

Multidisciplinary Collaborative Predictive Care in the World's First ALPPS Combined with Intraoperative Isolated Perfusion Chemotherapy for Diseased Liver Staged Hepatectomy

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Abstract

To summarize the nursing experience of a three-stage liver resection combined with ALPPS (associating liver partition and portal vein ligation for staged hepatectomy) and intraoperative isolated perfusion chemotherapy for a patient at a tertiary hospital in Shenzhen, China, in order to provide insights for the treatment of such cases in the future. This operation was conducted for the first time globally, presenting significant challenges and no prior nursing experience to reference. Through evidence-based thinking and literature review, preoperative multidisciplinary team (MDT) collaboration was implemented for the patient. This included psychological support, rehabilitation planning, preoperative exercise regimens, comprehensive nutritional interventions, standardized pain management, and close monitoring of the patient's blood drug concentrations during the operation. Intraoperatively, prevention and observation of potential complications were prioritized. As a result of the MDT interventions, the patient did not experience any related complications or adverse events during the perioperative period and was successfully discharged after recovery. Follow-up examinations conducted one month, six months, and one year post-discharge revealed no tumor recurrence, with all outcomes being favorable.

Keywords primary liver cancer; ALPPS; Non-ischemic isolated perfusion; multi-disciplinary team

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1 Introduction

In China, the mortality rate of primary liver cancer ranks the second among cancers, and the incidence rate ranks the fourth among cancers. The new cases account for about 45%~50% of the global total.^[1,2] At present, radical surgery and interventional therapy for liver cancer have made great progress, but the 5-year survival rate and high mortality rate still seriously threaten people's life and health.^[3]

The emergence of ALPPS technology has brought new hope for radical surgery to liver cancer patients.^[4-1] The procedure involves dividing the liver tumor resection into two phases. In the first phase, the diseased liver is separated from the healthy liver, and the portal vein on the affected side is ligated to allow the healthy liver time for compensatory hyperplasia until the FLRV reaches a resectable standard. The second phase then proceeds with the removal of the tumor on the affected side.^[4-2]

The staged liver resection with ALPPS combined intraoperative liver isolation perfusion chemotherapy involves administering high-dose chemotherapy to the tumor-bearing side of the liver during the first phase of ALPPS surgery. This can inactivate the tumor, significantly reducing the risk of metastasis and postoperative recurrence, while preserving the contralateral liver from exposure to high-dose chemotherapeutic agents, achieving "targeted treatment for liver cancer." However, due to the novelty of the "targeted liver cancer therapy" technique, which is being performed globally for the first time, the surgical process is complex, and nursing care is challenging. This has made perioperative care and postoperative rehabilitation a new challenge.

Through evidence-based thinking and multidisciplinary collaboration, predictive nursing care is provided before surgery. The most significant feature of the predictive nursing model is combining the patient's condition before surgery to predict potential postoperative scenarios, formulating detailed preventive and nursing intervention plans, and implementing corresponding nursing and intervention measures to reduce the incidence of postoperative adverse events.^[5-6] After effective treatment and care by the medical team, the patient recovered well and was discharged successfully. The nursing experience is reported as follows.

2 Clinical Treatment

2.1 General Information

A 53-year-old male patient was diagnosed with Hepatocellular Carcinoma (Stage CNLC IIIa, post-comprehensive treatment) and was undergoing chemotherapy, immunotherapy, and targeted therapy for malignant tumors. He was also a chronic HBV carrier and had a duodenal stromal tumor.

The patient presented to our department with "right upper abdominal pain for 10 days." On admission, alpha-fetoprotein (AFP) was elevated to 16,848.54 ng/mL. An abdominal MRI revealed a large mass in the right lobe of the liver (97 mm × 85 mm × 100 mm), suggestive of hepatocellular carcinoma.

His medical history included hepatitis (small three positives), tuberculosis, and a 30-year smoking history. At our hospital, he underwent three sessions of hepatic artery embolization combined with intraparenchymal chemotherapy using the FOLFOX regimen. Postoperatively, he received

lenvatinib 8 mg qd + toripalimab 200 mg q3w as anti-tumor therapy.

2.2 Treatment and Outcomes

Comprehensive examinations were performed, and a follow-up MRI indicated that the liver lesion had decreased in size, suggesting a positive response to treatment. The 10-minute indocyanine green (ICG) excretion rate was found to be greater than 10%, indicating sufficient liver function reserve. Contraindications for surgery were ruled out.

