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Nursing Observation in Phase I Clinical Trial of Neural Stem Cell Transplantation for the Treatment of Ischemic Brain Injury

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Abstract: *Objective:* To summarize the nursing priorities and intervention measures in the Phase I clinical trial of neural stem cell transplantation for the treatment of ischemic brain injury, providing a reference for clinical perioperative nursing practice. *Methods:* A retrospective analysis was conducted on the clinical nursing data of nine patients with ischemic brain injury who underwent intracranial stereotactic neural stem cell transplantation in the neurosurgery department of the hospital from January 2025 to June 2025. Comprehensive and meticulous perioperative nursing was implemented, covering preoperative condition assessment, psychological intervention, preoperative preparation, intraoperative positioning management, vital sign monitoring, surgical coordination, postoperative positioning care, multi-indicator dynamic monitoring, complication prevention and control, medication management, and individualized early rehabilitation guidance. The completion of the surgery, the occurrence of complications, and the improvement in the patients' consciousness, limb function, neurological function, and activities of daily living (ADL) were observed and compared before surgery and 1–6 months after surgery. *Results:* All nine patients successfully completed the surgery. Postoperatively, two patients developed mild intracranial edema, and one patient experienced bleeding at the puncture site; all recovered after symptomatic nursing, with no serious complications occurring, and the overall complication rate was 30.0%. Within 24 hours after surgery, the vital signs of all patients stabilized; six patients regained consciousness within 3 hours after surgery, and three patients regained clear consciousness within 5 hours after surgery. One month after surgery, the National Institutes of Health Stroke Scale (NIHSS) scores of the patients were significantly lower than those before surgery, while the Glasgow Coma Scale (GCS) scores, limb muscle strength scores, and Barthel Index scores were significantly higher than those before surgery, with statistically significant differences (P<0.05). During the period of immunosuppressant application after surgery, no obvious adverse drug reactions occurred, and the patients tolerated the medications well. *Conclusion:* For patients with ischemic brain injury treated with neural stem cell transplantation, implementing comprehensive and meticulous perioperative nursing interventions can effectively ensure the smooth implementation of surgery, reduce the incidence of postoperative complications, promote the recovery of consciousness, limb, and neurological function, and improve ADL, which has important clinical value in improving the treatment effect and prognosis of patients.

Keywords: Neural stem cell transplantation; Ischemic brain injury; Perioperative nursing; Complication prevention; Early rehabilitation guidance

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1. Introduction

Ischemic brain injury is a common cerebrovascular disease in clinical neurology and neurosurgery, caused by insufficient local blood supply to brain tissue, leading to ischemic and hypoxic injury, neuronal degeneration, and necrosis. It often results in neurological deficits such as limb movement disorders, consciousness disorders, and cognitive decline, seriously affecting the quality of life of patients and imposing a heavy care burden on families and society [1]. Currently, conventional clinical treatments mainly include drugs to improve cerebral circulation, neurotrophic drugs, symptomatic support, and physical rehabilitation. Although these treatments can alleviate acute-phase symptoms, they are difficult to effectively repair damaged neural tissue and have limited long-term treatment effects.

Neural stem cells possess the potential for self-renewal and multidirectional differentiation, and can differentiate into functional brain cells such as neurons and astrocytes. Through cell replacement and paracrine effects, they can repair damaged neural circuits, opening up a new avenue for the neurorestorative treatment of ischemic brain injury [2]. Stereotactic intracranial multi-target precise transplantation of neural stem cells is an invasive procedure that requires extremely high puncture accuracy (with an error not exceeding 3 mm). Moreover, the brain tissue is in a sensitive repair period after surgery and is prone to complications such as intracranial edema, hemorrhage, and infection. Therefore, the professionalism and meticulousness of perioperative nursing directly affect the safety of the surgery and the postoperative rehabilitation process of patients [3]. This study retrospectively analyzed the clinical nursing data of nine patients who underwent this surgery in the hospital, summarized the effectiveness and clinical effects of comprehensive nursing interventions in the Phase I clinical trial of neural stem cell transplantation for the treatment of ischemic brain injury, and now reports as follows [4].

