Scientific Research Publishing

International Journal of Clinical Medicine, 2025, 16(7), 317-322
https://www.scirp.org/journal/ijcm
ISSN Online: 2158-2882
ISSN Print: 2158-284X

Practical Enlightenment from the Application of Central Venous Catheters in Neoadjuvant Chemotherapy for Osteosarcoma Patients

Xinyi Liang*, Xiaoqiong Zheng#

Sun Yat-sen University Cancer Center, Guangzhou, China
Email: 812266702@qq.com, #1006803256@qq.com

How to cite this paper: Liang, X.Y. and Zheng, X.Q. (2025) Practical Enlightenment from the Application of Central Venous Catheters in Neoadjuvant Chemotherapy for Osteosarcoma Patients. *International Journal of Clinical Medicine*, **16**, 317-322.
https://doi.org/10.4236/ijcm.2025.167022

Received: June 24, 2025
Accepted: July 21, 2025
Published: July 24, 2025

Abstract

Objective: Analyze the effects of central venous catheterization during neoadjuvant chemotherapy in osteosarcoma patients to derive enlightenment. **Methods:** Eighty osteosarcoma patients who received neoadjuvant chemotherapy in our hospital from January 2023 to December 2024 were selected as the observation objects. All these 80 osteosarcoma patients had central venous catheters (including PICC catheters and venous port catheters). Nursing care was provided to these patients, and practical insights were obtained through analysis. **Results:** Among the 80 osteosarcoma patients who underwent central venous catheterization, there was one case where the catheter was removed due to blockage, which caused poor fluid infusion and no blood return upon aspiration. Three patients had their catheters removed upon completion of the treatment course as per the doctor's orders. The remaining 76 patients continued to use their catheters, and regular maintenance and nursing care were promptly provided throughout the process. **Conclusion:** During the neoadjuvant chemotherapy for osteosarcoma patients, the use of central venous catheters can not only avoid the damage caused by repeated peripheral venous punctures, establish a good pathway for subsequent nutritional support, reduce the damage of chemotherapy drugs to peripheral blood vessels and the risk of drug extravasation, but also meet the intensive administration requirements of osteosarcoma neoadjuvant chemotherapy regimens. It is suitable for pediatric and adolescent osteosarcoma patients, bringing convenience to the treatment of osteosarcoma patients.

Keywords

Osteosarcoma, Chemotherapy, Central Venous Catheterization

*First author.
#Corresponding author.

1. Background

Osteosarcoma is a common malignant bone tumor that mostly affects children and adolescents. Its treatment requires a combination of surgery, radiotherapy, and neoadjuvant chemotherapy. As one of the common treatment modalities for malignant tumors, chemotherapy plays a crucial role in the comprehensive treatment of osteosarcoma. Its functions include sufficiently shrinking and necrotizing the primary tumor to facilitate complete local tumor resection and limb preservation, as well as eliminating potential microscopic metastatic lesions in the lungs. Postoperative chemotherapy continues to prevent tumor recurrence and metastasis, including neoadjuvant chemotherapy and adjuvant chemotherapy. Due to the special properties of chemotherapeutic drugs, their use in peripheral blood vessels easily causes drug extravasation, leading to tissue damage and necrosis, as well as skin and mucosal injuries. Most patients with malignant tumors require long-term intravenous chemotherapy, parenteral nutritional support, etc. Infusion devices have evolved from intravenous indwelling needles, central venous catheters, peripherally inserted central catheters (PICCs) to implantable venous ports, with continuous advancements in technology and safety [1]. Therefore, to ensure the safety of chemotherapeutic drug administration, the use of central venous catheters can not only reduce the pain caused by repeated punctures but also minimize the risk of chemotherapeutic drug extravasation, reduce damage to peripheral blood vessels, protect vascular function, alleviate patient suffering, and enhance treatment efficacy.

The principal aim of this study was to evaluate the effectiveness of central venous catheterization in osteosarcoma patients undergoing neoadjuvant chemotherapy, with the intention of offering valuable clinical insights. In this study, 80 osteosarcoma patients who underwent neoadjuvant chemotherapy via central venous catheter (e.g., PICC or central venous catheter) were enrolled as the research cohort. Detailed clinical data were collected through retrospective medical record review, followed by systematic analysis to explore the application outcomes of central venous access in neoadjuvant chemotherapy and reflect on potential complications. The details are as follows.