On September 14, 2023, under general anesthesia, the patient underwent left and right hemihepatectomy, right portal vein ligation, ischemia-free right portal vein and right hepatic vein catheterization for isolation perfusion chemotherapy, and cholecystectomy. This procedure was performed as ALPPS (Associating Liver Partition and Portal Vein Ligation for Staged Hepatectomy) Phase I, combined with intraoperative liver isolation perfusion chemotherapy. The patient recovered well postoperatively and was discharged.

On October 11, 2023, the patient was readmitted for follow-up assessment. A CT scan showed that the residual liver volume had increased from 380 mL to 720 mL, an 89% increase, with the standard liver volume ratio rising from 31% to 58%, meeting the criteria for Phase II surgery.

On October 13, 2023, the patient underwent laparoscopic right hemihepatectomy and laparoscopic pelvic and abdominal adhesion lysis. This constituted ALPPS Phase II. After 13 days of personalized care, the patient recovered well and was discharged.

3 Nursing

3.1 Preoperative Care

Multidisciplinary Team (MDT)

To ensure the safety and effectiveness of this globally pioneering “Targeted Liver Cancer Treatment,” we have assembled a multidisciplinary team of experts. This team includes not only doctors and nursing staff from our department but also specialists from anesthesiology, gastrointestinal surgery, organ donation, blood transfusion, pharmacy, critical care medicine, nutrition, and rehabilitation departments.

Given the innovative nature of this surgery, patients and their families often have concerns regarding its safety and treatment outcomes. Therefore, the multidisciplinary team collaborates to determine the most suitable surgical method, ensuring the success of the operation.

The nursing team plays a crucial role by providing real-time updates on the patient’s condition, ensuring that all nursing tasks are accurately executed. To facilitate the smooth progression of the surgery, the team conducted extensive literature reviews, preoperative discussions, and provided detailed explanations of surgical risks to the patient and their family. They also formulated comprehensive surgical plans, implementation details, and emergency response measures.

Ultimately, the patient and their family agreed to proceed and signed the informed consent form. This multidisciplinary approach not only enhances the success of the surgery but also provides comprehensive medical services, demonstrating the professionalism and dedication of the medical team.

3.2 Implementation of Predictive Nursing

Personalized Preoperative Rehabilitation

Preoperative rehabilitation refers to a series of preoperative interventions aimed at improving the physical and psychological state of patients undergoing elective surgery to cope with the challenges brought by surgery^[7]. According to the patient's actual situation, we intervened in their preoperative psychological state, pulmonary rehabilitation, and preoperative exercise.

We assessed the patient's mental condition using an anxiety and depression scale and provided personalized psychological support. A trusting communication relationship was established with the patient by explaining disease knowledge and surgical procedures in simple language. Through intuitive methods such as simulation diagrams, we helped the patient understand the surgical process and potential benefits, thereby alleviating psychological pressure. At the same time, we introduced our experienced medical team, recent successful liver cancer surgery cases, and an experienced anesthesia team to support the patient, helping both the patient and their family build confidence.

Post-liver resection, pleural effusion often occurs. Given that the patient has a history of tuberculosis and has been smoking for 30 years, which are factors contributing to postoperative pulmonary complications, pulmonary rehabilitation training was necessary. Specific measures included supervising the patient's smoking cessation, guiding effective coughing and expectoration techniques, and formulating a daily exercise plan of three sessions, each lasting 15 minutes. The plan involved lip-sucking breathing, abdominal breathing, respiratory equipment use, and resistance training to enhance lung function and improve the patient's ability to cope with surgical stress.

Additionally, physical condition is crucial for postoperative recovery; decreased physical fitness has been proven to be an independent risk factor for poor postoperative outcomes^[8]. Therefore, in the preoperative rehabilitation stage, we developed a personalized exercise plan according to the patient's actual situation, aiming to improve their functional reserve and ensure that they meet the operation in the best possible condition.

Preoperative Overall Nutritional Intervention

Research has found that preoperative nutritional status plays a crucial role in postoperative recovery. Malnutrition not only increases the incidence of postoperative complications but may also affect the overall prognosis of patients^[9]. Therefore, providing comprehensive nutritional intervention for patients is particularly important.

In this case, the responsible doctor and nurse conducted a nutritional risk screening within 24 hours after the patient's admission, identifying a risk of malnutrition with a nutrition risk score of 3 points. To ensure that the patient's nutritional status improved effectively, we invited experts from the nutrition department for a specialized evaluation and developed a personalized nutritional plan for the patient.

Working together with the nutrition specialist team, we formulated a scientific dietary plan, providing elemental diets and guiding the patient to choose high-quality protein, low-fat, and high-vitamin foods, ensuring adequate intake of proteins, various vitamins, and trace elements.