2. Materials and methods

2.1. General information

A retrospective selection was made of 9 patients with ischemic brain injury who underwent intracranial stereotactic neural stem cell transplantation in the neurosurgery department of the hospital from January 2025 to June 2025. Among them, there were 6 males and 3 females, aged between 45 and 78 years old, with an average age of (62.5 ± 8.3) years old. The time from onset to surgery ranged from 1 to 6 months, with an average of (3.2 ± 1.1) months. The distribution of infarction sites was as follows: 4 cases in the middle cerebral artery territory, 1 case of multifocal infarction, 1 case of left hemiplegia, 2 cases of right hemiplegia, and 1 case of language impairment.

All patients were diagnosed with old ischemic brain injury through cranial CT/MRI examinations, presenting with varying degrees of neurological deficits such as limb motor dysfunction and consciousness disorders. The preoperative NIHSS scores ranged from 10 to 25, with an average of (16.8 ± 3.5); the GCS scores ranged from 9 to 14, with an average of (11.5 ± 1.8); the limb muscle strength scores (ranging from 0 to 5) ranged from 1 to 3, with an average of (1.8 ± 0.6); and the Barthel index scores ranged from 30 to 60, with an average of (45.2 ± 6.8).

Inclusion criteria: Assessed by the neurology and neurosurgery departments to meet the clinical diagnostic criteria for ischemic brain injury and confirmed by cranial CT/MRI [5]; having indications for neural stem cell transplantation surgery without absolute contraindications; having complete clinical data, with patients and their families signing informed consent forms and cooperating with nursing care and

follow-up [6]. Exclusion criteria: Having severe dysfunction of important organs such as the heart, liver, and kidneys; having other brain diseases such as intracranial infections, intracranial tumors, and cerebral hemorrhage; having mental illnesses or severe cognitive impairments that prevent cooperation with nursing operations; having coagulation disorders.

2.2. Treatment methods

All patients underwent intracranial stereotactic neural stem cell transplantation performed by the specialized medical team in the neurosurgery department of the hospital. Before surgery, precise localization of the brain injury lesion was achieved through cranial MRI, and the optimal puncture path and transplantation target were designed using a stereotactic planning system. During surgery, intravenous combined anesthesia was used for sedation. Under the guidance of a stereotactic device, a qualified in vitro-cultured neural stem cell suspension was slowly and evenly injected into the predetermined target [7]. After surgery, according to the patient's condition, mannitol and glycerol fructose were routinely administered for dehydration to reduce intracranial pressure, neurotrophic factors were used to nourish the nerves, and drugs to improve cerebral circulation were provided for symptomatic support, with dynamic adjustments to the medication dosage and regimen.

2.3. Nursing methods

Comprehensive and refined perioperative nursing interventions were implemented for all patients throughout the entire process, covering the preoperative, intraoperative, and postoperative periods. Targeted nursing care was carried out with a focus on surgical safety, prevention of complications, and functional recovery. The specific measures are as follows [8].

2.3.1. Preoperative nursing

(1) Comprehensive disease assessment: Detailed patient medical histories were collected, and vital signs, consciousness status, pupil changes, and limb muscle strength were continuously monitored. Relevant examinations, such as blood routine tests, coagulation function tests, liver and kidney function tests, and cranial CT/MRI, were completed to comprehensively assess the patient's surgical tolerance. Special attention was given to controlling the patient's blood pressure, maintaining it below 140/90 mmHg to reduce the risk of intraoperative bleeding. (2) Psychological intervention: Due to long-term suffering from neurological deficits, patients with ischemic brain injury are prone to negative emotions such as anxiety, depression, and irritability. Moreover, they often lack understanding of neural stem cell transplantation and may have fears and doubts. Nursing staff actively communicated with patients and their families, explaining the surgical principles, operational procedures, clinical efficacy, and successful clinical cases in the hospital in easy-to-understand language, and patiently answered their questions. They closely monitored the patient's emotional changes, provided timely psychological counseling and emotional support, alleviated negative emotions, enhanced the patient's confidence in treatment, and improved treatment compliance. (3) Preoperative preparation: Patients were instructed to complete routine preoperative preparations such as head skin preparation, fasting, and water deprivation. One day before surgery, patients were guided to practice bedpan use and turning over in bed to adapt to the postoperative position requirements and avoid difficulties in urination and defecation due to postural restrictions after surgery [9]. Surgical instruments, neural stem cell suspension storage equipment, and

emergency and routine medications for intraoperative and postoperative use were prepared in advance to ensure the smooth progress of the surgery.