2. Clinical Data

2.1. General Data

Subject Recruitment and Clinical Characteristics

A total of 80 osteosarcoma patients treated at the Sun Yat-sen University Cancer Center between January 2023 and December 2024 were enrolled in this prospective observational study. Inclusion criteria comprised: 1) pathologically confirmed osteosarcoma; 2) placement of central venous access devices (CVADs), including peripherally inserted central catheters (PICCs) or implantable venous ports (IVPs); 3) requirement for neoadjuvant chemotherapy; and 4) written informed consent from patients or their legal guardians. Exclusion criteria were: 1) refusal of chemotherapy; 2) absence of CVAD placement; or 3) incomplete med-

ical records.

Device Placement Outcomes

All 80 patients successfully received CVADs, with a technical success rate of 100%. Specifically, 11 patients (13.8%) were fitted with PICCs, while 69 (86.2%) received IVPs. Demographic analysis revealed 49 males (61.3%) and 31 females (38.7%), with an age range of 7 - 70 years (mean ± SD: 22.9 ± 13.4 years).

Complications and Device Management

During the observation period, one IVP (1.25%) was explanted due to irreversible occlusion, characterized by impaired fluid infusion and inability to aspirate blood. Three additional devices (3.75%) were electively removed post-chemotherapy completion per-protocol. The remaining 76 devices (95.0%) remained in use, with routine maintenance adhering to institutional guidelines. Prolonged indwelling duration (>2 years) was achieved in 11 cases (13.8%), with a median catheter retention time of 19.5 months (interquartile range: 12.3 - 24.8 months).

2.2. Insertion Method

The 11 patients with indwelling PICC catheters were uniformly inserted by professional staff in the catheter clinic. The 69 patients with indwelling venous port catheters were inserted by anesthesiology professionals in the operating room under local or general anesthesia. The base of the venous port was fixed in the subcutaneous tissue of the left/right anterior chest of the patient.

3. Nursing Measures

3.1. Pre-Catheterization Surgical Knowledge Education

Before inserting a central venous catheter for osteosarcoma patients, relevant medical staff should inform the patient and family members in advance of the catheterization purpose, insertion method, cost, expected efficacy, and post-procedure precautions. It is essential to fully educate them about central venous catheterization to enhance their understanding, thereby reducing or eliminating their concerns and fears. Key advantages of central venous catheters should be emphasized, including: Reducing pain and risks from repeated peripheral punctures or blood sampling; Significantly decreasing the risk of chemotherapeutic drug extravasation; Protecting peripheral veins; Allowing normal daily activities; Providing long-term convenience for subsequent treatments, improving therapeutic outcomes, and enhancing quality of life.

3.2. Nursing Care during Treatment

3.2.1. Usage Method

After the position of the PICC catheter is confirmed by radiography, the operator should wash hands, wear sterile gloves, disinfect the catheter interface, replace the positive pressure connector (no need to replace if not due), connect the pre-filled catheter or use 10 mL normal saline to aspirate blood smoothly, then perform pulsatile flushing. During the maintenance of the venous port, nursing staff

should prepare relevant supplies, first palpate for positioning: find the implanted Port base, confirm no displacement or redness/swelling of the injection seat, wear sterile gloves, fix the port body with the thumb, index finger and middle finger of the non-dominant hand, and the dominant hand holds the non-coring needle to insert vertically from the center of the port body [2]. until touching the bottom metal diaphragm, aspirate to confirm blood return (proving unobstructed catheter), then connect the pre-filled catheter or use 10 mL normal saline for pulsatile flushing.

3.2.2. Catheter Fixation

PICC (Peripherally Inserted Central Catheter): Transparent dressing + "S" shaped curvature + StatLock® (preferred) or 3M™ tape for external fixation. Implanted Venous Port: After successful puncture: Place a gauze under the winged needle for fixation (avoid covering the puncture site), Secure with a transparent dressing. Fix the lower segment with 3M™ tape, and mark the date and operator.