Standardized Pain Management

During the perioperative period, standardized and individualized pain management is crucial for the patient's recovery. Effective pain management not only reduces postoperative pain

but also promotes early oral intake and mobilization, thereby reducing postoperative complications^[10].

The patient underwent major abdominal surgery, which had a significant impact on the abdominal organs and tissues during the operation. Postoperatively, severe pain occurred when coughing or changing positions.

Before the surgery, a pain management team composed of anesthesiologists, general surgeons, and nurses was established to develop a personalized analgesia plan based on the type of surgery and the degree of anticipated postoperative pain.

To help the patient and their family better understand and cooperate with pain management, comprehensive health education was provided through various means such as videos, brochures, and seminars. The aim was to listen to the patient's needs, assess their psychological state, and eliminate misunderstandings and fears about postoperative pain^[11]. The nursing team also provided early mobilization education for the patient, postoperative position guidance, deep breathing relaxation therapy, distraction techniques, psychological care, and other methods to enhance recovery.

Diversified Health Education

From the time of admission to the day of surgery, diverse health education was provided, combining manuals and videos, with enthusiastic invitations for family members to participate. The entire process was structured around feedback-based health education to ensure its effectiveness.

Preoperative Education: The focus areas included disease and surgical knowledge, smoking cessation, lung function exercises, and diet management.

Postoperative Education: Key topics included pain management, early ambulation, diet, catheter management, and lung function rehabilitation.

Patients were educated about disease-related knowledge, and the surgical process and expected benefits were explained to both the patient and their family through simulation diagrams and other methods. Patients were encouraged to quit smoking and drinking while following a balanced diet rich in high-quality protein, low fat, and high vitamins.

By integrating these predictive nursing measures, the patient received comprehensive physical and psychological support, ensuring optimal surgical preparedness and postoperative recovery.

3.3 Intraoperative Nursing

Precise Drug Monitoring for Surgical Escort of Patients

Therapeutic drug monitoring (TDM) is an indispensable component of modern medicine. It involves measuring drug concentrations, pharmacological markers, or pharmacological indicators in a patient's body and utilizing advanced quantitative pharmacological models to customize the optimal drug treatment plan for each individual^[12].

The uniqueness of this procedure lies in the continuous administration of anticancer drugs directly to the liver tumor during surgery. During the operation, patients were administered fluorouracil and vancomycin. Precise drug concentration measurements were taken at multiple critical time points, ranging from before systemic perfusion to 24 hours after the completion of surgery.

Medical orders were rigorously verified to ensure sample accuracy, and blood drug concentrations were closely monitored throughout the process. The results were significant; postoperative

tumor necrosis was evident, and patients experienced no systemic chemotherapy-related side effects.

This monitoring approach not only provides valuable insights for clinical intervention but also offers a platform for scientifically interpreting pharmacokinetic data. It enables the development of more precise and rational drug treatment plans, ensuring the safety, efficacy, and cost-effectiveness of medication use^[13-14]. The ultimate goal is to provide patients with safer and more effective drug therapy, thereby achieving the best possible therapeutic outcomes.

3.4 Prevention and Observation of Postoperative Complications

Enhancing Liver Function Monitoring and Liver Protection Treatment

After liver resection, liver dysfunction becomes the most significant health threat to patients, as it is the most common and dangerous complication. The causes of this complication are numerous, including the obstruction of hepatic blood flow during surgery, blood loss, and the loss of liver tissue, all of which inevitably lead to postoperative liver damage^[15-1]. The following measures were implemented to mitigate this risk:

(1) In the first three days postoperatively, fasting blood draws were performed once daily. Thereafter, fasting blood was drawn every one to three days to ensure real-time monitoring of liver function, with additional tests conducted as needed.

(2) The patient's vital signs, mental status, skin and sclera color, as well as the presence of jaundice or ascites, were closely monitored. Sterile procedures were strictly followed to prevent infection. The patient's 24-hour fluid intake and output were accurately recorded, and abdominal circumference was measured daily.

(3) Biochemical indicators and liver function were closely monitored, with prompt correction of electrolyte imbalances. Special attention was paid to ALT and AST changes during the first two to three postoperative days, as these are sensitive indicators of hepatocyte mechanical injury.

(4) For liver protection therapy, anti-inflammatory, phospholipid, and chologogic drugs were administered per medical guidance. Patients were informed in detail about each medication's name, function, and potential side effects to ensure informed consent. Medication efficacy and adverse reactions were closely monitored, and treatment plans were adjusted accordingly. Studies have shown that combining different anti-inflammatory and liver-protective drugs may yield better therapeutic outcomes^[15-2].