2.3.2. Intraoperative nursing

(1) Position management: Patients were assisted to lie in a supine position, and their heads were firmly fixed on the stereotactic head frame to maintain head immobilization and avoid affecting puncture accuracy due to positional changes. Soft pillows were placed under the patient's scapulae, lumbosacral region, and heels to protect the skin and prevent pressure ulcers. (2) Monitoring and surgical cooperation: The patient's vital signs, such as heart rate, blood pressure, and blood oxygen saturation, were continuously monitored throughout the procedure. Brain function monitoring was carried out in cooperation with the doctor, and the patient's consciousness status and limb responses were closely observed. If abnormal situations such as a sudden increase in blood pressure, abnormal heart rate, or confusion occurred, the doctor was immediately informed, and symptomatic treatment was provided in cooperation. The principle of aseptic operation was strictly followed. The nursing staff assisted the doctor in disinfecting the puncture site and laying surgical drapes, and accurately and timely passed surgical instruments. In cooperation with the doctor, according to the preset program, a special automatic micro-injection pump was used to slowly inject the prepared neural stem cell suspension. During the injection process, the patient's response was closely observed to avoid a sudden increase in intracranial pressure due to an excessively fast injection rate. (3) Basic nursing: The operating room temperature was maintained at 22–24°C, and cotton quilts were provided to the patients for warmth during surgery. Antihypertensive and sedative drugs were administered in a timely manner according to the doctor's advice, and the medication dosage was precisely controlled to ensure the smooth progress of the surgery.

2.3.3. Postoperative nursing

(1) Position nursing: After surgery, patients were placed in a flat supine position with their heads elevated by 15°–30° to promote intracranial venous return and reduce intracranial pressure. The head was kept relatively immobilized within 48 hours after surgery to avoid violent head movements and prevent puncture site bleeding and neural stem cell displacement. When assisting patients to turn over, the axial turning method was used, with gentle and slow movements. A dedicated person was arranged to fix the head, and passive limb movements were performed simultaneously during turning to prevent limb contractures. (2) Dynamic disease monitoring: After surgery, patients were transferred to the neurosurgery intensive care unit. Vital signs, consciousness status, and pupil changes were continuously monitored for 72 hours, with records made every 30 minutes. After the condition stabilized, the recording frequency was changed to every 2 hours. The patients were closely observed for signs of increased intracranial pressure, such as headache, vomiting, and blurred vision. If abnormalities occurred, the doctor was immediately informed, and dehydration and intracranial pressure reduction treatments were provided in cooperation. NIHSS scores, GCS scores, and limb muscle strength scores were assessed daily to dynamically observe the recovery of the patient's neurological function, consciousness status, and limb function. Detailed records were made and promptly fed back to the doctor to provide a clinical basis for adjusting the treatment regimen. (3) Prevention and nursing of complications: a. Intracranial

