commonly used to monitor cerebral edema, but it is invasive and difficult for patients to tolerate, and may even lead to complications. Although simple imaging examinations can show the location and specific size of cerebral edema, they cannot provide real-time and dynamic monitoring. Therefore, it is necessary to combine other monitoring methods to obtain the most accurate monitoring results. Non-invasive dynamic cerebral edema monitoring can utilize the principle of foreign object disturbance, the theory of bioelectromagnetic fields, and impedance imaging technology to dynamically monitor the water content in brain tissue, accurately evaluate the severity of cerebral edema, and guide clinical treatment and nursing care [9]. In recent years, refined nursing has been widely applied in neurology, requiring a patient-centered approach and optimizing, refining, and elaborating clinical nursing measures according to the type and severity of the disease to enhance nursing effects.

This study found that compared with the control group, the observation group had lower hematoma volume and cerebral edema volume, lower scores for adverse emotions, and a lower incidence of postoperative complications, suggesting that non-invasive dynamic cerebral edema monitoring combined with refined nursing can alleviate cerebral hemorrhage conditions, improve patients' emotional states, and prevent postoperative complications. The reason is that non-invasive dynamic cerebral edema monitoring can collect electromagnetic signal differences between normal and damaged brain tissues and accurately reflect the dynamic changes in intracranial brain tissue of patients through disturbance coefficients. It is a real-time, safe, and non-invasive monitoring technology that can comprehensively assess the development trend of cerebral edema in patients and identify secondary lesions such as cerebral hernia [10]. Refined nursing has various advantages such as being meticulous, comprehensive, and scientific, which can improve the quality of clinical nursing, prevent related complications, and promote patients' early recovery. The combination of non-invasive dynamic cerebral edema monitoring and refined nursing can guide nurses to grasp the severity of cerebral edema in patients in real time, adjust nursing measures according to patients' actual needs, and fully leverage the targeted and scientific advantages of nursing to ensure nursing effects and quality.

5. Conclusion

In summary, the combined implementation of non-invasive dynamic cerebral edema monitoring and refined nursing in patients with cerebral hemorrhage can reduce hematoma and cerebral edema, alleviate adverse emotions, and prevent postoperative complications, making it worthy of clinical promotion.

Disclosure statement

The authors declare no conflict of interest.

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