Through meticulous nursing care, close liver function monitoring, and an active combination of hepatoprotective drugs, the patient did not develop liver dysfunction during hospitalization.

Coagulation Function Monitoring to Prevent Venous Thrombosis and Postoperative Bleeding

On the day of chemotherapy for liver cancer, immunotherapy, or major abdominal surgery, the patient's laboratory results showed: Hemoglobin (Hb): 77 g/L; International Normalized Ratio (INR): 1.76; Prothrombin Time (PT): 20.4 seconds; Fibrinogen (Fbg): 1.85 g/L (indicating coagulation disorders).

The drainage fluid contained blood, and the patient exhibited symptoms such as dizziness, weakness, tinnitus, palpitations, pale skin, pale conjunctiva, low blood pressure, and an increased heart rate. These symptoms indicated bleeding, necessitating immediate intervention.

To correct anemia, improve oxygen-carrying capacity, and supplement coagulation factors,

the patient received: 2U AB Rh(D) positive washed red blood cells (MAP); 800 ml virus-inactivated fresh frozen plasma; 10U cold-precipitated coagulation factor.

Vasopressors were administered to maintain blood pressure. The patient's postoperative Caprini thrombosis risk score was 6 points, indicating a high risk of deep vein thrombosis. To prevent this, multiple preventive measures were taken: Two daily pneumatic compressions; Skin color, temperature, and swelling assessments in both lower limbs every two hours. Continuous monitoring of consciousness and oxygen saturation; Close monitoring of D-dimer and platelet count^[16].

Additionally, vital signs, abdominal signs, and drainage fluid characteristics (volume, consistency, and color) were closely monitored. The drainage tube was properly secured to ensure unobstructed drainage. Under normal circumstances, blood drainage on the day of surgery should range between 100 and 300 mL; exceeding this range indicates a high risk of intra-abdominal bleeding.

Bone Marrow Suppression

Patients with a history of chemotherapy for liver cancer and immunotherapy are at risk of immune suppression. Since chemotherapy drugs were administered intraoperatively, vigilance for bone marrow suppression was necessary. Neutropenia, one of the primary complications of bone marrow-suppressive chemotherapy, represents the most dangerous hematological toxicity associated with such treatments^[17-1].

To mitigate bone marrow suppression, the following measures were taken: Strict adherence to medical advice, including the administration of usitastatin to improve systemic inflammatory responses; Comprehensive immune function tests, complete blood counts, and cytokine monitoring; Ensuring proper ward ventilation to maintain a fresh and clean environment; Limiting the number of caregivers and encouraging the patient to wear masks; Maintaining oral hygiene and skin cleanliness to prevent infections; Implementing stringent preventive isolation for patients with severely low white blood cell counts and performing daily air disinfection in the ward^[17-2].

Pleural Effusion Management

Pleural effusion is one of the most common pulmonary complications following hepatectomy, with an incidence ranging from 18% to 71%^[18-19]. Early identification and intervention are crucial to reduce complication rates.

Postoperatively, doctors and nurses assessed patients based on multiple factors, including smoking history, alcohol consumption, preoperative indocyanine green excretion test results, albumin levels, liver function indicators, surgical duration, and intraoperative blood loss—all of which can contribute to pleural effusion.

To prevent complications, early protein and diuretic supplementation were administered. Patients were closely monitored for symptoms such as coughing, breathing difficulties, chest tightness, and chest pain. Respiratory patterns and body temperature were regularly observed, and bedside chest X-rays and ultrasound examinations were performed as needed.

On postoperative day 4 (following Phase I of ALPPS combined with intraoperative liver isolation perfusion chemotherapy), ultrasound examination revealed a small amount of bilateral pleural effusion. After comprehensive evaluation, conservative treatment was adopted with dynamic follow-up ultrasounds. Concurrently, albumin supplementation, liver protection therapy, respiratory function exercises, and nebulization treatments were intensified.

On October 11, 2023, the patient was readmitted for further assessment. A CT scan showed a large right-sided pleural effusion. As a result, the patient underwent right thoracentesis and tube

placement for drainage.

On October 13, the second phase of ALPPS was successfully completed. A follow-up CT scan on October 18 showed a small residual pleural effusion on the right side, and by October 24, the right thoracic drainage tube was removed.

4 Conclusion

Through comprehensive postoperative monitoring, preventive interventions, and active management of complications, the patient successfully recovered without significant adverse events. These nursing strategies ensured timely detection and intervention for potential complications, optimizing the patient's surgical outcome and overall recovery.

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