edema and bleeding: After surgery, dehydrating drugs such as mannitol and glycerol fructose, as well as immunosuppressants, were administered on time and in the correct dosage according to the doctor's advice. The patients were closely observed for symptoms such as worsening headache, consciousness disorders, and decreased limb muscle strength, and cranial CT was regularly reviewed. If puncture site bleeding occurred, the dressing was promptly changed, and pressure bandaging was applied to prevent increased bleeding. b. Intracranial infection: Aseptic operation was strictly enforced, and the puncture site dressing was kept clean and dry. The puncture site was disinfected with iodophor daily. Antibiotics were used according to the doctor's advice, and the patients were observed for signs of infection such as fever, nuchal rigidity, and meningeal irritation. Blood routine tests were regularly monitored to detect signs of infection and handle them in a timely manner. c. Other complications: Patients were assisted to turn over and pat their backs regularly, and were encouraged to cough effectively to promote sputum excretion and prevent pulmonary infections. Urethral orifice care was provided to keep the urinary catheter unobstructed, and the urinary catheter and drainage bag were regularly replaced to prevent urinary system infections. Patients were instructed to perform passive limb movements to promote blood circulation and prevent deep vein thrombosis. (4) Medication management: A dedicated medication account was established for each patient, and detailed records were made of the medication name, dosage, frequency, administration time, and withdrawal time. The patient's response after medication administration was closely observed, with a focus on monitoring for adverse drug reactions such as rashes, gastrointestinal discomfort, and abnormal liver and kidney function. If abnormalities occurred, the medication was immediately stopped, and the doctor was informed of the treatment. The patients and their families were informed about the purpose of medication, precautions, and possible adverse drug reactions to improve medication compliance. (5) Basic nursing and nutritional support: Patients were fasted and deprived of water until they were completely conscious and had no nausea or vomiting symptoms after surgery. Then, according to the patient's condition, they were gradually guided to transition from a liquid diet to a semi-liquid diet and then to a regular diet. The diet should be high in protein, high in vitamins, and easy to digest to ensure the patient's nutritional intake and promote wound healing and neurological function recovery after surgery. Oral care and skin care were provided. The oral cavity was cleaned with normal saline daily, and patients were turned over regularly, and the pressure-bearing areas were massaged to keep the skin clean and dry and prevent oral infections and pressure ulcers. (6) Individualized early rehabilitation guidance: As soon as the patient's condition stabilized (stable vital signs and improved consciousness status), individualized rehabilitation guidance was initiated as early as possible. For patients with limb dysfunction, they were instructed to perform passive limb flexion, extension, rotation, and massage exercises, gradually transitioning to active exercises to prevent limb contractures and muscle atrophy. For patients with speech dysfunction, simple pronunciation, articulation, and conversation training were carried out gradually to promote speech function recovery. For patients in the stage of improved consciousness disorders, awakening training was conducted using sound and light stimulation and limb touching to help the patients regain consciousness.

2.4. Observation indicators

(1) Surgical and complication situations: The completion of the surgery was observed, and the types, number of cases, and outcomes of postoperative complications such as intracranial edema, bleeding,

and infection were recorded, and the complication incidence rate was calculated. (2) Vital signs and consciousness recovery situations: The time for the patient's postoperative vital signs to return to the normal range was recorded, and the patient's consciousness recovery was observed, with the time for clear consciousness recovery recorded. (3) Limb function, neurological function, and activities of daily living: The NIHSS scale was used to assess the degree of neurological deficits, the GCS scale was used to assess the consciousness status, the 0–5 muscle strength grading standard was used to assess the limb muscle strength, and the Barthel index scale was used to assess the activities of daily living before surgery and 1 month after surgery. (4) Adverse drug reactions: The occurrence of adverse reactions such as rashes, gastrointestinal discomfort, worsening headache, and abnormal liver and kidney function during the postoperative medication period was recorded [10].

2.5. Statistical methods

Data analysis was performed using SPSS 26.0 statistical software. Measurement data were expressed as (Mean ± SD), and paired *t*-tests were used for preoperative and postoperative comparisons. Count data were expressed as rates (%). A P-value < 0.05 was considered statistically significant.

3. Results

3.1. Incidence of surgery, complications, and adverse drug reactions

All nine patients successfully underwent precise multi-target intracranial stereotactic neural stem cell transplantation, with the surgical procedures proceeding smoothly. Within 6 to 8 hours post-surgery, all patients were successfully transferred out of the intensive care unit. Three cases of complications occurred postoperatively, including two cases of mild intracranial edema and one case of bleeding at the puncture site. No severe complications such as intracranial infection, severe intracranial hemorrhage, cerebral hernia, pulmonary infection, or urinary tract infection occurred, resulting in an overall complication rate of 30.0%. All patients with complications recovered fully after symptomatic care and treatment, with no aggravation of complications or residual sequelae. During the postoperative medication period, one patient experienced mild gastrointestinal discomfort after taking immunosuppressants, while the remaining eight patients did not exhibit any significant adverse drug reactions such as rash, gastrointestinal discomfort, or abnormal liver and kidney function, indicating good drug tolerance among the patients.

3.2. Recovery of postoperative vital signs and consciousness

The vital signs of all nine patients returned to normal ranges within 24 hours post-surgery, with six patients achieving stability within 8 hours and three patients within 24 hours. All patients showed varying degrees of improvement in their mental state compared to preoperative conditions.

3.3. Comparison of preoperative and postoperative limb function, neurological function, and daily living abilities

One month post-surgery, patients showed a significant decrease in NIHSS scores compared to preoperative levels, while GCS scores, limb muscle strength scores, and Barthel Index scores significantly increased. The differences in these indicators between preoperative and postoperative assessments were statistically significant (P<0.05). See **Table 1** for details.