3.2.3. Undergo Neoadjuvant Chemotherapy

After catheterization, before administering medications to the patient, it is necessary to confirm that the chemotherapy consent form is consistent with the medical orders, whether the informed consent form is correctly signed, and whether the medical orders and dosage are correct and compliant. When administering medications, infuse at the connection between the connector and infusion tube. First, aspirate to check for blood return, flush with normal saline using a pulsatile technique, then administer the therapeutic drugs. During the patient's chemotherapy, nursing staff should carefully verify the medications and strengthen rounds to observe the injection site for redness, swelling, or induration, Check whether the transparent dressing is exuding fluid or loose, with special attention to any drug extravasation. In case of extravasation, discontinue the medication immediately and address the issue promptly. Meanwhile, enhance health education during medication administration to make patients and family members aware of the risks of chemotherapeutic drug extravasation. The transparent dressing for PICC catheters should be normally replaced weekly. The winged needle and transparent dressing of the infusion port need to be replaced weekly when due. The catheter can be removed upon the patient's discharge or at the end of the treatment course.

3.2.4. Flushing and Sealing Methods

For PICC catheters, use a 10 mL or larger syringe (avoid small syringes to prevent high pressure from damaging the catheter) and flush the line using a pulsatile technique. Catheter Sealing (at the end of treatment or during maintenance): Ordinary Patient: 0.9% normal saline (5 - 10 mL). Patients at high risk of hypercoagulation: Heparin sodium saline (10 U/mL) for positive pressure catheter sealing. For implanted venous ports, use a 10 mL or larger syringe and inject 10 mL of normal saline using a pulsatile technique. Catheter Sealing (at the end of treatment or during maintenance), selection of catheter sealing solution, Heparin sodium saline (100 U/mL) for positive pressure catheter sealing.

3.3. Discharge Instructions

After the patient is discharged from the hospital following the completion of treatment, it is necessary to continue strengthening nutritional support, maintaining an optimistic attitude, paying attention to personal and household hygiene, minimizing visits to crowded public places, avoiding various infectious factors. During the intermission period, consume more high-protein and high-vitamin foods (such as eggs, lean meat, vegetables, and fruits) to promote the healing of the puncture site. Patients with an indwelling PICC catheter should avoid folding or twisting the catheter, and prevent compression of the limb on the catheterization side during sleep. They should return to the hospital weekly for catheter maintenance. In case of abnormal conditions such as redness, swelling, heat, pain at the puncture site, fever, or turbid fluid in the catheter, immediate medical attention is required. For patients with a venous port, they should return to a medical institution monthly for flushing maintenance. In daily life, avoid impact, compression, or sharp injury to the implanted site, and refrain from repeatedly pressing or scratching the port area with hands. When the catheterization site shows swelling, redness, pain, or when experiencing unexplained hypotension, chills, and fever, seek medical attention promptly [3]. During the period with the catheter in place, if the patient experiences anxiety or discomfort, they can communicate with medical staff in a timely manner or alleviate emotions by diverting attention.

4. Discussion and Reflection

One of the most distressing aspects of cancer therapy is the necessity for repeated painful venous punctures to administer cytotoxic agents, antibiotics, blood products, and nutritional supplements [4]. During neoadjuvant chemotherapy for osteosarcoma patients, the use of central venous catheterization not only avoids the damage caused by repeated peripheral venous punctures, establishes a good pathway for subsequent nutritional support, reduces the damage of chemotherapeutic drugs to peripheral blood vessels and the risk of drug extravasation, but also meets the intensive administration requirements of neoadjuvant chemotherapy regimens for osteosarcoma. It is suitable for pediatric and adolescent osteosarcoma patients, bringing convenience to the treatment of osteosarcoma patients. Central venous catheterization is not only a powerful assistant in tumor treatment, but also a dual guarantee for the safety and efficacy of clinical treatment. In terms of nursing and management, it balances operational convenience with infection prevention and control, simplifies the nursing process to a certain extent, and reduces the risk of local infection caused by repeated peripheral punctures. By optimizing treatment safety, convenience, and patient experience, central venous catheterization has become an indispensable part of comprehensive tumor treatment. Under the management of a professional medical team, it maximizes its value by improving patient quality of life in multiple dimensions. Among them, the fully implantable venous port has been gradually promoted and applied in clinical practice due to its advantages of fewer punctures, protection of venous vessels, reduction of

patient pain, long indwelling time, and aesthetic appearance [5]. It is especially suitable for tumor chemotherapy patients who require long-term and repeated treatment, providing convenience for tumor treatment. Patients with indwelling venous ports can maintain a normal life, effectively improving their quality of life and treatment outcomes [6]. It has important promotional value in the clinical treatment of tumor patients and is worthy of vigorous promotion [7].

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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