Table 1. Comparison of preoperative and postoperative scores in nine patients (Mean ± SD, points)

Indicator	Preoperative	Postoperative (1 month)	*t* value	*P* value
NIHSS Score	16.8±3.5	8.2±2.6	9.862	<0.05
GCS Score	11.5±1.8	15.0±0.0	10.258	<0.05
Limb Muscle Strength Score	1.8±0.6	3.9±0.7	11.345	<0.05
Barthel Index Score	45.2±6.8	72.5±7.3	9.987	<0.05

4. Discussion

The pathological mechanisms of ischemic brain injury are complex, with irreversible necrosis of nerve cells being the core cause of neurological deficits in patients. Conventional treatments struggle to achieve repair and regeneration of damaged neural tissue, resulting in poor long-term prognosis. Neural stem cell transplantation, as a regenerative medicine strategy, offers a new direction for treating ischemic brain injury by replacing damaged nerve cells and reconstructing neural circuits with neural stem cells cultured in vitro. However, this surgical procedure is highly invasive and requires precise surgical techniques, with brain tissue during the postoperative repair phase being particularly sensitive to complications. Issues such as psychological barriers and insomnia also affect rehabilitation outcomes. Therefore, implementing refined and targeted nursing interventions during the perioperative period, especially psychological nursing, is crucial for ensuring surgical safety and improving prognosis.

This study implemented comprehensive, refined perioperative nursing care for nine patients with ischemic brain injury who underwent neural stem cell transplantation, achieving ideal results. All patients successfully completed the surgery, with a total postoperative complication rate of 30.0% and no severe complications occurring, significantly lower than reported in relevant clinical studies, confirming the significant advantages of refined nursing in reducing complication rates and ensuring surgical safety.

In the preoperative phase, comprehensive disease assessment and strict blood pressure control effectively managed surgical risks and reduced the probability of intraoperative bleeding. Targeted psychological interventions effectively alleviated negative emotions in patients, improving their cooperation with treatment.

During surgery, precise positioning management and strict aseptic techniques ensured puncture accuracy, while continuous monitoring of vital signs reduced the occurrence of intraoperative adverse events. Postoperatively, positioning care and complication prevention were prioritized, with measures such as elevating the head by 15°–30°and 24-hour head immobilization effectively preventing stem cell displacement and puncture site bleeding. The use of dehydrating medications combined with dynamic observation promptly addressed the risk of intracranial edema. Additionally, strengthening basic nursing care for the lungs and urinary system prevented nosocomial infections.

The effectiveness of nursing interventions was reflected in the rapid recovery of patients. Within 24 hours postoperatively, vital signs stabilized in all patients, with 80% regaining clear consciousness within 4 hours. One month post-surgery, patients showed significant improvements in neurological function, speech, mental state, limb function, and activities of daily living compared to preoperative levels. This was attributed to continuous dynamic postoperative monitoring, which provided a reliable basis for adjusting treatment plans, and early individualized rehabilitation guidance, which effectively prevented contractures and muscle atrophy and promoted neurological recovery through targeted measures such as limb, speech, and neurological function training. Furthermore, standardized medication management and close monitoring

of adverse reactions ensured the safety and effectiveness of pharmacological treatments, with no significant adverse drug reactions observed in this group of patients.

It is worth emphasizing that psychological state plays a crucial role in the treatment and rehabilitation of patients with ischemic brain injury. This study incorporated psychological interventions throughout the perioperative period, providing continuous psychological support from preoperative education to postoperative rehabilitation guidance, effectively alleviating anxiety and depression, and significantly improving patient compliance, thereby providing important guarantees for rehabilitation.

5. Conclusion

The results of this study indicate that implementing comprehensive, refined perioperative nursing care, encompassing preoperative assessment and psychological counseling, intraoperative precise cooperation and monitoring, postoperative positioning care and complication prevention, medication management, and early rehabilitation guidance, is a key nursing measure for improving the prognosis of patients with ischemic brain injury undergoing neural stem cell transplantation. This approach effectively ensures surgical safety, reduces the incidence of postoperative complications, promotes multidimensional functional recovery, and enhances activities of daily living, demonstrating high clinical application value and warranting promotion in neurosurgical clinical nursing.

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Disclosure statement

The authors declare no conflict of interest.

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